Appendix E

Preliminary Business Case Report

City of San José DOT

San José International Airport Automated Transit Network Feasibility Study

Preliminary Business Case Report

October 17, 2012

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 214-704

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Disclaimer

This preliminary set of draft findings are issued and produced by Arup for the benefit of the City of San José (City) under the terms of Arup's agreement with the City dated September 17, 2011 for transportation planning and design services relating to the San José Automated Transit Network.

The Arup consulting team has used information received from a range of sources, including information provided by the City and benchmarking data from similar projects. Any statements or findings contained within this report are all based upon this information. In the course of Arup's evaluation of the San José Automated Transit Network, Arup provides no assurance as to the accuracy of any such information, and bears no responsibility for the results of any actions taken on the basis of these initial findings.

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1 Executive Summary

1.1 Project Vision
1.2 Purpose
1.3 Background
1.4 Evaluation Criteria and Methodology
1.5 Evaluation Results
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1 Executive Summary

1.1 Project Vision

The City of San José (City) Department of Transportation is evaluating the feasibility of developing an Automated Transit Network (ATN or Project) in and around the Norman Y. Mineta San José International Airport (Airport). An ATN is an "on-demand" (i.e., no schedule, responsive to passenger travel requirements) system of small (2–6-passenger), computer-controlled (driverless) vehicles operated on or suspended below an elevated guideway.

This Project aligns with the City's "Green Vision" and environmental, transportation, and economic development goals. In addition, the Project would improve the convenience and capacity of public access to and from the Airport. The City would also like to reinforce its reputation as a center of innovation and capitalize on the strength of the local high-tech industry, by leading the adoption of new technology and identifying creative strategies to finance the delivery of those improvements.

The Project consists of a 6.4 linear-mile alignment with a combination of at-grade and elevated concrete structures. The system includes 10 stations connecting the Airport terminals, the car-rental facility, and two parking lots with Santa Clara Valley Transportation Authority (VTA) Light Rail line towards the east and Caltrain commuter rail and planned Bay Area Rapid Transit District (BART) station toward the west. It is expected that by 2030 the Project would accommodate an overall passenger-carrying capacity of approximately 14,000 users per day.

1.2 Purpose

The purpose of this Preliminary Business Case is to support the City's decision-making process on whether to move forward to the next stage of the Project (i.e., detailed planning, engineering, technology assessment, and procurement, etc.) and, if so, to determine the range of viable project development options. This study presents a high-level cost comparison of the ATN to other modes of transportation.

1.3 Background

This Project is being completed in partnership with the Airport and the VTA. An ATN, also referred to as Personal Rapid Transit (PRT), is an innovative, emerging transit-system concept.

There are several ATNs in operation worldwide. In 2011, three systems commenced operations at London Heathrow Airport, in Masdar City (Abu Dhabi) and at Rovisco Pais Hospital (Portugal) and another one is under construction in Suncheon, South Korea. As per Aerospace's report titled "Automated Transit network Feasibility Evaluation – San José Mineta International Airport" and dated

August 7, 2012, the ATN technology has not been fully deployed on the scale required for the San José application. Current ATN systems serve several low-volume stations in a linear or "WYE" configuration. The San José application would consist of 10 stations, two of which with high-volume and all of which would be connected via a network that allows passengers to travel nonstop to any point within the network. Therefore, the technology requires further development to demonstrate its ability to deliver the passenger-carrying capacity required for the network of stations contemplated for this Project.

The purpose of the study commissioned by the City (Feasibility Study) is to determine the feasibility of the ATN to perform the role of an Airport Transit Connector (ATC). The Project seeks to fulfill the 2000 Measure A ballot provision to study the feasibility of an automated transit system to connect the Airport terminals with the VTA light rail, Caltrain and BART and potentially points in between.

For the Feasibility Study, the City selected two consultants, Arup North America Ltd (Arup) and The Aerospace Corporation (Aerospace), to initially assess the feasibility of using an ATN as the ATC. The planning, design, technology, regulatory, approvals, and environment assessment are outside the scope of this Preliminary Business Case, but these aspects are considered in the Arup Feasibility Study Final Report or elsewhere. The Preliminary Business Case will reference these other reports when necessary.

1.4 Evaluation Methodology

This Preliminary Business Case uses quantitative and qualitative methods to evaluate the Project's feasibility from a funding perspective. The quantitative assessment was undertaken as a "funding gap" analysis recognizing that a more complete financial analysis will be undertaken during the next stage of the Project's development.

In the context of this report, the funding gap is the difference between project costs and the revenues currently available to fund the construction and operations of the Project. A risk-adjusted cash flow model was built to estimate a range of the funding gap. The funding gap range was developed using three scenarios considering different risk confidence levels and sensitivities.

The qualitative assessment evaluated five characteristics of the Project that were considered key to deliver the Project but were not quantitatively measurable. These included (1) the compliance with Measure A funding requirements, (2) the affordability compared to alternative systems, (3) the minimization of overall uncertainty, (4) the maximization of "equity of use" and (5) maximization of revenue potential without compromising the "equity of use".

Finally, Arup evaluated potential strategies to develop the Project from initial feasibility to commencement of operations and identified the areas to focus on at the next stage of the Project's development.

1.4.1 Quantitative Evaluation Methodology

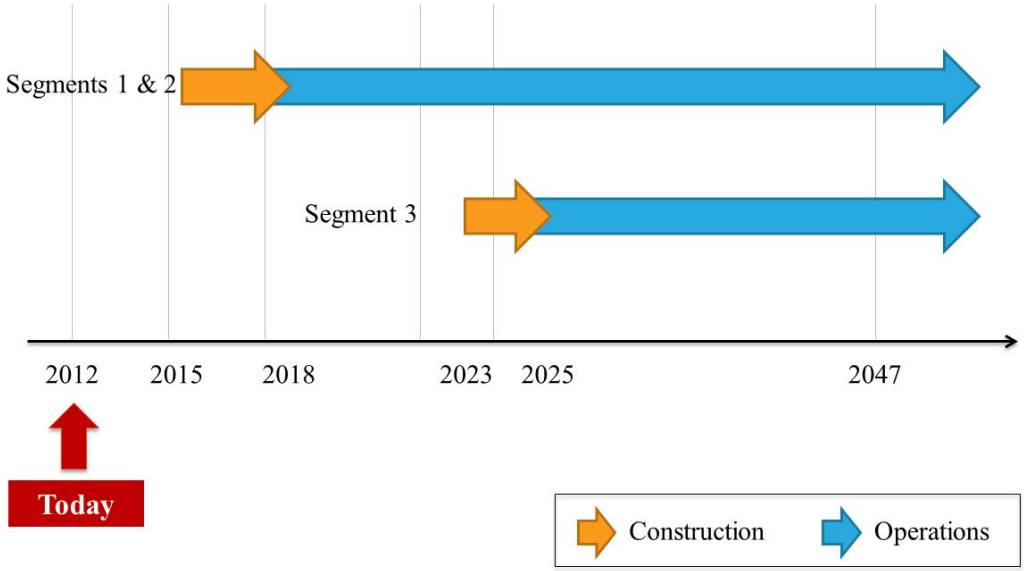
For the purpose of this analysis, the following Project timeline was assumed:

- The Project would start construction in 2015, after a 3-year development and procurement period starting in 2012.
- The overall Project forecast would then last 33 years, which accounts for a 3-year initial construction period and a 30-year operation period.
- Segments 1 (2.7 miles) and 2 (1.3 miles) would be built together between 2015 and 2018. They would begin operations in 2018 and continue operations through the end of 2047.
- Construction of Segment 3 (2.4 miles long) would begin in 2023. Despite longer guideways, it would only take 2 years to complete (i.e., 1 year less than Segments 1 and 2) due to the simpler layout. Operations would begin in 2025 to coincide with the commencement of BART service to Santa Clara station.

For the purpose of this analysis, the operating costs and revenues have been considered through the end of 2047. However, the system's operations would continue beyond that date.

Figure 1 illustrates the timeline assumptions for the purpose of this analysis.

Figure 1: Project Timeline [(1)]



Source: Arup

[(1)] An operating period of 30 years has been assumed for this analysis (i.e., 2018–2047) to account for at least one full cycle of vehicle replacement for all three segments.

The Project consists of a 6.4 linear-mile alignment with a combination of at-grade and elevated concrete structures and 10 stations. Arup developed baseline cost estimates for the construction and operation of the Project. These estimates are based on benchmark data and project-specific bottom-up analysis.

In line with industry best practices, Arup assessed Project risks for the likelihood of occurrence and potential cost or schedule impact. Three scenarios were simulated, each defined by different confidence levels: the Optimistic Case, the Most Likely Case, and the Pessimistic Case.

In collaboration with the City, Arup identified potential revenues from the following sources to support the operations and maintenance of the Project:

- Annual Airport operations budget savings from the discontinuation of the current Airport shuttle bus services that would be completely replaced by the ATN services ("Bus Savings")
- Incremental parking revenue associated with the increased demand for the ATN system
- Advertisement on the ATN system

At this time, the City has not identified funding sources to support the construction of the Project.

For the revenue estimates it was considered appropriate to use sensitivities applied on the Bus Savings component of the potential revenue sources listed above.

Table 1 below provides a summary of the assumptions used in the three scenarios. Discussions with the City indicated that the Most Likely Case was the scenario that best aligned with the City's cost and risk preferences and therefore would be the basis for Arup's conclusions and recommendations.

Table 1: Scenario Definition

Scenario	Description	Assumptions
Optimistic Case	Reflects the view generally taken by construction builders and implies a 70% chance that the costs will be higher than the value presented	▪ Risk-adjusted construction costs @ 30th percentile ▪ Risk-adjusted operating costs @ 30th percentile ▪ Bus Savings sensitivity @ +25%
Most Likely Case	Reflects the view generally taken by the Federal Transit Administration (FTA) and implies a 20% chance that the costs will be higher than the value presented	▪ Risk-adjusted construction costs @ 80th percentile ▪ Risk-adjusted operating costs @ 80th percentile ▪ No Bus Savings sensitivity
Pessimistic Case	Reflects the view generally taken by lenders and implies a 5% chance that the costs will be higher than the value presented	▪ Risk-adjusted construction costs @ 95th percentile ▪ Risk-adjusted operating costs @ 95th percentile ▪ Bus Savings sensitivity @ -25%

Source: Arup

Finally, in order to estimate a funding gap range, a cash flow model was created for each scenario, comparing the Year-Of-Expenditure (YOE) (i.e., indexed) risk-adjusted construction, operations and maintenance costs with forecasted revenues over the assumed 33-year life of the Project.

1.4.2 Qualitative Evaluation Methodology

In collaboration with the City, Arup identified a number of overarching delivery objectives for the Project grouped into four main areas: technology, procurement, transportation, and funding/financing.

Working with the City five Project Delivery Objectives were prioritized and evaluation criteria were defined for each of these in order to assess the Project. Table 2 summarizes the Project Delivery Objectives and related evaluation criteria.

Table 2: Project Delivery Objectives and Evaluation Criteria

Project Delivery Objectives	Evaluation Criteria
1. Be compliant with VTA and Measure A funding requirements	▪ The Project should fulfill the Measure A requirement to build an automated rail connection between the Airport and the VTA, Caltrain, and BART systems.
2. Be affordable when compared to alternative systems	▪ Ongoing operations and maintenance costs should be comparable to or less than the costs of operating existing shuttle bus services. ▪ Construction costs should be comparable to or less than the APM option previously considered.
3. Minimize overall Project uncertainty (e.g., technology, regulatory approvals)	▪ The Project risk profile should be at a level acceptable to the City and there should be no apparent "fatal flaws." [(1)]
4. Maximize access and "equity of use" (e.g., for economically disadvantaged groups and Airport staff)	▪ The Project should not collect fares from the general public or Airport staff.
5. Maximize revenue potential without compromising access and "equity of use"	▪ All viable commercial revenue sources, other than fares, should be considered.

Source: Arup

[(1)] A "fatal flaw" is a technical or financial factor that would rule out proceeding with the Project to the next level of evaluation. A technical fatal flaw may involve the ATN technology, the Project's physical context, alignment or ridership. A financial fatal flaw may involve the City's affordability limit with regards to operations and maintenance costs and construction costs. An absence of apparent fatal flaw at this stage is not a recommendation to proceed but rather an absence of evidence that would bar the Project from proceeding to the next level of evaluation.

1.5 Evaluation Results

1.5.1 Quantitative Results

1.5.1.1 Funding Gap Analysis

The results of the funding gap analysis are summarized in Table 3 and include the effect of inflation from 2012 to 2047 (i.e., YOE dollars).

The funding gap assessment has been conducted to differentiate between the construction and operation period of the Project. This is because potential restrictions exist for different sources of funds. Federal grants may only be used for construction projects while saving generated from discontinued shuttle bus services may only be used for operating the Project.

Based on the Most Likely Case, which best reflects the City's cost and risk preferences, the results indicate that:

- The funding identified for the Project's operations (i.e., bus savings) is greater than the estimated operations and maintenance costs (i.e., there is no funding shortfall during operations).[1]
- A significant construction funding gap would need to be overcome to build the project given that no capital funding has been committed yet.

Table 3: Quantitative Assessment Summary (YOE Dollars)[(1)]

	Optimistic Case (YOE $, Million)	Most Likely Case (YOE $, Million)	Pessimistic Case (YOE $, Million)
Average Annual Operations Funding Surplus / (Gap)	9	1	(6)
Construction Funding Surplus / (Gap) [(2)]	(747)	(1,019)	(1,205)

Source: Arup
[(1)] The assumed base date is January 1, 2012 for indexation purposes.
[(2)] This analysis does not include possible private financing costs as it assumes that construction will be funded by public sources (local, state and federal). As noted elsewhere in the report, the option to use private financing as part of a possible project development and procurement strategy will be considered in the next phase of the studies.

1.5.1.2 Transportation Mode Comparison

As shown in Table 4, Arup has also conducted a high-level cost comparison of the ATN system was made with shuttle buses and Automated People Mover (APM) modes of transportation. The APM option was previously considered by the City, under a separate study by another consultant team. The APM comparison in this study represents the route that was the most analogous to the ATN route. Please see Arup's memorandum titled "San José ATN Feasibility Study Cost Comparison Methodology", which provides further details on how the APM risk-adjusted costs were derived.

The comparison shows that there is no apparent financial fatal flaw with the Project since the ATN system, based on the Most Likely Case, meets Project Delivery Objective 2 of affordability by offering:

- Operations and maintenance costs that are comparable to the cost of operating existing shuttle bus services
- Construction costs that are lower than the APM option.

In addition, the ATN system offers improved passenger experience and level of service.

[1] Subsequent to the preliminary business case analysis, the Airport reduced its shuttle bus budget for FY 2012-2013. If the City were to move forward with this project at some time in the future, all potential revenue sources would be reevaluated at that time.

