LINKING BIKE PATH TO TRAIN TRACK:
RECOMMENDATIONS FOR IMPROVED BICYCLE PARKING FACILITIES
AT THE FUTURE BASELINE LRT STATION, OTTAWA

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EXECUTIVE SUMMARY

Transit station bicycle parking is good public policy. This is clear in the scholarly literature and is reflected in the practices of leading transit agencies. Implemented appropriately, it supports active transportation and public transit, an attractive outcome in view of the links between transportation mode choices and urban congestion, pollution, sustainability, and public health.

This report develops recommendations for bicycle parking at Baseline Station in Ottawa. The station was selected in light of its clear potential to benefit from improved bicycling integration: it is highly accessible by bicycle paths to a large population base and its current parking facilities are well-used. Moreover, the station is set to become a vital hub for both buses and trains once a light rail extension planned for 2023 is completed. This transition represents a unique opportunity to reassess the potential for improved intermodal linkages.

Recommendations are based on a literature review of international precedents and best practices, as well as case studies focused on Bay Area Rapid Transit (BART) and Metrolinx's Eglinton Crosstown project, adjusted for the local context using data sourced from Statistics Canada and the City of Ottawa. Key recommendations of this report include:

- **Bicycle Parking Quantity**
  Provide enough bicycle parking spaces to meet future demand. A conservative estimate of parking requirements in 2031 is 170 to 219 spaces, a projection which should be fine-tuned as planning for the light rail extension progresses. Provision for future expansion should be made at early stages of station design, and bicycle parking facilities should be routinely monitored to ensure spare capacity is available at all times.

- **Bicycle Parking Types**
  Offer an appropriate mix of parking types, recognizing the varying needs of users. An optimal composition for increasing ridership is roughly 22% for short-term facilities and 78% for long-term. Long-term parking should offer higher security by preventing public access to parked bicycles, for instance with bicycle cages or lockers.

- **Bicycle Parking Security**
  Allay fears of bicycle theft and vandalism by following best practices in facility security. Good security reduces a significant psychological barrier for prospective bicycle access transit users, and avoids ridership attrition among users who become victims of theft. Best practices include the use of active or passive surveillance, good lighting, and proactive maintenance.
• **Planning Context**
  The City of Ottawa should commit to a citywide target for increasing bicycle access ridership. Inaction has costs of its own. Bicycle access rates at major transit stations should be monitored and the success of investments in bicycle parking facilities evaluated. The City should also assess bicyclists’ willingness to pay for long-term parking, and investigate the possibility of integrating payment with the existing Presto smart card system.

• **Considerations and Supporting Measures**
  Evaluate the potential effect on bicycle access rates and parking needs of permitting bicycles to be brought on board light rail trains all day or only during off-peak hours. Ensure bicycle access routes are prioritized for clearance following a snowfall, and locate bicycle parking close to station entrances to minimize the distance bicyclists must walk after dismounting. Promote investments in improved bicycle parking facilities, potentially using empty advertising spaces on transit vehicles. Improve customer awareness of bicycle security through the placement of information posters or hang tags on parked bicycles, and post station area maps near station entrances indicating recommended bicycle routes and parking facilities.

Baseline Station has the potential to be a leading example of cycle-transit integration. Implementation of the report recommendations would be consistent with the existing policy direction of the City of Ottawa, and would increase transit ridership through bicycle access.

The introduction of LRT represents a rare opportunity to redesign Baseline Station with the bicycle infrastructure that supports the needs of today and tomorrow. Ottawa would be well-advised to seize it.
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1. INTRODUCTION

Recent decades have seen the emergence of active transportation as a priority for public health and planning professionals. The benefits of increased active mode share are manifold, ranging from diverse health benefits to reduced traffic congestion, lowered pollution and improved urban sustainability. Scholarly literature indicates there is good reason for public transit agencies to be attentive to the parking needs of bicyclists. It shows that improved connections between active transportation and public transportation offer considerable potential to be mutually reinforcing and produce increased rates of both active and public transportation use (Taylor & Mahmassani, 1996; Pucher & Buehler, 2009; Pucher, Dill, & Handy, 2010). Bicycle parking facilities offer a low-cost solution to what planners refer to as the first- and last-mile problem – the challenge of bringing passengers from their homes to transit hubs, and from transit hubs to final destinations that are beyond a convenient walking distance. These facilities can be provided at a significantly lower cost than neighbourhood feeder buses or car park and rides (Pucher & Buehler, 2009, p.79).