Table 4: ATN, Shuttles Buses, and APM Cost Comparison in 2012 Dollars

Mode	Risk-Adjusted Construction Costs (2012 $, Million)	Annual Operations and Maintenance Base Costs (2012 $, Million)	Comments
ATN system	758 [2]	10	▪ Waiting time generally less than 1 minute ▪ On-demand point-to-point travel ▪ Reduced walking distance due to 10 passenger stations ▪ Passenger experience: Excellent e.g., improved wait time, travel time, comfort, point-to-point service
Shuttle Buses	N/A	10	▪ Longer travel times for Airport shuttle buses and VTA Flyer Line 10 ▪ Longer headways [5] for VTA Flyer Line 10 (15-20 minutes) ▪ Stops at all stations
Airport People Mover [3]	967 [4]	Estimates not available for comparison purposes [1]	▪ Passenger experience: Good, but service limited to half the locations of the ATN or shuttle bus services ▪ Headway [5] 2 minutes on routes between the terminal stations and 4 minutes on routes to Caltrain and VTA ▪ Stops at 5 passenger stations and would not serve Lot 4 Daily Parking

Source: Arup, Airport FY 2011–12 budget, and San Jose International Airport APM Projects Conceptual Cost Estimate (September 2001)

[1] Operations and maintenance cost comparison were not available from previous studies.

[2] Most Likely Case, expressed in 2012 dollars (note that Table 3 costs are expressed in YOE dollars)

[3] An underground option was explored in 2001, which assumed free transfer of tunnel boring machines from the BART extension project. The route used for comparison here is based on the alignment around the Northern end of the airfield and does not use tunnel boring machines.

[4] Includes 40% categorical risk contingency, which is significantly less than the ATN categorical risk contingency (based on the Most Likely Case, 134%). This is due to the fact that the APM is a proven technology with a track record and regulatory approval in the United States.

[5] Headway is defined as the interval time between vehicles.

1.5.2 Qualitative Results

Based on the evaluation of the City's Project Delivery Objectives, summarized in Table 5, in order to proceed with the next stage of the Project as it is currently planned, the priority should be to reduce the Project uncertainty to an acceptable level for the City and prepare an adequate funding plan to address the funding gap identified. At that point a financing and procurement method assessment can be made.

Table 5: Qualitative Assessment Summary

Project Delivery Objectives	Evaluation Criteria	Evaluation Results
1. Be compliant with VTA and Measure A funding requirements	▪ The Project should fulfill the Measure A requirement to build an automated rail connection between the Airport and the VTA, Caltrain, and BART systems.	Objective met: ▪ The Project achieves VTA criteria to date.
2. Be affordable when compared to alternative systems	▪ Ongoing operations and maintenance costs should be comparable to or less than the costs of operating existing shuttle bus services. ▪ Construction costs should be comparable to or less than the APM option previously considered.	Objective met: ▪ The Project achieves both criteria within reasonable range. (See section 1.5.1 Quantitative Results above).
3. Minimize overall Project uncertainty (e.g., technology, regulatory approvals)	▪ The Project risk profile should be at a level acceptable to the City and there should be no apparent fatal flaws.	Objective not met: ▪ There are no apparent fatal flaws. ▪ The ATN technology requires further development (1) ▪ The cost and risk analysis conducted in this study conservatively estimates the technology and Project-specific risks at this point of development of the ATN technology.
4. Maximize access and "equity of use" (e.g., for economically disadvantaged groups and Airport staff)	▪ The Project should not collect fares from the general public or Airport staff.	Objective met: ▪ The Network provides direct connection to public transit; no fares assumed for users.
5. Maximize revenue potential without compromising access and "equity of use"	▪ All viable commercial revenue sources, other than fares, should be considered.	Objective met: ▪ No fares assumed, but all viable alternative revenue sources have been considered (e.g., advertising).

Source: Arup

(1) As per Aerospace's report titled "Automated Transit network Feasibility Evaluation – San José Mineta International Airport" and dated August 7, 2012.

1.6 Conclusions and Recommendations

As explained in section 1.2.1, the conclusions and recommendations of the Preliminary Business Case are based on the Most Likely Case, which best reflects the City's cost and risk preferences.

1.6.1 Conclusions

The quantitative and qualitative assessments have demonstrated that there is no apparent fatal flaw with the Project. In this context, it is important to consider that the quantitative cost and risk analysis conducted in this study have conservatively estimated the technology and Project-specific risks at this point of development of the ATN technology. In particular, the following conclusions can be drawn:

- The Project is self-sustaining during the operations phase and generates an average annual operating surplus of $1 million (YOE dollars) relative to the potential revenue sources considered in this study. However, with no capital funding committed or identified for the Project to date, a $1 billion (YOE dollars) construction funding gap would have to be overcome to build it. The City should prepare a robust Project funding plan to address this gap in construction funding.
- When compared to alternative modes of transportation systems, there is merit to explore the Project as a viable alternative because the estimates are that it has lower construction costs than the previously considered APM project, in addition to offering improved connectivity (i.e. twice as many passenger stations), passenger experience, and level of service.
- As shown in Table 5 above, the Project meets four of the City's five Project Delivery Objectives (Project Delivery Objectives 1, 2, 4, 5) and there are no apparent technical (i.e., technology, physical context, alignment, ridership) or financial (i.e., breach of the City's affordability limit) fatal flaws. An absence of apparent fatal flaw at this stage is not a recommendation to proceed but rather an absence of evidence that would bar the Project from proceeding to the next level of evaluation.
- As per Aerospace's report titled "Automated Transit network Feasibility Evaluation – San José Mineta International Airport" and dated August 7, 2012, the ATN technology requires further development to demonstrate its ability to deliver the passenger-carrying capacity required for the network of stations contemplated for this Project.
- The uncertainty levels are within the expected benchmark range for a project of this complexity, technology track record, and level of design development; but inherent in any project are unrecognized risks, which may change the expected results. As the Project is further developed these uncertainties can be further identified and mitigated and the contingency levels reduced.

During the next stage of the Project Arup recommends that the City focus its effort to address the following key Project development tasks that are considered critical for its success:

1. Demonstrate readiness of the ATN technology to meet the Project's specific requirements.
2. Engage the ATN technology industry's availability and ability to deliver.
3. As the technology is further developed, identify strategies to optimize the Project costs and mitigate risks and uncertainties.
4. Prepare a robust capital funding plan.
5. Develop a plan to resolve regulatory, environmental, and stakeholder approvals.

Arup has identified possible development options in Section 4 to address these key Project development tasks.

1.6.2 Recommendations

1.6.2.1 Project Development Options

In order to develop the Project further, Arup has considered four possible development options. These options are strategies to address the first four key Project development tasks identified above. The last Project development task (i.e., regulatory, environmental, and stakeholder approvals) is outside the scope of this report, but Arup recognizes this should be addressed in parallel. It will have a critical impact on the schedule for delivering the Project and gaining the appropriate level of political/public support.

For analysis purposes, each of the following development options has been considered independently, but in practice, they may have shared components:

- Option 1: The ATN industry leads the market with its own research and development, plus the experience gained from delivering other projects around the world (i.e., the City waits for the market to mature).
- Option 2: The City and any other collaborating agencies, leads a research and development program.
- Option 3: The City and any other collaborating agencies, and the ATN industry collaborate with shared costs and benefits. Note that this option has two sub-options, namely, Option 3A – "Preferred Supplier" and Option 3B – "Industry Collaboration".
- Option 4: The City prepares an RFP for a "starter project" that can be delivered with the current technology and industry delivery capabilities.

1.6.2.2 Project Development Recommendation

Following several Project team workshops with the City, Arup evaluated the relative merits of each development option. Arup recommends Option 3A – "Preferred Supplier" in order to address the Project development tasks identified.

The Project is a transportation project with significant innovation of technology and type of service it provides. There are no standard approaches for development and procurement for delivering the Project. As identified above, this Project will involve a significant amount of development, requiring a creative approach in order to deliver it successfully.

The key aspect of the recommended approach is to engage industry effectively in order to advance the Project's feasibility. This approach would allow a "client" and "supplier" to focus on a particular project in order to advance the understanding of technology readiness and the industry's delivery capabilities.

In addition, this approach would demonstrate commitment and willingness to succeed on both sides. Based on Arup's discussions with industry suppliers during the 2011 Request for Information process, the ATN industry is willing to engage in collaborative efforts, within commercially feasible limits, in order to advance the technology.

The primary benefits of this option are the ability to maintain a constructive and collaborative engagement with the Preferred Supplier, while respecting intellectual property rights and / or commercially sensitive information. The Preferred Supplier approach should lead to more efficient progress and incorporate innovation early in the process.

The recommended next steps are summarized in Section 5.

2 Introduction and Methodology

2.1 Introduction
2.2 Background
2.3 Project Description
2.4 Evaluation Methodology

2 Introduction and Methodology

2.1 Introduction

2.1.1 Purpose

The purpose of the study commissioned by the City of San José (Feasibility Study) is to determine the feasibility of the ATN to perform the role of an Airport Transit Connector (ATC). The Project seeks to fulfill the 2000 Measure A ballot provision to study the feasibility of an automated transit system to connect the Airport terminals with VTA's light rail service towards the east with Caltrain commuter rail service (Caltrain) and BART toward the west, and potentially points in between. This study is focused specifically on the ATN mode of transportation, and generally does not compare the ATN technology to other modes.

For the Feasibility Study, in 2010 the City selected two consultants, Arup North America Ltd (Arup) and The Aerospace Corporation (Aerospace), to initially assess the feasibility of using an ATN as the ATC.

The purpose of this Preliminary Business Case is to support the City's decision-making process on whether to move forward to the next stage of the Project (i.e., detailed planning, engineering, technology assessment, and procurement, etc.) and, if so, to determine the range of viable project development options. This study presents a high-level cost comparison of the ATN to other modes of transportation.

The planning, design, technology, regulatory, approvals, and environment assessment are outside the scope of this report, but these aspects are considered in the Arup Feasibility Study report or elsewhere. The Preliminary Business Case will reference these other reports, where necessary.

2.1.2 Report Structure

The approach to the analysis for this report is reflected in the diagram structured as follows:

Figure 2: Report Structure

Source: Arup

2.2 Background

2.2.1 Project History

The City and VTA had originally considered building an APM. The preferred alignment considered was a 1.5-mile tunnel under the Airport runways to connect the Airport to VTA light rail and Caltrain stations. This option was eventually discarded in 2008 because of its cost.

After completing an industry Request for Information (RFI) process in 2008, the City decided to explore the ATN as an alternative option to achieve the Measure A requirements.

2.2.2 Automated Transit Network Technology

An ATN is an "on-demand" (i.e., no schedule, responsive to passenger travel requirements) system of small (2–6-passenger), computer-controlled (driverless) vehicles operated on or suspended below an elevated guideway.

An ATN does not have a scheduled or fixed route. Vehicles wait at stations for passengers to arrive. Passengers decide when and where to go in the fixed guideway network and depart within seconds of arriving at a station. Stations are off the main line, so vehicles do not need to stop at intermediate stations. Computers identify the optimum route to a given destination and avoid collisions by ensuring a safe distance between vehicles.

There are several ATNs in operation worldwide. In 2011, three systems commenced operations at London Heathrow Airport, in Masdar City (Abu Dhabi) and at Rovisco Pais Hospital (Portugal) and another was under construction in Suncheon, South Korea. As per Aerospace's report titled "Automated Transit network Feasibility Evaluation – San José Mineta International Airport" and dated August 7, 2012, the ATN technology has not been fully deployed on the scale required for the San José application. Current ATN systems serve several low-volume stations in a linear or "WYE" configuration. The San José application would consist of 10 stations, two of which with high-volume and all of which would be connected via a network that allows passengers to travel nonstop to any point within the network. Therefore, the technology requires further development to demonstrate its ability to deliver the passenger-carrying capacity required for the network of stations contemplated for this Project.

2.3 Project Description

2.3.1 Location

The Project is located in and around the Norman Y. Mineta San José International Airport (Airport). The Airport is located in the heart of Silicon Valley, the center of global technology innovation, two miles from downtown San José. The Airport is a completely self-supporting enterprise owned and operated by the City of San José. San José is Northern California's largest city, and the tenth largest city in the United States. The Airport serves approximately 30,000 passengers per day and approximately 8 million passengers per year.

Figure 3: Project Location

Source: http://www.airports-guides.com/

2.3.2 Project Scope

The Project consists of a 6.4 linear-mile alignment with a combination of at-grade and elevated concrete structures. The system includes 10-station system connecting the following:

- Airport's Terminal A and its parking garage (Terminal A)
- Airport's Terminal B and Consolidated Rent-A-Car (ConRAC) garage (Terminal B)
- Surface parking lot north of Terminal A (Economy Lot 1)
- Surface parking lot south of Terminal B (Daily Lot 4)
- VTA Metro/Airport light rail station
- Santa Clara future BART station

The Project has been split into three Segments that correspond to distinct portions of the ATN alignment. These Segments may be concurrently or consecutively built. The phasing assumptions used for the quantitative analysis are detailed in Section 2.4.3.2.

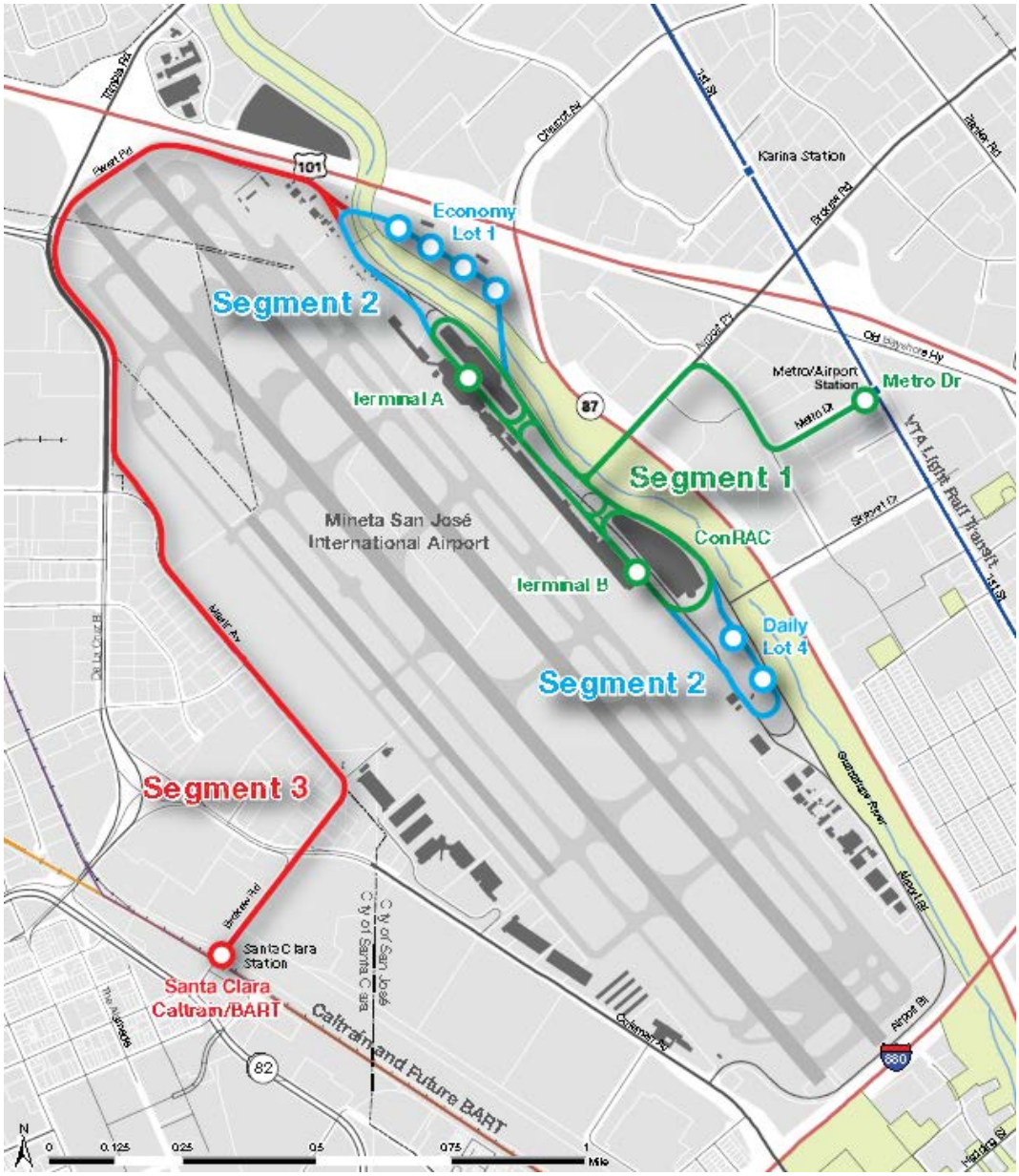
Table 6 below describes how the ATN alignment and stations have been split between each Project Segment. Figure 4 provides an illustration of the ATN alignment per Segment.

Table 6: ATN Alignment per Segment

Segment	ATN Alignment and Stations	ATN approximate length
Segment 1	▪ Metro/Airport VTA Station ▪ Terminal A ▪ Terminal B	2.7 miles
Segment 2	▪ Economy Lot 1 ▪ Daily Lot 4	1.3 miles
Segment 3	▪ Santa Clara Caltrain Station	2.4 miles

Source: Arup

Figure 4: ATN Alignment per Segment at the Airport



Source: Arup

2.3.3 Passenger Demand

It is expected that by 2030, the 10-station ATN system will accommodate a passenger-carrying capacity of approximately 14,000 users per day. Table 7 below provides a split per Segment of the expected daily passenger demand in 2030.

Table 7: Daily Passenger Demand per Segment in 2030

Segment	Daily ATN Trips in 2030
Segment 1	8,850
Segment 2	3,730 additional trips
Segment 3	1,580 additional trips
TOTAL	**14,160**

Source: Arup

2.4 Evaluation Methodology

2.4.1 Evaluation Criteria

In collaboration with the City, Arup identified a number of overarching delivery objectives for the Project grouped into four main areas: technology, procurement, transportation, and funding/financing.

Table 8: Overarching Project Delivery Objectives

Technical	Procurement
▪ Maximize asset life ▪ Maximize cost and schedule certainty	▪ Maximize stakeholder and political support (e.g., compelling Project) ▪ Minimize overall Project uncertainty (e.g., cost, schedule, technology and regulatory approvals) ▪ Maximize industry competition ▪ Maximize use of industry experience, market precedence, and innovation ▪ Use a fair and transparent procurement process ▪ Maximize support from the local community ▪ Achieve timeliness (e.g., capitalize on first mover advantage)
Transportation	**Funding and Financing**
▪ Maximize access and "equity of use" (e.g., economically disadvantaged groups and Airport staff) ▪ Lead technology development and innovation for solving long-term transportation needs ▪ Maximize value and service quality to end users	▪ Be compliant with VTA and the Measure A funding requirements ▪ Be affordable when compared to alternative systems ▪ Maximize efficient use of available public funds ▪ Maximize use of alternative funding and financing sources (e.g., private finance, land value capture) ▪ Maximize revenue potential without compromising access and "equity of use"

Source: Arup

Working with the City five delivery objectives (Project Delivery Objectives) were prioritized and evaluation criteria were defined for each of these in order to assess the Project. Table 9 summarizes the Project Delivery Objectives and related evaluation criteria.

Table 9: Evaluation Criteria

Project Delivery Objectives	Evaluation Criteria
1. Be compliant with VTA and Measure A funding requirements	▪ The Project should fulfill the Measure A requirement to build an automated rail connection between the Airport and the VTA, Caltrain, and BART systems.
2. Be affordable when compared to alternative systems	▪ Ongoing operations and maintenance costs should be comparable to or less than the costs of operating existing shuttle bus services. ▪ Construction costs should be comparable to or less than the APM option previously considered.
3. Minimize overall Project uncertainty (e.g., technology, regulatory approvals)	▪ The Project risk profile should be at a level acceptable to the City and there should be no apparent "fatal flaws." (1)
4. Maximize access and "equity of use" (e.g., for economically disadvantaged groups and Airport staff)	▪ The Project should not collect fares from the general public or Airport staff.
5. Maximize revenue potential without compromising access and "equity of use"	▪ All viable commercial revenue sources, other than fares, should be considered.

Source: Arup

(1) A "fatal flaw" is a technical or financial factor that would rule out proceeding with the Project to the next level of evaluation. A technical fatal flaw may involve the ATN technology, the Project's physical context, alignment or ridership. A financial fatal flaw may involve the City's affordability limit with regards to operations and maintenance costs and construction costs. An absence of apparent fatal flaw at this stage is not a recommendation to proceed but rather an absence of evidence that would bar the Project from proceeding to the next level of evaluation.

2.4.2 Factors to Consider

The Project evaluation and decision-making process should reflect the City's Project Delivery Objectives, as described above.

The key factors considered during the evaluation of the City's Project Delivery Objectives are summarized in Table 10 below:

Table 10: Factors to Consider

Category	Factors to Consider
Technology	▪ Readiness and reliability ▪ Capacity ▪ Intellectual property ▪ Testing and commissioning
Market	▪ Technical and delivery capacity/ability and track record ▪ Financial strength ▪ Competition ▪ Conflict of interest
Performance Requirements	▪ Design development ▪ Operating performance ▪ Project complexity
Legal/Regulatory Framework	▪ Applicable standards and codes ▪ Impact on cost and schedule
Funding and Financing	▪ Affordability ▪ Funding plan ▪ Marketing ▪ Market's ability to raise finance
Political/Public Support	▪ Political support and need ▪ Project management ▪ Public acceptance

Source: Arup

2.4.3 Quantitative Evaluation

2.4.3.1 Funding Gap Analysis

This Preliminary Business Case uses quantitative and qualitative methods to evaluate the Project's feasibility from a funding perspective. The quantitative assessment was undertaken as a "funding gap" analysis recognizing that a more complete financial analysis will be undertaken during the next stage of the Project's development.

In the context of this report, the funding gap is the difference between Project costs and the revenues currently available to fund the construction and operations of the Project. A risk-adjusted cash flow model was built to estimate a range of the funding gap. A funding gap range was developed using three scenarios considering different risk confidence levels and sensitivities.

The funding gap assessment differentiates between the construction and operation period of the Project. This is because potential restrictions exist for different sources of funds. Federal grants may only be used for construction projects whilst

savings generated from discontinued shuttle bus services may only be used for operating the Project.

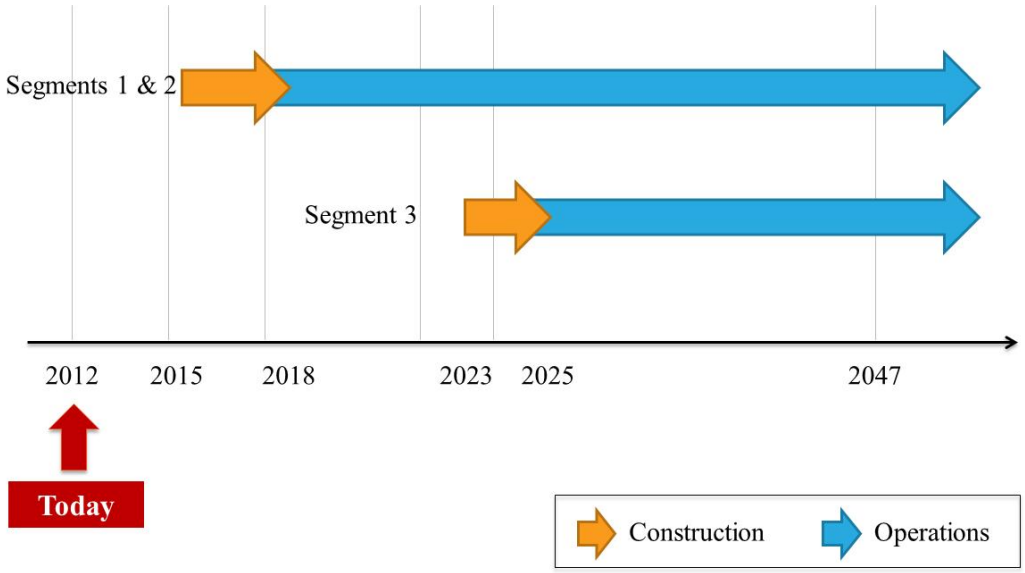
2.4.3.2 Scenario Definition

For the purpose of this analysis, the following Project timeline was assumed:

- The Project would start construction in 2015, after a 3-year development and procurement period starting in 2012.
- The overall Project forecast would then last 33 years, which accounts for a 3-year initial construction period and a 30-year operation period.
- Segments 1 (2.7 miles) and 2 (1.3 miles) would be built together between 2015 and 2018. They would begin operations in 2018 and continue operations through the end of 2047.
- Construction of Segment 3 (2.4 miles) would begin in 2023. Despite longer guideways, it would only take 2 years to complete (i.e., 1 year less than Segments 1 and 2) due to the simpler layout. Operations would begin in 2025 to coincide with the commencement of BART service to Santa Clara station.
- Operating costs and revenues would continue up until the end of 2047. However, it is probable that the system's operations would continue beyond that date.

Figure 5 illustrates the timeline assumptions for the purpose of this analysis.

Figure 5: Project Timeline [(1)]



Source: Arup

[(1)] An operating period of 30 years has been assumed for this analysis (i.e., 2018–2047) to account for at least one full cycle of vehicle replacement for all three segments.

The Project consists of a 6.4 linear-mile alignment with elevated concrete structures and 10 stations. Arup developed baseline cost estimates for the construction and operation of the Project. These estimates are based on benchmark data and project-specific bottom-up analysis.

In line with industry best practices, Arup assessed Project risks for the likelihood of occurrence and potential cost or schedule impact. Three scenarios were simulated, each defined by different confidence levels: the Optimistic Case, the Most Likely Case, and the Pessimistic Case.

In collaboration with the City, Arup identified potential revenues from the following sources to support the operations and maintenance of the Project:

- Annual Airport operations budget savings from the discontinuation of the current Airport shuttle bus services that would be completely replaced by the ATN services ("Bus Savings")
- Incremental parking revenue associated with the increased demand for the ATN system
- Advertisement on the ATN system

At this time, the City has not identified funding sources to support the construction of the Project.

For the revenue estimates it was considered appropriate to use sensitivities applied on the Bus Savings component of the potential revenue sources listed above.

Table 11 below provides a summary of the assumptions used in the three scenarios. Discussions with the City indicated that the Most Likely Case was the scenario that best aligned with the City's cost and risk preferences and therefore would be the basis for Arup's conclusions and recommendations.

Table 11: Scenario Definition

Scenario	Description	Assumptions
Optimistic Case	Reflects the view generally taken by construction builders and implies a 70% chance that the costs will be higher than the value presented	▪ Risk-adjusted construction costs @ 30th percentile ▪ Risk-adjusted operating costs @ 30th percentile ▪ Bus Savings sensitivity @ +25%
Most Likely Case	Reflects the view generally taken by the Federal Transit Administration (FTA) and implies a 20% chance that the costs will be higher than the value presented	▪ Risk-adjusted construction costs @ 80th percentile ▪ Risk-adjusted operating costs @ 80th percentile ▪ No Bus Savings sensitivity
Pessimistic Case	Reflects the view generally taken by lenders and implies a 5% chance that the costs will be higher than the value presented	▪ Risk-adjusted construction costs @ 95th percentile ▪ Risk-adjusted operating costs @ 95th percentile ▪ Bus Savings sensitivity @ -25%

Source: Arup

Finally, in order to estimate a funding gap range, a cash flow model was created for each scenario, comparing the Year-Of-Expenditure (YOE) (i.e., indexed) risk-adjusted construction, operations and maintenance costs with forecasted revenues over the assumed 33-year life of the Project.

2.4.4 Qualitative Evaluation

The qualitative assessment evaluated the five Project Delivery Objectives identified in Section 2.4, because these are considered key to deliver the Project but are not quantitatively measurable.

In addition, Arup evaluated potential strategies to develop the Project from initial feasibility to commencement of operations and identified the areas to focus on at the next stage of the Project's development.

Finally, Arup conducted a market sounding process with the industry. This was done by interviewing the ATN technology providers on the key issues relating to the key risks. The results of these discussions have been considered throughout this report.

3 Evaluation

3.1 Base Costs Analysis
3.2 Revenue Analysis
3.3 Risk Analysis
3.4 Risk-Adjusted Costs
3.5 Quantitative Evaluation
3.6 Qualitative Evaluation
3.7 Conclusions

3 Evaluation

3.1 Base Costs Analysis

Arup used benchmark data and project-specific bottom-up analysis to develop preliminary life-cycle costs, consisting of construction, operation, maintenance, and renewal costs.

The base costs for the Project Segments have been estimated in 2012 dollars prior to the risk adjustments. Note that the base costs should not be used for budgetary or planning purposes. Only the total risk-adjusted figures, presented in Section 3.3.4.3 below, should be used for that intent. Table 12 below provides a summary of the base costs.

Table 12: Base Costs Summary – Not for Budgetary or Planning Purposes

Base Costs	2012 $, Million
Construction Base Costs (Total – All Segments)	280
Development Base Costs (Total – All Segments)	70
Operations and Maintenance Base Costs (Annual – All Segments)	10

Source: Arup

3.1.1 Construction Base Costs

The construction base costs are based on Arup's memorandum titled "Rough Order of Magnitude Cost Estimate" (Appendix C1 of the San José International Airport Automated Transit Network Feasibility Study Final Report – July 2012). The construction base costs include the direct costs of building the Project, as well as the indirect costs associated with construction. The direct construction costs include the following components:

- Guideway (single-track, double-track, and triple-track)
- Minor stations (Economy Parking Lot 1, Daily Parking Lot 4, VTA Metro/Airport and Santa Clara Caltrain/future BART stations)
- Major stations (Terminals A and B)
- A maintenance facility
- General allowances for utility relocations and small subcontracted work
- Control system (as a proportion of construction costs)
- Vehicles (based on assumed unit cost and fleet size of 300)

Indirect costs and other additions include the following components:

- Contractor's indirect costs

- Contractor's overhead and profit
- Design engineering
- Project insurance
- Performance and payment bond

The primary construction cost differences between the Segments are in proportion to the vehicle and station numbers, and the length of reinforced concrete elevated guideways.

- In Segment 1 approximately 80% of the vehicles (245 of 300) would be procured to meet passenger demand forecasts. This compares to 13% and 7% for Segment 2 and Segment 3 respectively. Segment 1 has two "major stations", a maintenance facility, and one "minor station". In addition, Segment 1 has 2.7 miles (i.e., 42% of the total network length) of elevated guideways. These guideways have a mixture of single, double and triple track alignments.
- Segment 2 has the shortest alignment length with 1.3 miles (i.e., 20% of the total network length). Segment 2 also has six "minor stations".
- Segment 3 has the longest elevated double track guideway and a small length of single track guideway, representing 2.4 miles (i.e., 38% of the total network length).