Transit service in Ottawa is provided by OC Transpo, run by the city’s Transit Services Department. The transit network will undergo major changes in coming years as the existing bus rapid transit (BRT) system is incrementally converted to a light rail transit (LRT) system. Meanwhile, increasing the attractiveness of bicycling as a commute choice and improving intermodal connections at transit stations have been touted as priorities in the city’s Transportation Master Plan and Cycling Plan. The Cycling Plan recognizes that the introduction of light rail will force some transit users to transfer between buses and trains, and proposes supporting direct bicycle access to LRT stations as an alternative (City of Ottawa, 2013a, p.35, 36, 47). Ensuring the new transit stations respond to forecasted bicycle infrastructure needs will support the realization of these goals.

This report assesses bicycle parking facility requirements at Baseline Station, already a key hub along Ottawa’s BRT spine. This station was selected because it exhibits significant potential to benefit from improved bicycling integration. Baseline Station can already be accessed via bicycle paths from several directions, and a large population lives within bicycling distance. Existing facilities at the station are basic in nature but are well-used and frequently at capacity, suggesting significant potential for growth in bicycle access ridership should these facilities be improved. Already one of OC Transpo’s busiest, the profile of Baseline Station is set to increase when it is converted as part of the western extension of the Confederation Line LRT. Scheduled for completion by 2023, the station will become a light rail terminus and assume the role of a main transfer point to the BRT routes that continue to further destinations. This transition represents a unique opportunity to reassess the potential for improved intermodal linkages and deliver on the potential to increase transit ridership through bicycle access. This report provides recommendations to the City of Ottawa regarding the quantity and type of bicycle parking facilities at Baseline Station in view of this transition to a LRT hub.
This report is organized in nine chapters. Chapter 2 discusses the methods employed in this report for developing bicycle parking recommendations for Baseline Station. Chapter 3 outlines the scholarly literature covering key aspects of bicycle parking provision at transit stations, and discusses international precedents and best practices developed for a range of cities and transit agencies. Chapter 4 presents the historical and geographic context of Baseline Station, existing conditions and changes anticipated for the station area in the coming years, and also outlines the bicycle catchment area considered for the purpose of this report. Chapters 5 and 6 present the case studies of Bay Area Rapid Transit (BART) and Metrolinx’s Eglinton Crosstown project, and their respective approaches to assessing bicycle parking requirements at their stations. Chapter 7 analyzes the implications of the case study approaches to assess potential bicycle parking needs at Baseline Station in 2031. Chapter 8 outlines a series of recommendations based on this analysis and the best practices identified in the literature and international examples. Chapter 9 concludes the report.
2. METHOD

The report uses a literature review, two case studies, and analysis of Ottawa's Baseline Station to develop bicycle parking recommendations in view of the planned conversion of the station into a light rail terminus.

2.1 Literature and Policy Document Review
Recommendations are informed by a review of academic literature and best practices in cycle-transit integration, including domestic and international examples such as Toronto, Calgary, Vancouver, and London, England. Key topics that are covered include the imbalance between bicycle parking supply and potential demand, security, catchment areas, acceptable costs of such a service to the public, and seasonality. Academic sources were primarily accessed through journal databases. This review provides a body of knowledge that contextualizes the discussion about bicycle parking facilities and underpins many of the recommendations developed for Baseline Station.

2.2 Case Studies
Case studies covering the approaches taken by two major public transit agencies to determining bicycle parking requirements at stations are reviewed in the report. BART, the transit agency serving the San Francisco Bay Area, has in recent years published detailed reports about bicycle parking facilities at its transit stations, covering their existing conditions and recommended improvements. BART, like the City of Ottawa, aims to render cycle-transit trips more attractive and reduce demand on its car park and ride facilities in a context of sustained long-term ridership growth. The reports published by BART offer a comprehensive picture, including ridership data, customer survey responses, station evaluations, and an overview of the method used to determine future parking needs. The agency employs a spreadsheet-based Bicycle Investment Tool to assess the likely impact of various bicycle infrastructure investments on bicycle access ridership. BART invites other public transit bodies to use the tool to help make sound investment decisions (Bay Area Rapid Transit, 2012b).