Table 13 below provides a summary of the construction base costs per Project Segment:

Table 13: Construction Base Costs per Project Segment

Construction Base Costs	2012 $, Million
Segment 1	141
Segment 2	54
Segment 3	85
TOTAL	**280**

Source: Arup

3.1.2 Development Base Costs

At this stage of the design development detail (i.e., < 2%), an allowance for the Project development base costs has been assumed to be equal to 25% of construction base costs. This is in line with industry benchmarks and the cost accounts for the following pre-construction activities:

- Preliminary design engineering
- Right-of-way engineering
- Environmental documentation

- Procurement costs, such as bid documentation and award of contract
- Permit approvals

Table 14 provides a breakdown of development base costs per Project Segment:

Table 14: Development Base Costs per Project Segment

Development Base Costs	2012 $, Million
Segment 1	35
Segment 2	14
Segment 3	21
TOTAL	**70**

Source: Arup

3.1.3 Operating and Maintenance Base Costs

The operations, maintenance, and renewal base costs are based on Arup's memorandum titled "Rough Order of Magnitude Cost Estimate" (Appendix C1 of the San José International Airport Automated Transit Network Feasibility Study Final Report – July 2012). The operations, maintenance, and renewal base costs have been benchmarked and estimated on an annual basis. These costs include the following components:

- Staffing
- Maintenance
- Periodic renewals
- Energy use

Arup used the following basis to estimate each cost category:

- Staffing costs are based on a "bottom-up" approach that applies California labor rates for an ATN specific Project organization structure.
- Maintenance needs are based on length of track, number of berths, and number of vehicles.
- Periodic renewals include vehicle replacement over the assumed 30-year operating period, as well as periodic information system replacements and guideway inspections.
- Energy usage is calculated using benchmark data from similar projects.

The primary operations, maintenance and renewal cost differences between the Segments are in proportion to the vehicle and station numbers, energy demand and network length. The majority of the management, operations and labor staff costs have been allocated Segment 1, with an incremental increase in proportion to the vehicle and station numbers, and network length for Segments 2 and 3.

Table 15 provides a summary of these annual base costs per Project Segment:

Table 15: Annual Operations and Maintenance Base Costs per Project Segment

Annual Operations and Maintenance Base Costs	2012 $, Million
Segment 1	8
Segment 2	1
Segment 3	1
TOTAL	**10**

Source: Arup

3.2 Revenue Analysis

In order to fulfill the two Project Delivery Objectives of (1) maximizing access to the Airport and (2) providing "equity of use," the City recommended that the Project not collect fares from the general public or Airport staff. This approach is in line with other international benchmarks.

The primary source of Project revenues considered at this time are the Bus Savings defined as the savings from the Airport's operating budget as a result of discontinuing the shuttle bus services at the Airport and the VTA Flyer Line 10 since those services would be replaced by the ATN service. This budget includes all vehicle, fuel, staff and overhead costs. The shuttle bus budget was assumed to increase annually by 1.50% per annum between 2012 and 2027 to account for the forecasted growth in Airport passengers. However, the City Council would need to take action to dedicate the Bus Savings to the Airport ATN Project. If it chose otherwise, the ATN Project revenues assumptions would need to be altered.

Empirical evidence obtained at other airports around the world show that an improved passenger experience to travel from remote parking lots to airport terminals results in high utilization of the parking lots (i.e., increased demand). Arup has assumed that all of the incremental revenue from the car-parking lots connected to the ATN will be dedicated to fund the ongoing operations of the ATN system. In addition, Arup has estimated that the increase in parking revenue will be approximately equal to 10% of the current annual revenue at the car-parking lots served by the ATN.

This source of revenue is assumed to commence in the second year of operation. This ramp-up period is in line with Airport expectations and benchmarking data. Thereafter, this revenue is index-linked to the Airport passenger growth forecast (i.e., 1.50% per annum).

In line with the benchmarking analysis performed, advertisement revenue has been assumed to commence in the third year of operations (i.e., 2020). This would allow sufficient time for the Project to establish market confidence with the

system's reliability and ensure increased passenger-service quality and brand recognition.

This revenue has been assumed to increase year-on-year from 2020 by approximately $70,000 (2012 dollars) per annum up to a maximum amount of $0.5 million (2012 dollars) in the second year of operation of Segment 3 (i.e., 2026). Thereafter, this revenue is capped at $0.5 million (2012 dollars) per annum.

As discussed in Arup's memorandum titled "San José ATN Feasibility Study Alternative Revenue Sources", other revenue sources (e.g., revenue from adjacent developments) were considered, but these sources were not deemed to be commercially viable at this stage of the analysis.

Table 16 below provides a summary of the estimated revenues, primarily considered to support the operations and maintenance of the Project.

Table 16: Revenue Summary to Support the Project's Operations and Maintenance

Revenue Source	Annual Revenue Estimate (2012 $)
Bus Savings	▪ Total for all Project segments: $9 million o Segments 1 and 2: $8 million o Segment 3: $1 million ▪ 2018–2027: 1.50% increase per annum[(1)]
Other Revenues – Incremental Parking Revenue dedicated to the ATN system	▪ 2019: $1.2 million ▪ 2020–2027: 1.50% increase per annum
Other Revenues – Advertisement Revenue on the ATN system	▪ 2020–2025: $70,000 increase per annum up to a cap of $0.5 million per annum ▪ 2026–thereafter: capped at $0.5 million per annum

Source: Arup

[(1)] The Airport expects a 1.50% annual increase in budget for shuttle buses between 2012 and 2027. To account for this, bus savings have also been increased by 1.50% per annum between 2012 and 2018, commencement year of operations.

3.2.1 Bus Savings Assumptions

In collaboration with the City, Arup identified that the savings realized from discontinuing the various shuttle bus services to and at the Airport as a result of the Project would be allocated to the Project as a source of revenue. This budget includes all vehicle, fuel, staff, and overhead costs. The City's commitments for this source of funding for the Project, was dependent on the following conditions:

- The Project provides equal or better services than the shuttle buses
- The Project boosts the visibility and image of the Airport
- The Project does not impede the Airport's expansion plans

- The Airport's financial position improves.

Based on the 2011–12 Airport budget, Arup has identified these savings would come from the following sources:

- On-Airport shuttle buses
- VTA Flyer

These sources are explained further in the following sections.

3.2.1.1 On-Airport Shuttle Buses

Arup has assumed the following:

- Segments 1 and 2 will bring about savings from the complete discontinuation of the inter-terminal "Terminal A–Terminal B" route and the surface parking "Economy Lot 1–Daily Lot 4" route.
- The surface parking lot route servicing lots 5 and 6 will be discontinued in 2027 due to the building of a new Airport terminal. The demand for Hourly Lot 5 will transfer to Hourly Lot 3, which does not require an ATN station because of its proximity to Terminal B station. The demand for Daily Lot 6 will transfer to Daily Lot 4, which is served by an ATN station. The savings realized from discontinuing this route will therefore not be allocated to the Project.
- The Airport will maintain a small contingency contract for back-up and special events, which, due to its immateriality, has not been modeled in the funding gap analysis.

3.2.1.2 VTA Flyer

The VTA Flyer is the shuttle bus operated by the VTA and currently linking Metro/Airport VTA station, the Airport terminals, and Santa Clara station (Line 10). For savings related to the VTA Flyer, Arup has assumed the following:

- Segments 1 and 2 will bring about savings from the discontinuation of the route connecting the VTA Metro/Airport light rail station to the Airport terminals (15% of the total route serviced by the VTA Flyer).
- Segment 3 will bring about savings from the discontinuation of the route connecting the Airport terminals to Santa Clara Caltrain/future BART station (85% of the total route serviced by the VTA Flyer).
- In 2018, the Airport will resume contributions to the VTA Flyer's costs ($1.25 million per annum in 2012) due to the expected growth in passengers (see further details below).

3.2.1.3 Insurance Costs

In addition, Arup has assumed that the discontinuation of on-Airport shuttle buses would eliminate the need for insurance on these vehicles. The savings relating to insurance costs were split equally between all Segments.

3.2.1.4 Staff Costs and Overheads

While on-Airport shuttle bus services will be discontinued, Arup has assumed that Airport staff costs and overhead (less than $0.1 million per annum as per Airport 2011–12 budget) will not be reduced, since Airport staff will administer the Project operations.

3.2.1.5 Shuttle Bus Budget Increase

The Airport has forecasted a growth in passengers from 8.2 million in 2010 to 17.6 million in 2027. As a result, the Airport expects a 25% linear increase in the demand, and hence overall budget, for shuttle buses between 2012 and 2027 (or 1.50% per annum). Table 17 below provides a summary of bus savings assumptions, based on the 2011–12 Airport budget:

Table 17: Bus Savings Summary

Segment	Category	Assumptions (2012 $)
Segments 1 and 2	On-Airport shuttle buses: Inter-terminal "Terminal A–Terminal B" route and surface parking "Economy Lot 1–Daily Lot 4" route	$7,837,061
	VTA Flyer: Airport contribution	$187,500
	Insurance	$9,600
	Total Segments 1 and 2	**$8,034,161**
Segment 3	VTA Flyer: Airport contribution	$1,062,500
	Insurance	$4,800
	Total Segment 3	**$1,067,300**
	TOTAL	**$9,101,461**
All Segments	Shuttle buses budget increase	1.50% per annum 2018–2027 (1)

Source: 2011–12 Airport budget
(1) The Airport expects a 1.50% annual increase in budget for shuttle buses between 2012 and 2027. To account for this, bus savings have also been increased by 1.50% per annum between 2012 and 2018, commencement year of operations.

3.3 Risk Analysis

The objective of the risk analysis was to determine the total expected costs based on Project-specific knowledge. The Project-specific risk analysis was conducted using a number of industry best-practice methods, such as Monte Carlo simulation

of key risks, risk workshops with the Project team, discussions with industry/supplier experts and construction practitioners, and incorporation of experience from precedent projects.

For the purposes of this risk analysis, the construction method assumed was a Design–Build approach. This was assumed given the technical complexity and specialist expertise required to build the Project, and market precedents of comparable projects.

The risk contingencies, summarized in Table 18 along with risk-adjusted costs, are within the expected benchmark range for a project of this complexity, technology track record, and level of design development detail.

Table 18: Risk-Adjusted Costs – All Segments

Scenario	Optimistic Case (2012 $, Million)	Most Likely Case (2012 $, Million)	Pessimistic Case (2012 $, Million)
Confidence Range [(1)]	*30th Percentile*	*80th Percentile*	*95th Percentile*
Total Risk-Adjusted Construction Costs	537	758	909
Total Risk-Adjusted Annual Operations and Maintenance Base Costs	11	13	14
Construction Risk [(2)]	66%	134%	181%
Operations and Maintenance Risk [(3)]	8%	24%	35%

Source: Arup
[(1)] "80th percentile confidence range" means an 80% probability the values in Table 18 will not be exceeded
[(2)] This is calculated as Categorical Risk / (Total Base Cost + Elemental Risk ($318 million))
[(3)] This is calculated as (Elemental Risk + Categorical Risk) / Annual Base Costs ($10 million)

Based on the Most Likely Case, the results include a significant risk contingency (134%) when compared to other fixed guideway transportation systems which have a longer track record of commercial operations and longer track record of obtaining regulatory approvals in the United States. For example, the APM project identified in Table 25 includes a 40% risk contingency. The cost and risk analysis conducted in this study conservatively estimates the technology and Project-specific risks at this point of development of the ATN technology.

It is critical for the City to setup a process to manage all of the identified Project risks and communicate these expectations to the appropriate stakeholders. Proactively addressing these risks and implementing mitigation strategies will reduce uncertainty and total expected Project costs. To achieve this objective, the City should implement a detailed risk-management process with the objective of reducing or mitigating the potential outcomes of the risks.

Engaging effectively with the industry will also be critical to understand better the key Project risks and the market's ability to manage these. As the Project proceeds

the risk analysis performed to date can become the basis for the evaluation and development of a preferred procurement method and the commercial agreements with the private sector appropriate for that method.

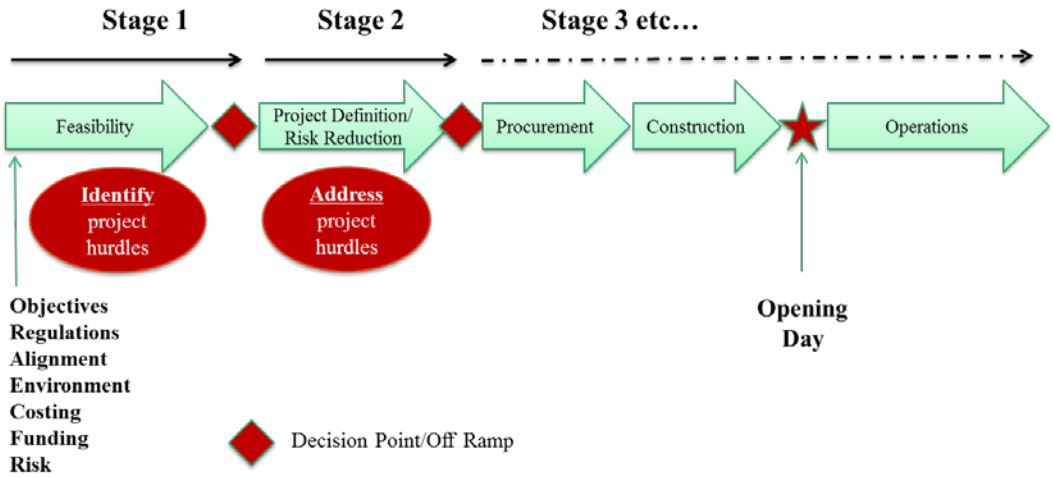
3.3.1 Risk and Decision-Making Background

Project cost escalation is a significant problem facing public agencies. The failure to deliver individual projects and programs within established budgets can have a significant impact on later programs. In particular, large-scale infrastructure projects greater than $100 million can be extremely complex and are often fraught with uncertainty, especially if the project incorporates new technologies with limited track records.

A comprehensive risk management approach can help project teams control project risks and has a direct impact on the success or failure of projects. It is critical to recognize uncertainties in order to identify, manage and mitigate risks at interim stages throughout a project's lifecycle. It is also essential to communicate these uncertainties and their impact to stakeholders and decision-makers to allow appropriate decisions to be taken on whether to proceed with a project or not.

As illustrated in Figure 6 below, key decisions should be taken throughout the Project development process in order to maintain control over Project risks, establish the most appropriate path forward, and identify any potential technical or financial fatal flaws:

Figure 6: Project's Key Decision Points



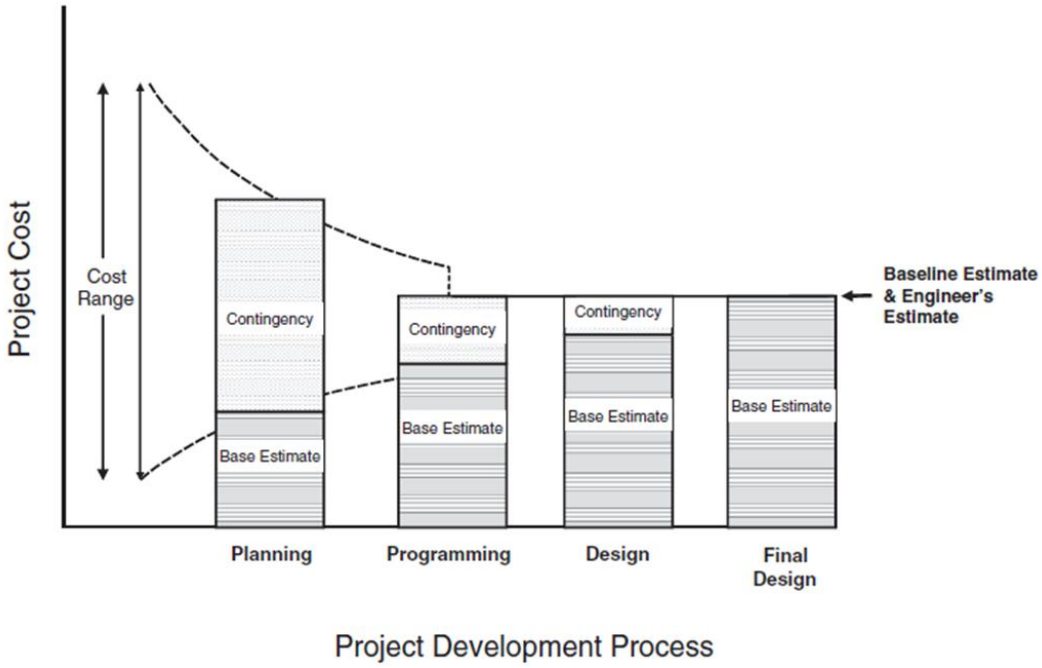
Source: Arup

3.3.2 Risk Analysis Objective

The objective of the risk analysis undertaken in this section is to determine the total expected cost of the Project today based on Project-specific knowledge. The total expected cost is defined as the risk-adjusted Project costs, which include contingencies for potential costs in excess of anticipated levels. As shown in Figure 7 below, Project risks will change throughout the Project development

process, but they should be managed and mitigated in order to control Project costs. Quantifying Project risks encourages stakeholders and decision-makers to monitor these risks and reduce them through risk-management techniques, project development, and improved information.

Figure 7: Project Development Process and Risk Quantification



Source: *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs*, National Cooperative Highway Research Program

3.3.3 Risk Contingency Types

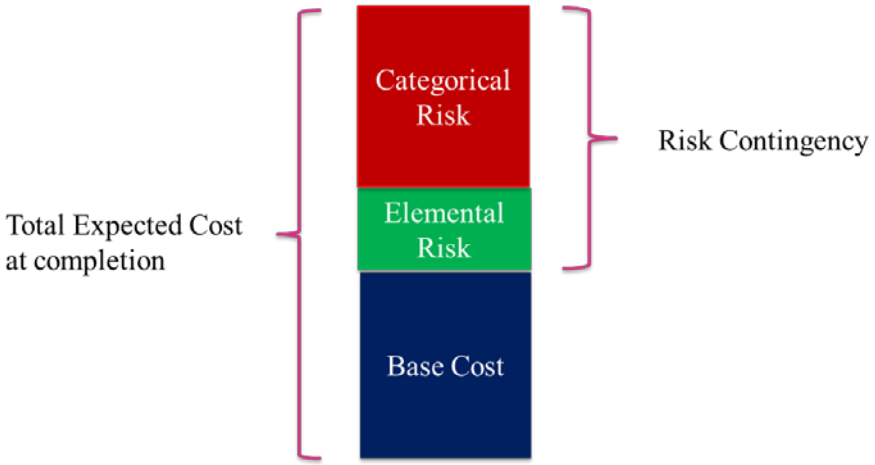
The base costs represent an estimate of the quantity and unit cost rates for each cost category and do not include any risk contingencies.

Risk contingencies can be classified into two categories:

- The elemental risk contingency accounts for the uncertainty underlying the quantification of base costs due to the early stage of project definition. It relates to the variation of costs due to the estimators assumptions for labor, equipment, and materials
- The categorical risk contingency accounts for the events that could cause the total expected cost to increase. Such events may include delays due to uncertain geotechnical ground conditions or change of Project scope by the City.

Figure 8 below illustrates how these risk contingencies build up on top of the base costs:

Figure 8: Risk Contingency Types



Source: Arup

3.3.4 Risk Management

The risk management methodology adopted for the Project at this stage is as follows:

1. Risk identification: Determine the risks that might affect the project and document their characteristics by brainstorming with the Project team through workshops, discussing with industry experts and construction practitioners, and reviewing checklists.
2. Risk assessment: Analyze through quantitative and qualitative risk analysis procedures the likelihood and impact of the risks identified. This assessment assists in deriving risk contingency estimates.
3. Risk mitigation and planning: Prepare potential risk response options (e.g., improved information, acceptance, avoidance, mitigation, or transference) and decide how to approach and plan risk-management activities.

The following steps have not been considered in this report, but should be adopted in subsequent stages of the Project development process:

4. Risk allocation: Allocate responsibility for each Project risk to a particular party, typically through a contract. The fundamental rationale of risk allocation is to allocate each risk to the party best able to manage it in alignment with Project goals.
5. Risk monitoring and control: Capture, analyze, and report Project performance, usually as compared to the risk management plan. Risk monitoring and control also assists in contingency tracking and resolution.

6. Update risk assessment: Continuously revise the risk assessment throughout the Project life as events occur and improved information is obtained.

3.3.4.1 Risk Identification

Risks identified at outreach workshops are grouped into the following risk categories:

- Design and Construction
- Operation and Maintenance
- Market and Political
- Procurement and Legal
- Funding and Financing

A full Project risk register is shown in Appendix A1.

3.3.4.2 Risk Assessment

Using the information developed in the Project risk register, Arup has performed a quantitative risk analysis. This exercise aims to assess Project risks for likelihood of occurrence and potential cost or schedule impact.

Using the construction and operations and maintenance base costs described in Section 3.1, as well as Project schedule estimates, Arup has applied the Monte Carlo simulation to quantify the probability that the Project will finish within objectives.

As described previously, Arup has simulated three possible scenarios, defined by confidence levels, in terms of total expected costs: the Optimistic Case, the Most Likely Case, and the Pessimistic Case. Savings and revenues have not been risk-adjusted, but sensitivities have been run on bus savings.

Risk Assessment Approach

Arup's approach to conduct the quantitative risk assessment is as follows:

1. The ten key Project risks with the highest cost impact on the Project have been simulated. Arup has not attempted to quantify an exhaustive list of risks since their cost impacts overlap at this early stage of Project development. The goal was to assess the risks that had a sufficient degree of accuracy and reasonable risk-measurement quantity and to ensure Project estimates were not unrealistically high.

2. The objective of the quantitative risk assessment has been to evaluate, for each key Project risk, the probability of potential cost and schedule overrun. For each risk, a description has been provided with examples of potential risk triggers (see below for the list of key Project risks).

3. These risks have been assessed in the @RISK software (Monte Carlo simulation) using Optimistic, Most Likely, and Pessimistic scenarios with the corresponding confidence levels: 30th, 80th, and 95th percentile ranges.
4. At this early stage of Project development, Arup has assumed the project delivery option to be a design–build approach, given the technical complexity, specialist expertise, and market precedent for comparable projects.
5. Only the total risk-adjusted costs for the Project have been determined at this stage. Arup has not considered the possible risk allocation between the various parties.

Key Project Risks

Table 19 below summarizes the key Project risks identified. These risks have been assessed for their potential impact during the construction or operations phase of the Project.

A summary of potential impact for these risks is also provided in Appendix A2.

Table 19: Key Project Risks

Risk	Risk Description and Example Triggers
Construction Costs	Risk that the actual capital costs are higher than anticipated (e.g., increased scope, quantities, or poor quality)
Construction Schedule	Risk that the construction schedule is longer than anticipated (e.g., adverse weather conditions, labor disputes, lack of experience of supplier to deliver Project, or unknown ground conditions such as geotechnical/archeological issues)
Operation, Maintenance, and Renewal Costs	Risk that operation, maintenance, and renewal costs are higher than anticipated (e.g., lack of historical data, increased O&M activities/quantities, lower useful life, and increased energy costs)
Bus savings ("Revenue") [(1)]	Risk that the revenue source changes (e.g., no guaranteed commitments to support Project payments)
Technology	Risk that the chosen technology is not adequate to accommodate the Project requirements/performance, becomes obsolete, or fails
Market Capability	Risk that suppliers do not have sufficient experience or partners to deliver the Project (e.g., primarily R&D experience and lack of experience delivering commercially viable systems)
Market Competition	Risk of insufficient number of suppliers in the market for a competitive procurement process and selection of the most suitable partner/bidder (e.g., premium on price due to lack of industry competition)
Funding and Financing	Risk that the City does not establish an adequate funding and financing plan (e.g., the Project attracts insufficient interest and poor creditworthiness among potential investors, lenders, and public authorities (federal, state and local) to support the funding and financing plan)
Regulatory Codes and Standards	Risk that existing regulatory codes and standards, requirements, and approval process have to be amended to suit the ATN system, causing procurement delays and increased requirements
Stakeholder Approval	Risk that stakeholder approval is not obtained, delayed, or changes the Project requirements
Permits and Approvals	Risk that necessary approvals are not obtained, or are obtained but are subject to unanticipated conditions which have adverse cost consequences or cause prolonged delays (e.g., environmental approval process)

Source: Arup

[(1)] This risk has not been quantified. The Bus Savings estimates used for the Funding Gap Analysis do not include any risk contingency. However, sensitivities of +25% and -25% have been run on these.

3.3.4.3 Risk Mitigation and Planning

Each Project risk is unique, but is often linked to other risks. A tailored risk mitigation strategy is therefore required to address risks proactively, which will in turn reduce uncertainty and total expected Project costs. This process should be repeated continuously as the Project develops.

Arup has drawn on precedents and lessons learned from other relevant projects in order to determine the potential risk mitigation strategies for each Project risk. Ultimately risk mitigation will involve procurement contracting and Project delivery options that include some risk transfer. Efficient risk transfer should allocate the responsibility of each risk to the party best able to manage it.

Potential risk mitigation strategies for the Project are presented in Appendix A3.

3.4 Risk-Adjusted Costs

3.4.1 Risk-Adjusted Construction Costs

The risk-adjusted construction costs produced by Arup's risk assessment approach are presented in Table 20 below.

The risk contingencies are within the expected benchmark range for a project of this complexity, technology track record, and level of design development (i.e., less than 2% of the design is complete). For planning purposes, the Washington State Department of Transportation (WS DOT) relies a benchmark of -50% – +200% for the estimated range of cost variance for capital projects at a 2% design development stage.

WS DOT's practice is derived from an extensive review of the literature and an industry survey representing responses from 48 state highway authorities and the Federal Highway Administration. Leading public agencies from outside the highway sector have also been considered in WS DOT's results, including the FTA, the New York Metropolitan Transit Authority, and the Department of Energy.

The elemental risk contingency is constant throughout the three scenarios because it relates to the "estimators contingency" (i.e., variations in the estimators assumptions used at the current level of design development). It relates to the variation of costs due to the estimators assumptions for labor, equipment, and materials.

The categorical risk contingency accounts for the events that could cause the total expected cost to increase. Such events may include delays due to uncertain geotechnical ground conditions or change of Project scope by the City.

Table 20: Risk-Adjusted Construction Costs – All Segments

Scenario	Optimistic Case (2012 $, Million)	Most Likely Case (2012 $, Million)	Pessimistic Case (2012 $, Million)
Confidence Range	*30th Percentile*	*80th Percentile*	*95th Percentile*
Construction Base Costs	280	280	280
Elemental Risk	44	44	44
Categorical Risk	213	434	585
Total Risk-Adjusted Construction Costs	**537**	**758**	**909**
Construction Risk[(1)]	66%	134%	181%

Source: Arup
(1) This is calculated as Categorical Risk / (Total Base Costs + Elemental Risk ($318 million))

3.4.2 Risk-Adjusted Operations and Maintenance Costs

The risk-adjusted operations, maintenance, and renewal costs produced by Arup's risk assessment approach are presented in Table 21 below and are detailed in Arup's memorandum titled "Rough Order of Magnitude Cost Estimate" (Appendix C1 of the San José International Airport Automated Transit Network Feasibility Study Final Report – July 2012). The elemental and categorical risk contingencies were combined for operations and maintenance costs due to lack of operating track record and available and reliable sources of data. The goal was to assess the risks that had a sufficient degree of accuracy and reasonable risk-measurement quantity and to ensure Project estimates were not unrealistically high.

The risk contingencies are within the expected benchmark range for a project of this complexity, technology track record, and level of design development detail. For example, the risk contingency for operations and maintenance costs on California High-Speed Rail amounts to 10%.

Table 21: Risk-Adjusted Annual Operations and Maintenance Costs – All Segments

Scenario	Optimistic Case (2012 $, Million)	Most Likely Case (2012 $, Million)	Pessimistic Case (2012 $, Million)
Confidence Range	*30th Percentile*	*80th Percentile*	*95th Percentile*
Annual Operations and Maintenance Base Costs	10	10	10
Elemental and Categorical Risk	1	3	4
Total Risk-Adjusted Annual Operations and Maintenance Base Costs	**11**	**13**	**14**
Operations and Maintenance Risk(1)	8%	24%	35%

Source: Arup
(1) This is calculated as (Elemental Risk + Categorical Risk) / Annual Base Costs ($10 million)

3.4.3 Risk-Adjusted Costs per Segment

The risk-adjusted costs per Project segment for construction and operations and maintenance are presented in Table 22 and Table 23. These numbers, and not the base costs presented in Section 3.1, should be used for budgetary and planning purposes.

Table 22: Risk-Adjusted Construction Costs per Segment

Scenario	Optimistic Case (2012 $, Million)	Most Likely Case (2012 $, Million)	Pessimistic Case (2012 $, Million)
Segment 1	226	318	382
Segment 2	145	205	245
Segment 3	166	235	282
TOTAL	**537**	**758**	**909**
Construction Risk(1)	66%	134%	181%

Source: Arup
(1) This is calculated as Categorical Risk / (Total Base Cost + Elemental Risk ($318 million))

Table 23: Risk-Adjusted Annual Operations and Maintenance Costs per Segment

Scenario	Optimistic Case (2012 $, Million)	Most Likely Case (2012 $, Million)	Pessimistic Case (2012 $, Million)
Segment 1	9	10	11
Segment 2	1	2	2
Segment 3	1	1	1
TOTAL	**11**	**13**	**14**
Operations and Maintenance Risk(1)	9%	24%	35%

Source: Arup
(1) This is calculated as (Elemental Risk + Categorical Risk) / Annual Base Costs ($10 million)

3.5 Quantitative Evaluation

3.5.1 Funding Gap Analysis

The results of the funding gap analysis are summarized in Table 24 and include the effect of inflation from 2012 to 2047 (i.e., YOE dollars).