The second case study, the Eglinton Crosstown LRT, overseen by Metrolinx, is located in Toronto. The engineers involved in assessing the bicycle parking needs of the Crosstown stations summarized their process in a paper presented to a Canadian Institute of Transportation Engineers conference (Gough & Walker, 2014). Steps involved identifying a bicycle parking target relative to daily station ridership figures. These high level targets were then adjusted on the basis of detailed assessments of individual stations’ space constraints and other features.

The case studies were chosen on the basis of the practical consideration that their assessment processes were published and thus easily available, but also because, within a rapidly evolving field of study focused on bicycling in urban settings, they constitute very recent examples of approaches to the provision of bicycle parking at transit stations – indeed, the Crosstown case study reflects a currently ongoing project. In addition, both BART and Metrolinx represent major transit authorities and have made strong
commitments to encourage bicycle access ridership. Like Ottawa’s upcoming light rail system, BART’s network represents a key transportation spine. The Toronto example has the additional advantage of stemming from a context highly similar in geography and climate, and the Crosstown in many ways resembles Ottawa's Confederation Line in terms of technology, capacity, and routing through areas of ranging land uses.

2.3 Baseline Station Context & Analysis
The report considers the background, existing conditions, and future of Baseline Station and its immediate surroundings. Site visits at the station were performed from July, 2014, to April, 2015, to informally observe bicycle parking utilization. Census data from 2006 are used to assess the population within a proposed bicycle catchment area. Along with ridership data and projections for Baseline Station obtained from the City of Ottawa, these sources of information are key to applying the BART and Metrolinx/Eglinton Crosstown approaches to Baseline Station.

Analysis of the implications of the two approaches for Baseline Station is conducted in three steps: first, in the absolute number of bicycle parking spaces likely to be required; second, in the division of these spaces between short-term and long-term; and third, in the potential bicycle parking type options, including their potential bicycle access ridership benefit and capital and operating costs. The parking requirements are projected to 2031, consistent the time frame of the City of Ottawa’s ridership projections, by which time the light rail extension to Baseline Station will be complete and ridership levels matured.

2.4 Recommendations
On the basis of this research, the report makes recommendations for the future Baseline LRT station. Broadly, these cover the quantity and type of parking spaces, facility security, the planning context, and additional considerations and supporting measures.
3. LITERATURE & PRECEDENTS OVERVIEW

3.1 Academic Literature

Recent years have seen a flurry of academic attention directed towards improving intermodal connectivity between active transportation and public transit. This literature has addressed themes such as the imbalance between the supply of bicycle parking and the potential demand, security, catchment areas, the acceptable costs of such a service to the public, and seasonality.

In their study of major North American cities, Pucher and Buehler (2009) observed a significant gap between the demand for bicycle parking and its low supply. While bicycling and transit use have risen sharply in absolute numbers (in Canada, the former by 42% from 1996 to 2006; the latter by 46% from 1995 to 2008), the supply of bicycle parking spaces has often not kept up with demand.

Much of the literature has focused on security. Bicyclists are clearly particular about the kind of bicycle parking they will use. In their survey of Texas bicyclists, Taylor and Mahmassani (1996) found that secure bicycle parking was a major incentive for cycle-transit commuting (p.86). Even partial improvements, such as installing shelters, increased utility for bicyclists. Private lockers were most attractive, as they were seen to provide superior protection against theft and vandalism. The study also underlines the cost-effective nature of bicycle parking. Contrasting bicycle parking facilities with other bicycle infrastructure improvements, the authors found that, to the bicyclists sampled, the provision of lockers was as strong an incentive for bicycle access ridership as providing a segregated bicycle lane (p.91). Given the relative ease of installing bicycle lockers and the strong incentive they deliver, the authors argue that they should be “the first policy a transit agency should pursue” (p.94).

Noland and Kunreuther (1995) reached a similar conclusion, identifying secure bicycle parking as among the easiest ways of increasing the convenience of bicycling as a commute option (p.78). A range of surveys have clearly demonstrated the value bicyclists place on secure parking facilities. At the broad level, Tilahun, Levinson, and Krizek (2007) found that bicyclists were willing to endure longer travel times to enjoy greater bicycling amenities, supporting similar findings of Nelson and Allen (1997) and Dill and Carr (2003), who identified a correlation between better bicycle infrastructure and bicycle commuting (p.7).