The funding gap assessment differentiates between the construction and operation period of the Project. This is because potential restrictions exist for different sources of funds. Federal grants may only be used for construction projects whilst savings generated from discontinued shuttle bus services may only be used for operating the Project.

Based on the Most Likely Case, which best reflects the City's cost and risk preferences, the results indicate that:

- The funding identified for the Project's operations (i.e., bus savings) is greater than the estimated operations and maintenance costs (i.e., there is no funding shortfall during operations).
- A significant construction funding gap would need to be overcome to build the project given that no capital funding has been committed yet.

Table 24: Quantitative Evaluation Summary (YOE Dollars) [1]

	Optimistic Case (YOE $, Million)	Most Likely Case (YOE $, Million)	Pessimistic Case (YOE $, Million)
Average Annual Operations Funding Surplus / (Gap)	9	1	(6)
Construction Funding Surplus / (Gap) [2]	(747)	(1,019)	(1,205)

Source: Arup
[1] The assumed base date is January 1, 2012 for indexation purposes.
[2] This analysis does not include possible private financing costs as it assumes that construction will be funded by public sources (local, state and federal). As noted elsewhere in the report, the option to use private financing as part of a possible project development and procurement strategy will be considered in the next phase of the studies.

3.5.2 Transportation Mode Comparison

As shown in Table 25, Arup has also conducted a high-level cost comparison of the ATN system with shuttle buses and Automated People Mover (APM) modes of transportation. The APM option was previously considered by the City, under a separate study by another consultant team. The APM comparison in this study represents the route that was the most analogous to the ATN route. Please see Arup's memorandum titled "San José ATN Feasibility Study Cost Comparison Methodology", which provides further details on how the APM risk-adjusted costs were derived.

This comparison shows that there is no apparent financial fatal flaw with the Project since the ATN system, based on the Most Likely Case, meets Project Delivery Objective 2 of affordability by offering:

- Operations and maintenance costs that are comparable to the cost of operating existing shuttle bus services
- Construction costs that are lower than the APM option.

In addition, the ATN system offers improved passenger experience and level of service.

Table 25: ATN, Shuttles Buses, and APM Cost Comparison in 2012 Dollars

Mode	Risk-Adjusted Construction Costs (2012 $, Million)	Annual Operations and Maintenance Base Costs (2012 $, Million)	Comments
ATN system	758 [2]	10	▪ Waiting time generally less than 1 minute ▪ On-demand point-to-point travel ▪ Reduced walking distance due to 10 passenger stations ▪ Passenger experience: Excellent e.g. improved wait time, travel time, comfort, point-to-point service
Shuttle Buses	N/A	10	▪ Longer travel times for Airport shuttle buses and VTA Flyer Line 10 ▪ Longer headways [5] for VTA Flyer Line 10 (15-20 minutes) ▪ Stops at all stations
Airport People Mover [3]	967 [4]	Estimates not available for comparison purposes [1]	▪ Passenger experience: Good, but service limited to half the locations of the ATN or shuttle bus services ▪ Headway [5] 2 minutes on routes between the terminal stations and 4 minutes on routes to Caltrain and VTA ▪ Stops at 5 passenger stations and would not serve Lot 4 Daily Parking

Source: Arup, Airport FY 2011–12 budget, and San Jose International Airport APM Projects Conceptual Cost Estimate (September 2001)
[1] Operations and maintenance cost comparison were not available from previous studies.
[2] Most Likely Case, expressed in 2012 dollars (note that Table 24 costs are expressed in YOE dollars)
[3] An underground option was explored in 2001, which assumed free transfer of tunnel boring machines from the BART extension project. The route used for comparison here is based on the alignment around the Northern end of the airfield and does not use tunnel boring machines.
[4] Includes 40% categorical risk contingency, which is significantly less than the ATN categorical risk contingency (based on the Most Likely Case, 134%). This is due to the fact that the APM is a proven technology with a track record and regulatory approval in the United States.
[5] Headway is defined as the interval time between vehicles.

3.5.3 Assumptions and Analysis

3.5.3.1 Indexation Assumptions

The assumed base date for indexation purposes is January 1, 2012. Table 26 provides a list of the indices used in the analysis to escalate the costs and revenues over the Project timeline:

Table 26: Indices

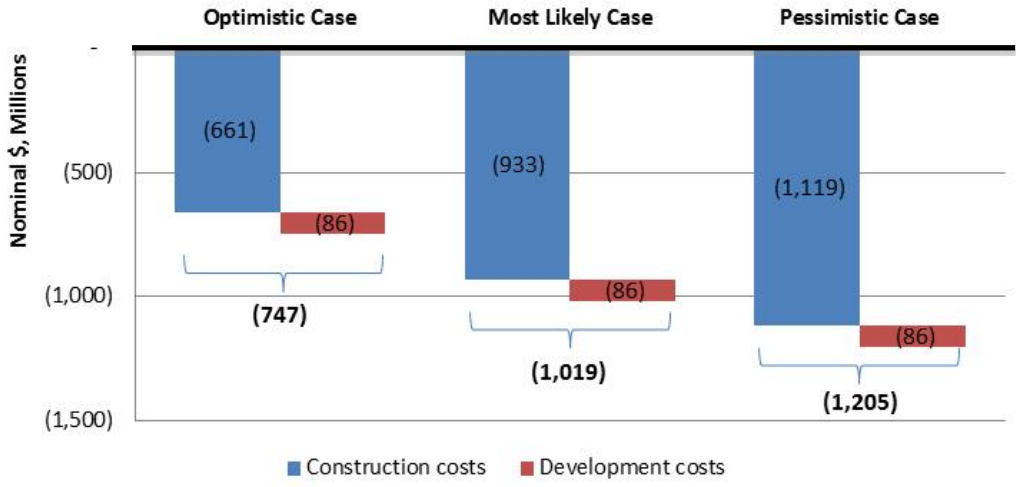
Category	Rate	Description
Construction Costs/ Development Costs (2012–2022)	3.12%	10-year average for Construction Cost Indices (CCI) Source: *Engineering News Record*
Construction Costs (after 2023)	4.50%	30-year average for CCI Source: *Engineering News Record*
Operations and Maintenance Costs	3.23%	30-year average Consumer Price Index (CPI) (All Urban Consumers) for the area "San Francisco–Oakland–San Jose" Source: Bureau of Labor Statistics
Savings and Revenues	3.23%	30-year average CPI (All Urban Consumers) for the area "San Francisco–Oakland–San Jose" Source: Bureau of Labor Statistics

Source: Arup

3.5.3.2 Cumulative Construction Funding Gap

Figure 9 summarizes the funding gap that the City faces to construct the Project in each scenario. Based on the Most Likely Case, the total funding gap of $1,019 million (YOE dollars) to build the Project consists of $933 million of construction costs and $86 million of development costs.

Figure 9: Cumulative Construction Funding Gap

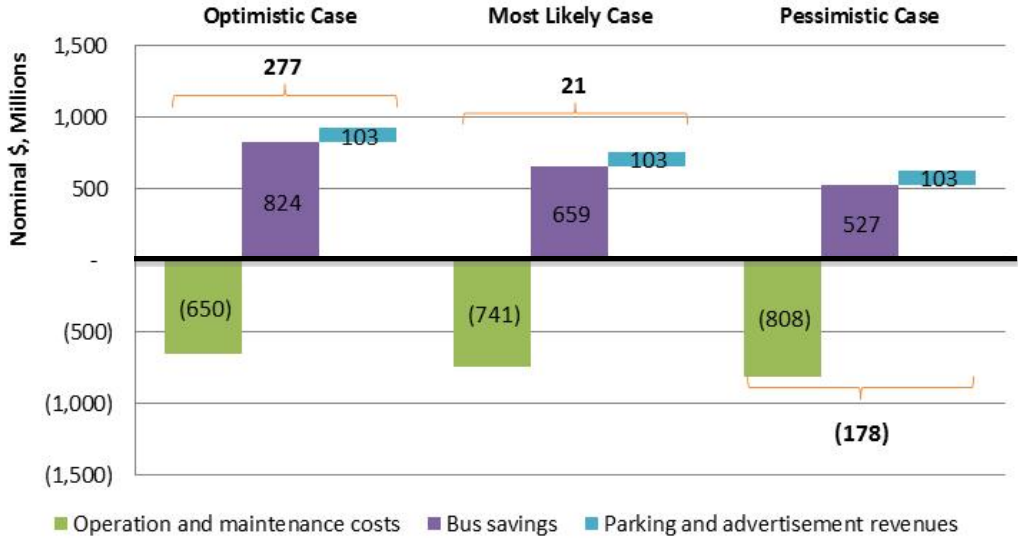


Source: Arup

3.5.3.3 Cumulative Operations Funding Gap

Figure 10 summarizes the cumulative funding gap or surplus identified to operate and maintain the Project over the 30-year operating period. Based on the Most Likely Case, the total operating surplus is $21 million (YOE dollars).

Figure 10: Cumulative Operations Funding Surplus/Gap



Source: Arup

3.6 Qualitative Evaluation

Based on the evaluation of the City's Project Delivery Objectives, summarized in Table 27, in order to proceed with the next stage of the Project as it is currently planned, the priority should be to reduce the Project uncertainty to an acceptable level for the City and prepare an adequate funding plan to address the funding gap identified. At that point a financing and procurement method assessment can be made.

Table 27: Qualitative Assessment Summary

Project Delivery Objectives	Evaluation Criteria	Evaluation Results
1. Be compliant with VTA and Measure A funding requirements	▪ The Project should fulfill the Measure A requirement to build an automated rail connection between the Airport and the VTA, Caltrain, and BART systems.	Objective met: ▪ The Project achieves VTA criteria to date.
2. Be affordable when compared to alternative systems	▪ Ongoing operations and maintenance costs should be comparable to or less than the costs of operating existing shuttle bus services. ▪ Construction costs should be comparable to or less than the APM option previously considered.	Objective met: ▪ The Project achieves both criteria within reasonable range. (See section 1.5.1 Quantitative Results above).
3. Minimize overall Project uncertainty (e.g., technology, regulatory approvals)	▪ The Project risk profile should be at a level acceptable to the City and there should be no apparent fatal flaws.	Objective not met: ▪ There are no apparent fatal flaws. ▪ The ATN technology requires further development (1) ▪ The cost and risk analysis conducted in this study conservatively estimates the technology and Project-specific risks at this point of development of the ATN technology.
4. Maximize access and "equity of use" (e.g., for economically disadvantaged groups and Airport staff)	▪ The Project should not collect fares from the general public or Airport staff.	Objective met: ▪ The Network provides direct connection to public transit; no fares assumed for users.
5. Maximize revenue potential without compromising access and "equity of use"	▪ All viable commercial revenue sources, other than fares, should be considered.	Objective met: ▪ No fares assumed, but all viable alternative revenue sources have been considered (e.g., advertising).

Source: Arup

(1) As per Aerospace's report titled "Automated Transit network Feasibility Evaluation – San José Mineta International Airport" and dated August 7, 2012.

3.7 Conclusions

The quantitative and qualitative assessments have demonstrated that there is no apparent fatal flaw with the Project. In this context, it is important to consider that the quantitative cost and risk analysis conducted in this study have conservatively estimated the technology and Project-specific risks at this point of development of the ATN technology. In particular, the following conclusions can be drawn:

- The Project is self-sustaining during operations and generates an average annual operating surplus of $1 million (YOE dollars) relative to the potential revenue sources considered in this study. However, with no capital funding committed or identified for the Project to date, a $1 billion (YOE dollars) construction funding gap would have to be overcome to build it. The City should prepare a robust Project funding plan to address this gap in construction funding.
- When compared to alternative modes of transportation systems, there is merit to explore the Project as a viable alternative because the estimates are that it has lower construction costs than the previously considered APM project, in addition to offering improved connectivity (i.e., twice as many passenger stations), passenger experience, and level of service.
- As shown in Table 27 above, the Project meets four of the City's five Project Delivery Objectives (Project Delivery Objectives 1, 2, 4, 5) and there are no apparent technical (i.e., technology, physical context, alignment, ridership) or financial (i.e., breach of the City's affordability limit) fatal flaws. An absence of apparent fatal flaw at this stage is not a recommendation to proceed but rather an absence of evidence that would bar the Project from proceeding to the next level of evaluation.
- As per Aerospace's report titled "Automated Transit network Feasibility Evaluation – San José Mineta International Airport" and dated August 7, 2012, the ATN technology requires further development to demonstrate its ability to deliver the passenger-carrying capacity required for the network of stations contemplated for this Project.
- The uncertainty levels are within the expected benchmark range for a project of this complexity, technology track record, and level of design development; but inherent in any project are unrecognized risks, which may change the expected results. As the Project is further developed these uncertainties can be further identified and mitigated and the contingency levels reduced.

During the next stage of the Project Arup recommends that the City focus its effort to address the following key Project development tasks that are considered critical for its success:

1. Demonstrate readiness of the ATN technology to meet the Project's specific requirements.
2. Engage the ATN technology industry's availability and ability to deliver.

3. As the technology is further developed, identify strategies to optimize the Project costs and mitigate risks and uncertainties.
4. Prepare a robust capital funding plan.
5. Develop a plan to resolve regulatory, environmental, and stakeholder approvals.

Arup has identified possible development options in Section 4 to address these key Project development tasks.

4 Development Options

4.1 Introduction
4.2 Option Evaluation
4.3 Recommendations
4.4 Co-development Process

4 Project Development Options

4.1 Introduction

In order to develop the Project further, Arup has considered four possible development options. These options are strategies to address the first four key Project development tasks identified above. The last Project development task (i.e., regulatory, environmental, and stakeholder approvals) is outside the scope of this report, but Arup recognizes this should be addressed in parallel. It will have a critical impact on the schedule for delivering the Project and gaining the appropriate level of political/public support.

For analysis purposes, each of the following development option has been considered independently but in practice, they may have shared components:

- Option 1: The ATN industry leads the market with research and development, plus the experience gained from delivering other projects around the world (i.e., the City waits for the market to mature).
- Option 2: The City and any other collaborating agencies, leads a research and development program.
- Option 3: The City and any other collaborating agencies, and the ATN industry collaborate with shared costs and benefits. Note that this option has two sub-options, namely, Option 3A – "Preferred Supplier" and Option 3B – "Industry Collaboration".
- Option 4: The City prepares an RFP for a "starter project" that can be delivered with the current technology and industry delivery capabilities.

4.2 Options Evaluation

Following several Project team workshops with the City, Arup evaluated the relative merits of each development option and cross-checked its assessment against the 'factors to consider' in Section 2.4.2. This allowed Arup to sift through the options in order to provide a clear recommendation.

A summary of the pros and cons of each option is provided in Table 28.

Table 28: Project Development Options Assessment

Options	Pros	Cons
Option 1: "Do nothing"	▪ Minimum City resource effort required. ▪ Minimum public funds required. ▪ Low political risk. ▪ Significant time for regulatory approval (i.e., no lead agency to support the Project).	▪ No control over Project outcome (i.e., may never get built). ▪ Lose "path finder" position in the United States. ▪ No control over development process/timing. ▪ Weak Project pipeline.
Option 2: Research Program	▪ High profile as an industry leader. ▪ Medium control over Project outcome. ▪ Lower failure risk for City. ▪ High industry and local support. ▪ Higher cost certainty. ▪ Reasonable time for regulatory approval. ▪ Reasonable time to obtain funding. ▪ Higher supplier experience. ▪ Reasonable time for due diligence. ▪ Reasonable time for stakeholder education and consensus.	▪ Medium upfront and longer term public funds required to develop / promote research program (source unknown). ▪ Need to develop Project pipeline to attract industry. ▪ Longer timeframe before "live" Project. ▪ Not core business of the City. ▪ Lose "path finder" opportunities for political support. ▪ Difficult to maintain control and manage potential conflict of interest of lead suppliers within the industry.

Options	Pros	Cons
Option 3: Public/Private Collaboration	▪ Medium profile as industry leader. ▪ Medium failure risk for City. ▪ Reasonable risk transfer. ▪ Share development costs. ▪ Medium timeframe before "live" Project. ▪ Strong control over Project outcome. ▪ High engagement with industry. ▪ Reasonable time for due diligence. ▪ Reasonable time for stakeholder education and consensus. ▪ Medium industry and local support. ▪ Incentivize industry innovation. ▪ Medium cost certainty. ▪ Higher supplier experience.	▪ Low upfront and longer term public funds required. ▪ Medium City resource effort required. ▪ Medium political risk. ▪ Difficult to maintain control and manage potential conflict of interest of lead suppliers within the industry.
Option 4: "Starter Project"	▪ Higher certainty of successful delivery. ▪ Reasonable risk transfer. ▪ Gain "path finder" opportunities with political support. ▪ Reduced Project cost and funding. ▪ Operational Project to prove performance. ▪ Shorter timescale – first to market.	▪ Low consensus i.e., not a compelling Project. ▪ Reduced service quality and ridership relative to larger project. ▪ Stakeholder buy-in is challenging at this time.

Source: Arup

4.2.1 Public/Private Collaboration Assessment

Arup recommended Option 3 (Public/Private Collaboration) to the City to develop the Project. This option was further considered by evaluating two sub-options, Option 3A "Preferred Supplier" and Option 3B "Industry Collaboration:

- Option 3A involves the City selecting a supplier to develop the Project from initial feasibility to commencement of operations
- Option 3B involves the City working collaboratively with the industry to develop the Project from initial feasibility to commencement of operations.

Figure 11 illustrates how both options would function in practice.

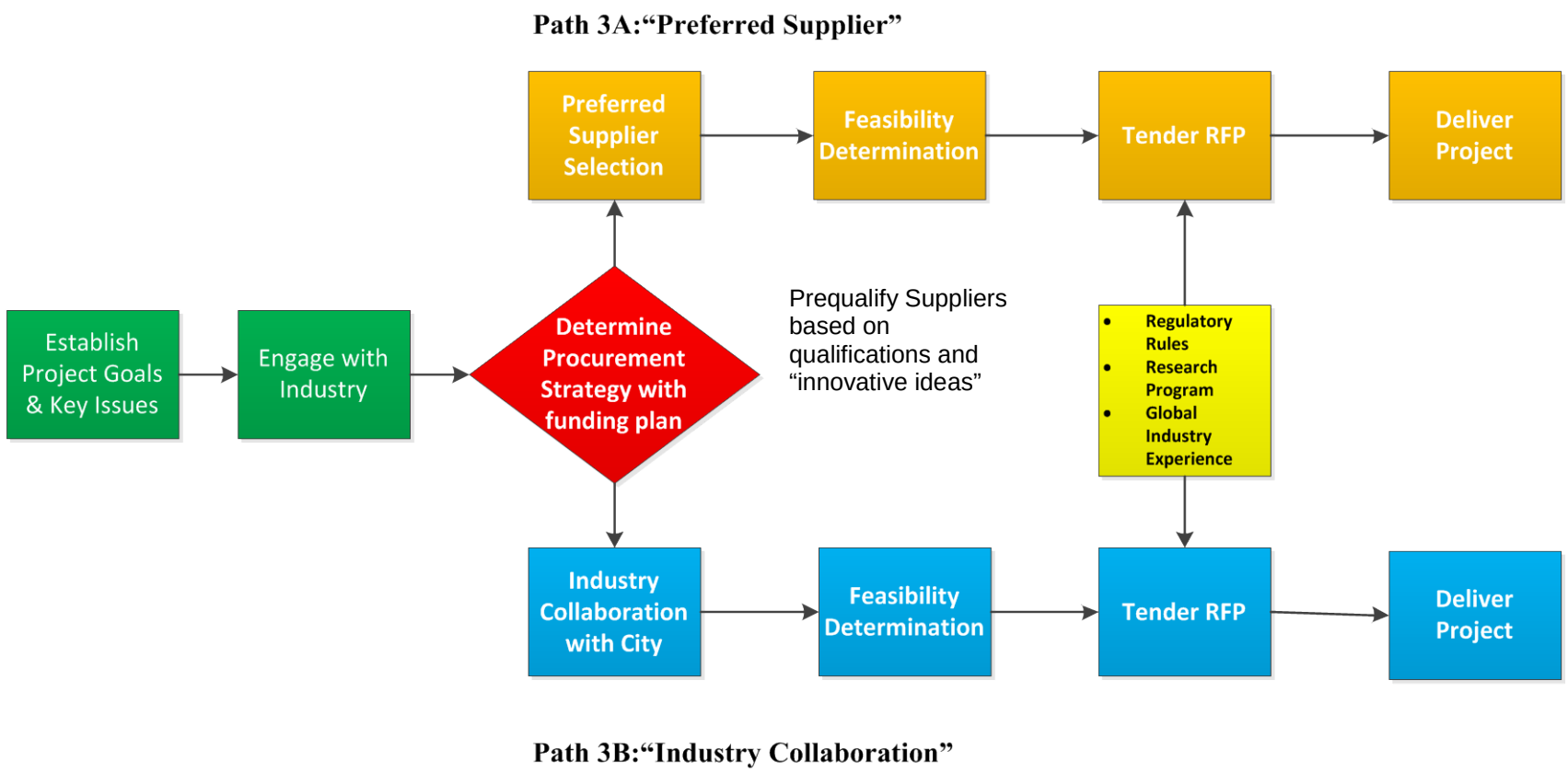
The qualitative evaluation of both development options is summarized in Table 29.

Table 29: Options 3A and 3B Assessment

Option	Pros	Cons
Option 3A: "Preferred Supplier"	▪ Lower development cost ▪ Obtain developed "winning ideas" on innovation earlier ▪ Simpler process (e.g. engagement with single supplier) ▪ Potentially develop Project earlier (e.g., focused with one supplier) ▪ Selection based on qualification and price	▪ Potential or perceived conflict of interest during development stage with preferred supplier. ▪ Maintain fair and transparent procurement process. ▪ Solution may be tailored towards one supplier only (i.e., no easy alternative)
Option 3B: "Industry Collaboration"	▪ Wider collection of industry experience ▪ Higher confidence with larger number of supplier engagement ▪ Opportunity to compare different technologies ▪ Alternative suppliers available to deliver Project (e.g., company failure)	▪ Higher development cost ▪ Higher level of effort required for supplier management ▪ Longer development phase may be required ▪ Difficulty achieving consensus between suppliers ▪ Lack of willingness to share information (e.g., innovation, IP and commercially sensitive information)

Source: Arup

Figure 11: Options 3A "Preferred Supplier" and 3B "Industry Collaboration"



Source: Arup

4.3 Recommendations

Following several Project team workshops with the City, Arup recommends Option 3A – "Preferred Supplier" in order to address the Project development tasks identified in Section 3.7.

The Project is a transportation project with significant innovation of technology and type of service it provides; therefore, there are no standard approaches for development and procurement for delivering the Project. As identified above, this Project will require a significant amount of development which will need creative approaches in order to deliver it successfully.

The key aspect of the recommended approach is to engage industry effectively in order to advance the Project's feasibility. This approach would allow a "client" and "supplier" to focus on a particular project in order to advance the understanding of technology readiness and the industry's delivery capabilities.

In addition, this approach would demonstrate commitment and willingness to succeed on both sides. Based on Arup's discussions with industry suppliers during the 2011 Request for Information process, the ATN industry is willing to engage in collaborative efforts, within commercially feasible limits, in order to advance the technology.

The primary benefits of this option are the ability to maintain a constructive and collaborative engagement with the Preferred Supplier, while respecting intellectual property rights and / or commercially sensitive information. The Preferred Supplier approach should lead to more efficient progress and incorporate innovation early in the process.

The benefits of pursuing the recommended Option 3A – "Preferred Supplier" development option are summarized follows:

- Leadership
- Project goals
- Industry understanding
- Right partnership
- Mutual goals
- Maintain competition

These "success factors" are described in more detail in the following sections.

4.3.1 Leadership

The City should show strong leadership by engaging with industry early to attract and incentivize progress, and advance the schedule to achieve "first mover" advantage. This could allow the City to capitalize on the current momentum for

this Project. This could help maintain the political and stakeholder support, attract potential funding commitments, and promote the City as an innovative leader among peers.

4.3.2 Project Goals

The City should establish clear expectations by defining the outline Project requirements and identifying clear Project goals. This is critical in order to advance the Project.

4.3.3 Industry Understanding

The City should establish a comprehensive industry understanding by sharing the key findings to solicit constructive feedback, innovative ideas, identify any fatal flaws, and better understand and validate the industry expertise and capability. This will allow the City to determine and develop the most appropriate procurement and funding strategy for the Project.

4.3.4 Right Partnership

The City should identify the right partnership and relationships by openly communicating and engaging with prequalified suppliers (e.g., selection based on capabilities, experience, financial standing/capability, key personnel, approach, and Project understanding).

With an independent peer review, this should give the City better understanding of the depth of the supplier pool available and an increased understanding of their ability to stay in business over the long-term. This will increase confidence that the City would select the most appropriate partner to further develop the Project.

4.3.5 Mutual Goals

Define mutual goals by creating the appropriate attitudes and incentives in order to engage industry innovation and reduce the Project uncertainty. The City should create a “win-win” scenario. This could involve a shared cost “co-development” agreement with clear decision-making/acceptance criteria.

4.3.6 Maintain Competition

Maintain competition: Maintain control of a fair, competitive, and transparent procurement process. The City should seek objective results with sufficient flexibility to maintain control of a competitive procurement process. With a “co-development” agreement cost sharing provisions could be adopted on an “open book” basis. In addition, the City could establish an “option to re-bid” the final delivery contract, once the feasibility determination stage has been reached. This will allow alternative suppliers to bring wider industry experience and knowledge to the bid of the Project, if necessary. In addition the City would include appropriate “off- ramps” in the co-development agreement to ensure competitive tension is maintained with the Preferred Supplier. At the end of the development

process (i.e., the point at which the Project has been determined feasible for procurement), the City would start a new procurement process to complete the design, construction and operation of the Project.

4.4 Co-development process

In order to deliver the "success factors" highlighted in the previous section, Arup created a "Co-development" process that could help the City to deliver a successful Project.

A successful project is ultimately dependent on the final negotiated agreement to deliver the project, which is subject to negotiation of efficient risk transfer between both parties and funding availability. In the following section, Arup describes the key attributes for this "Co-development" process:

- Shortlist a number of prospective bidders for a contract to help co-develop the Project. The winning bidder would enter into an exclusive interim agreement to act as a "co-developer" with the City. This first step would be to define a suitable Project to meet the City objectives and requirements. The City would need to have its own independent advisors to protect its interests.
- With a stipend offered by the City, it could utilize developers outline concepts/ideas. This could demonstrate the industry's ability to achieve the City's objectives, and allow the City to incorporate industry innovation early in the development process.
- During this "co-development" stage, the developer could be reimbursed using an "open book" or transparent basis up to a defined point with which the City is comfortable with the Project risk profile (e.g., feasibility determination stage). The co-developer could be reimbursed for achieving interim milestone(s) or receive a "success fee" based on independent verification of achieving the appropriate acceptance criteria.
- To ensure effective commitment on the private side, it is important to demonstrate their willingness to pursue and/or deliver a particular project (i.e., put "skin in the game"). This could be achieved in a number of ways, for example, cost sharing of project development costs, "sweat equity" for obtaining regulatory approval, "proving" technology capabilities at their own expense, or investing equity into the Project / development costs. During a "co-development" stage of the Project the cost sharing provisions could be adopted (e.g., 50/50) on an "open book" of actual time/material basis up to a cap, which would include reasonable allowance for profit.
- At the final delivery stage, among the other commercial incentives, the City could create meaningful commitments on the bid side with the appropriate level of performance bonds and security requirements etc.
- In order to allow the City flexibility and maintain control of a competitive procurement process, the City should maintain an "option to re-bid" the final delivery contract, once the feasibility determination stage has been

reached. In parallel, during the co-development stage or during the negotiation stage, industry experience and knowledge from global research programs, regulatory approvals, or completed projects, could be incorporated into the final bid documents.

- In return for achieving the feasibility determination stage, the City could offer, under a re-bid scenario, the original co-developer a 5% or 10% discount on the final bid price. This would be recognition for their contribution during the "co-development" stage. Again, at final bid stage, the City could offer stipends for conforming bids.
- Alternatively at the final bid stage, the City could conduct a sole source negotiation with the co-developer for a final agreement to deliver the Project, following acceptance at the feasibility determination stage. The City would need to have its own independent advisors to protect its interests.

The recommended next steps are summarized in 5.

5 Next Steps

The following is an outline of recommended next steps in order to further develop the Project as necessary to decide on the most appropriate implementation strategy:

Project Delivery/Leadership

- Set up a dedicated City Project-delivery team with appropriate leadership, management and governance resources
- Determine the decision-making protocol
- Establish and maintain political leadership and support at local, state and federal levels

Partnerships/Stakeholders

- Leverage valuable partner relationships to develop the Project (e.g., ATN vendors, local industry, state, and federal agencies)
- Consider engaging stakeholders with Memorandums of Understanding, etc.
- Determine the public outreach/communication protocol

Technology

- Engage with industry and adopt a suitable path forward to test/prove the technology
- Prepare a “bankable” risk profile (e.g., identified development options)

Approvals/Regulatory

- Solicit input from regulators on applicable codes/standards
- Define environmental approval process
- Define the Project approval process (e.g., approval agencies, legislative approval, etc.)

Costs/Risks

- Define the minimum Project performance requirements
- Advance the level of design detail and refine costs/risk estimates
- Define the acceptable level of overall affordability (i.e., construction costs and operations, and maintenance costs)
- Implement Project risk-management strategies
- Define the acceptable risk-tolerance level

Funding

- Identify a stable, predictable funding plan for short, medium and long-term goals with levels of commitments and timing of availability

Financing/Tax/Insurance

- Consider alternative procurement strategies and evaluate which one is best suited for the City using a VfM analysis (e.g., Design–Build, Design–Build–Finance, and Design–Build–Finance–Operate–Maintain, etc.)
- Explore private sector appetite for procurement methods that rely on transfer of risks to the private sector and the use of private financing

Appendix A

Risk Analysis

A1 Risk Identification

A summary of the risk identification and ranking (high, medium, and low) is shown below.

No.	Risk	Risk Description	Current Priority
Design and Construction			
1	Construction Costs	Risk that the actual capital costs are higher than anticipated (e.g., scope change, quantities or poor quality).	High
2	Design Specification	Risk that the design of the facility is incapable of delivering the services at the anticipated cost or that there are errors or omissions.	Medium
3	Site Condition	Risk that the geotechnical conditions vary from those assumed (e.g., unknown utilities, archaeological artifacts are discovered or unknown ground contamination) which causes construction costs to increase and/or causes construction delays.	Medium
4	Right-of-Way	Risk that the appropriate Project Right-of-Way is not addressed so as to enable the Project to be delivered as planned.	Low
5	Construction Schedule	Risk that the construction schedule is longer than anticipated (e.g., adverse weather conditions, labor disputes, lack of experience of supplier to deliver Project, or unknown ground conditions such as geotechnical / archaeological issues).	High
6	Testing and Commissioning	Risk that the commissioning and testing period is longer than anticipated and thus delays the start of operations/substantial completion.	High

No.	Risk	Risk Description	Current Priority
Operations and Maintenance			
7	Operation, Maintenance and Renewal costs	Risk that operations, maintenance and renewal costs are higher than anticipated (e.g., lack of historical data, increased O&M activities/quantities, reduced useful life, and increased energy costs).	High
8	Technology	Risk that the chosen technology is not adequate to accommodate the Project requirements/performance (e.g., becomes obsolete or fails).	High
Market and Political			
9	Market Capability	Risk that the ATN vendors do not have sufficient experience or partners to deliver the Project (e.g., primarily R&D experience and lack of experience delivering commercially viable systems).	High
10	Political Change	Risk that a change in political leadership could stop or change the Project as a result of different political priorities.	Medium
11	Project Management/Delivery	Risk that the appropriate level of City oversight and guidance is not achieved and critical project decisions are not made in a timely manner.	Medium
12	City Reputation	Risk that the Project fails as a result of poor decision-making or the failed Project damages the public confidence in the City's leadership and political support.	Medium
13	Ridership	Risk that the system does not serve the targeted population or reduce airport traffic, resulting in lower than expected ridership and an under-utilized/oversized facility.	Medium
14	Termination/ Default	Risk the vendors or City defaults, resulting in the Project being terminated.	Low
15	Force Majeure	Risk that the service in not delivered (pre- or post-completion) due to a force majeure.	Low
16	Option finder Opportunity	Risk the "first mover" opportunities will be lost if the project is not delivered first.	Medium

No.	Risk	Risk Description	Current Priority
Procurement and Legal			
17	Market Competition	Risk that there are not sufficient numbers of vendors in the market for a competitive procurement process and selection of the most suitable partner/bidder.	High
18	Regulatory Codes and Standards	Risk that existing regulatory codes, standards requirements, and approval process has to be amended to suit the ATN system, causing procurement delays and increased requirements.	High
19	Procurement Law	Risk that the City's procurement authority does not permit the Project to be procured as a Public-Private-Partnership (P3) or alternative delivery method.	Low
20	Stakeholder Approval	Risk that stakeholder approval is not obtained, is delayed, or is contingent on changes in the Project requirements.	High
21	Legal Challenge	Risk that a legal challenge is taken against the Project from opposition interest groups or local residents.	High
22	Permits and Approvals	Risk that necessary approvals are not obtained or are obtained but are subject to unanticipated conditions that have adverse cost consequences or cause prolonged delays (e.g., environmental approval process).	High
23	Procurement Strategy/Interface	Risk that the procurement strategy results in interface challenges that cause cost increases and poor performance (e.g., interface between Design/Construction and Operations/Maintenance).	Medium
24	Change in Law	Risk that a change in law or policy, which could not be anticipated, has adverse consequences on capital and/or operating costs.	Low
25	Award Protest	Risk that a legal challenge is taken against the project award.	Low

No.	Risk	Risk Description	Current Priority
Funding and Financing			
26	Bus savings ("Revenue")	Risk that the "Revenue" source changes i.e., no guaranteed commitments to support project payments.	High
27	Funding and Financing	Risk that the City does not establish an adequate funding and financing plan (e.g., the Project does not generate enough interest and creditworthiness among potential investors, lenders, and public authorities (federal, state and local) to support the funding and financing plan).	High
28	Additional Revenue	Risk that the revenue from additional sources are lower than anticipated (e.g., advertisement, parking user-charges etc.).	Low

A2 Potential Risk Impacts

A summary of the potential impact for the quantified key Project risks listed in Section 3.3.4 is presented below:

Construction Costs Risks

	Risks	Risk Description	Potential Impacts
1	Construction Costs	Risk that the actual capital costs are higher than anticipated (e.g. scope change, quantities, or poor quality).	▪ Increase in construction costs ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Increase in the public funding required
2	Construction Schedule	Risk that the construction schedule is longer than anticipated (e.g., adverse weather conditions, labor disputes, lack of experience of supplier to deliver Project, or unknown ground conditions such as geotechnical/archeological issues).	▪ Delay or inability to complete the Project ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Delay could lead to termination of contract, and replacement required

	Risks	Risk Description	Potential Impacts
3	Commissioning, Change in Law/Regulations, Permits and Approvals	Risk that the commissioning, testing, and Project approvals/permit period is longer than anticipated and thus delays the start of operations or achievement of substantial completion	▪ Delay or inability to complete the Project ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Suppliers do not maintain capacity to deliver project (e.g., insufficient financial standing) ▪ Increase in construction costs due to delay or legal pursuit ▪ Inability to secure necessary clearances and approvals (e.g., environmental)

	Risks	Risk Description	Potential Impacts
4	Technology Readiness, Funding Plan, Project Commencement	Risk of delay of Project commencement by regulatory approval of technology or technology readiness to achieve Project performance requirements, adequate funding plan or legal challenge (e.g., Project implementation could occur as early as 2015 or as late as 2025).	▪ Delay or inability to complete the Project ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Suppliers do not maintain capacity to deliver project (e.g., insufficient financial standing) ▪ Increase in construction costs due to delay or legal pursuit ▪ Inability to secure necessary regulatory approvals ▪ Increase in public funding required ▪ Re-scoping of Project or contract approaches ▪ Loss of private investment support
5	Market Capacity	Risk of insufficient number of vendors for a competitive procurement process and selection of the most suitable partner/bidder (e.g., premium on price due to lack of industry competition).	▪ Loss of stakeholder/political support ▪ Increase in Project costs ▪ Suppliers do not maintain capacity to deliver Project (e.g., insufficient financial standing)

Source: Arup

Operation & Maintenance Expenditure Risks

	Risks	Risk Description	Potential Impacts
1	Staff Cost	Risk that the actual staff costs are higher than anticipated (e.g., increased staff numbers, increased responsibilities, and specific expertise required, resulting in increased remuneration).	▪ Increase in operation costs ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Increase in public funding required
2	Maintenance Cost	Risk that the actual maintenance costs are higher than anticipated (e.g., increased frequency of parts replacement, higher "wear and tear," technology redundancy, lack of spare-parts supply).	▪ Increase in operations costs ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Increase in public funding required
3	Periodic Renewal Cost	Risk that the actual periodic renewal costs are higher than anticipated (e.g., lower useful asset life period than planned, unplanned replacement due to defects, technology obsolescence).	▪ Increase in operations costs ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Increase in public funding required
4	Energy Cost	Risk that the actual energy costs are higher than anticipated (e.g., uncertain weather conditions require increased vehicle cooling/ventilation, change in energy supply or market prices, energy demand is higher than expected for normal operations).	▪ Increase in operations costs ▪ Loss of stakeholder/political support ▪ Delay or inability to receive or keep funding ▪ Increase in public funding required

Source: Arup

A3 Potential Risk Mitigation Strategies

The table below highlights potential risk mitigation strategies for the key risks identified at this stage.

Construction Costs Risks

	Risks	Risk Description	Potential Mitigation Strategies
1	Construction Costs	Risk that the actual capital costs are higher than anticipated (e.g. scope change, quantities, or poor quality).	▪ Improve definition of Project scope of work, level of design, and requirements ▪ Conduct appropriate level of site testing and inspection ▪ Provide adequate Project team and organization with relevant experience to deliver Project and make timely decisions ▪ Allow sufficient risk and inflation contingencies in budget estimates ▪ Communicate uncertainty to stakeholder/political decision makers ▪ Allow a sufficient schedule extension in the planning ▪ Secure and maintain funding commitments ▪ Adopt appropriate procurement and contract strategy to manage and transfer risk efficiently ▪ Update, review, and validate cost projections ▪ Engage with industry for innovation and expertise ▪ Ensure adequate quality records and independent

	Risks	Risk Description	Potential Mitigation Strategies
			inspections are maintained ▪ Continue to incorporate value engineering to reduce overall Project cost without compromising quality or safety ▪ Maintain competitive procurement process with flexibility to incorporate innovation and change ▪ Select most appropriate partner to deliver the Project with relevant experience and financial standing
2	Construction Schedule	Risk that the construction schedule is longer than anticipated (e.g., adverse weather conditions, labor disputes, lack of experience of supplier to deliver Project, or unknown ground conditions such as geotechnical/archaeological issues).	▪ Develop a schedule for the entire Project based on highly dependent critical path items (e.g., regulatory and environmental approval, funding, etc.) ▪ Provide adequate Project team with relevant experience to deliver Project and make timely decisions ▪ Select most appropriate partner with relevant experience to deliver the Project ▪ Allow a sufficient schedule extension in the planning ▪ Allow sufficient site investigation and analysis to be undertaken ▪ Engage with labor unions and include adequate labor agreements in contract terms ▪ Engage with and commit stakeholders (e.g., environmental testing/inspection, Right-of-Way,

	Risks	Risk Description	Potential Mitigation Strategies
			access, etc.)
3	Commissioning, Change in Law/Regulations, Permits and Approvals	Risk that the commissioning, testing, and Project approvals/permit period is longer than anticipated and thus delays the start of operations or achievement of substantial completion.	▪ Engage with and commit stakeholders early in the process (e.g., regulatory bodies, legal/legislative and safety compliance, etc.) ▪ Maintain an independent peer review and test technology off site, based on acceptable standards ▪ Leverage global industry experience and expertise ▪ Engage, educate, and continue communication with approval bodies ▪ Outline approval process for suppliers Maintain legal review of pending changes
4	Technology Readiness, Funding Plan, Project Commencement	Risk of delay of Project commencement by regulatory approval of technology or technology readiness to achieve Project performance requirements, adequate funding plan or legal challenge (e.g., Project implementation could occur as early as 2015 or as late as 2025).	▪ Provide project requirements aligned with proven technologies and operational knowledge/results ▪ Maintain commercial incentives to achieve results (e.g., performance guarantees, letters of credit, etc.) ▪ Maintain an independent peer review and test technology off site, based on acceptable standards ▪ Provide innovative and efficient ways to transfer risk related to technology to the private sector ▪ Provide backup funding plan ▪ Maintain stakeholder support for the Project ▪ Maintain effective communication with all

	Risks	Risk Description	Potential Mitigation Strategies
			stakeholders, including public outreach ▪ Maintain an understanding of the Project risks ▪ Consider and monitor the interest of alternative sources of funds (e.g., private finance) to help deliver the project ▪ Maintain an investment grade project and procurement agency ▪ Maintain third-party agreements/interface and cooperation agreements with stakeholders
5	Market Capacity	Risk of insufficient number of vendors for a competitive procurement process and selection of the most suitable partner/bidder e.g., premium on price due to lack of industry competition	▪ Engage and continue communication with alternative supplier sources ▪ Provide incentives to engage and maintain interest of the supplier/private investors ▪ Provide a fair and transparent procurement process (i.e., not specified or tailored to one supplier). ▪ Define and articulate the Project "need" and political support ▪ Provide a pipeline of comparable projects ▪ Manage and monitor conflicts of interest

Source: Arup

Operation & Maintenance Expenditure Risks

	Risks	Risk Description	Potential Impacts
1	Staff Cost	Risk that the actual staff costs are higher than anticipated (e.g., increased staff numbers, increased responsibilities, and specific expertise required, resulting in increased remuneration).	▪ Develop a range of cost projections, including Low, Medium, and High scenarios, to understand the impact on the operational and long-term viability ▪ Allow sufficient risk and inflation contingencies in budget estimates ▪ Leverage global industry experience and expertise ▪ Conduct local market soundings ▪ Concur with fair and reasonable labor agreements
2	Maintenance Cost	Risk that the actual maintenance costs are higher than anticipated (e.g., increased frequency of parts replacement, higher "wear and tear," technology redundancy, lack of spare-parts supply).	▪ Develop operation model using an actual system and compare with tests/known results ▪ Allow sufficient risk and inflation contingencies in budget estimates ▪ Leverage global industry experience and expertise ▪ Maintain good practice procedures and adhere to recommended codes/standards
3	Periodic Renewal Cost	Risk that the actual periodic renewal costs are higher than anticipated (e.g., lower useful asset life period than planned, unplanned replacement due to defects, technology obsolescence).	▪ Develop operation model using an actual system and compare with tests/known results ▪ Allow sufficient risk and inflation contingencies in budget estimates ▪ Leverage global industry experience and expertise ▪ Maintain good practice procedures and adhere to recommended codes/standards
4	Energy Cost	Risk that the actual energy costs are higher than anticipated (e.g., uncertain weather conditions require increased vehicle	▪ Allow sufficient risk and inflation contingencies in

	Risks	Risk Description	Potential Impacts
		cooling/ventilation, change in energy supply or market prices, energy demand is higher than expected for normal operations).	budget estimates ▪ Leverage global industry experience and expertise in energy efficient technology ▪ Maintain good practice procedures and adhere to recommended codes/standards for energy efficiency ▪ Consider options/strategies to reduce energy demand or increase savings ▪ Consider commercial strategies to hedge against energy price fluctuations

Source: Arup

Appendix B

Possible Federal Grant Programs

Funding Source	Overview	Eligible Activities Relevant to the Project	Match Requirement
Section 5307 – Urbanized Area Formula Program	The program provides assistance for transit capital and operating expenditure in urbanized areas and for transportation-related planning.	- Planning, engineering design, and evaluation of transit projects and other technical transportation-related studies - Capital investments in new and existing fixed guideway systems including rolling stock, overhaul and rebuilding of vehicles, track, signals, communications, and computer hardware and software	Yes
Section 5309 – New Starts Program	The program supports the construction of new or extensions to fixed guideway systems.	- Light rail, rapid rail (heavy rail), commuter rail, monorail, automated fixed guideway system (such as a "people mover"), or a busway/high occupancy vehicle (HOV) facility, or an extension of any of these	Yes
Flexible Funding for Highway and Transit – Congestion Mitigation and Air Quality Improvement Program (CMAQ)	The program funds transportation projects or programs that contribute to improving air quality and relieving congestion.	- New or expanded transportation projects that reduce emissions, including capital investment in transportation infrastructure, congestion relief efforts, or other capital projects	Yes
Flexible Funding for Highway and Transit – Surface Transportation Program (STP)	The program supports a broad range of surface transportation capital needs, including many roads, transit, sea and airport access, vanpool, bike, and pedestrian facilities.	- Planning activities such as surface transportation planning activities, transit research and development, and environmental analysis	Yes
FTA National Research and Technology Program	The program seeks to improve public transportation by funding research, development, demonstration, and deployment projects.	- Research, development, demonstration, and deployment projects, and evaluation of technology of national significance to public transportation	No