Hunt and Abram (2006) found in their survey of Edmonton bicyclists that availability of secure parking was valued as approximately equal to a reduction of 26.5 minutes in commute time on a road in mixed traffic. By contrast, bicyclists weighed shower facilities at the destination as equivalent to a reduction of merely 3.6 minutes. Surprised by the results, the authors underlined that they reflected the importance of security for prospective commuter bicyclists (p.463). This effect is especially pronounced for younger demographics (p.465).
Catchment areas are a third key theme. Transit agencies usually use a catchment radius for bicycle access of 2.5 kilometres, corresponding to a 10 minute bicycle ride, though some agencies also consider obstacles and the directness of bicycling routes (Sherwin & Parkhurst, 2010; City of Ottawa, 2010). In the Netherlands, however, bicycle access transit users seem willing to travel longer distances – encouraged, perhaps, by bicycle-friendly infrastructure and terrain. There, proclivity to take a bicycle to a train station only drops significantly at distances greater than 3.5 kilometres (Keijer & Rietveld, 2000). It is clear, however, that bicycle catchment radiuses are significantly larger than those of pedestrians. Transit users that reach rail stations on foot are generally assumed to be unwilling to walk farther than 400 metres to 800 metres (Canepa, 2007, cited in TransLink, 2010b; Walker, 2012). The land area covered in a 2.5 kilometre radius is nearly ten times that of an 800 metre radius, suggesting that bicycle use can significantly increase the accessibility of transit.

Acceptable costs are the fourth major area of interest in the literature. Typically, it addresses the trade-off between user fees and security. Public attitudes are mixed when it comes to willingness to pay for secure bicycle parking. A Montreal study conducted by van Lierop, Lee, and El-Geneidy (2012) found that 43% of respondents were willing to pay at least $0.50 a day for this service. Commuters who were most influenced against bicycling by the fear of theft were most likely to demonstrate a willingness to pay for secure parking. The researchers emphasized, however, that cities should minimize the end-user cost of secure parking to ensure it remains an incentive for bicycling (p.17).

Research conducted for the regional transportation authority for Metro Vancouver found a strong relationship between willingness to pay and the perceived security of various parking options. By illustration, the study found that the most secure option, an attended bicycle station, offered for $15 per month was nearly as desirable as the next most attractive option, a bicycle cage with video surveillance accessible by card reader, offered at $8 (TransLink, 2009, p.53).

The results of a 2006 commuter bicyclist survey in Calgary indicated that 19% of respondents had had their bicycle stolen within the past five years, and that 48% of respondents were somewhat or very likely to use a bicycle station facility that offered secure lockup and showers. Of those who indicated they would use such a facility, the average daily cost they would be willing to pay was $1.95, or a monthly cost of $27.63 (City of Calgary, 2006, p.19-20).

The financial burden of providing the most basic bicycle parking facilities should be only a modest deterrent for municipalities, as it is significantly less expensive than park and ride facilities for cars. Each bicycle space requires a maximum of two square metres of land, compared to thirty square metres for cars, and a fraction of the capital and operating costs (Litman et al., 2006, p.43).

A final area of focus relates to seasonality, especially in the Canadian context. There is evidence that bicycling rates are reduced in the winter months in northern cities, but the
extent of the decrease can be managed. In their study of Swedish cities, Bergstrom and Magnusson (2003) found that between the summer and winter, commuter bicycling trips dropped 47%, but that improved snow clearance on bicycle routes could return an increase of winter bicycling trips of 18%. Presumably there is a concomitant reduction in transit passengers who access stations by bicycle in the winter. However, given the relatively short bicycling distance in bicycle access transit trips – with bicycling constituting a fraction of the full trip distance – the winter reduction is likely to be less pronounced than for commuter bicycling. This suggests that bicycle access transit trips can remain a highly viable transportation method year-round, especially if snow clearance along bicycling routes is performed to a high standard.

Long term parking rates may also be used to encourage year-round bicycling. By rendering monthly or six-month subscriptions relatively more expensive than annual passes, users are encouraged to continue bicycling even into the winter months. Such a pricing strategy was proposed in a report prepared for TransLink (2009, p.15).

3.2 Domestic and International Precedents

A range of cities have demonstrated willingness to set standards for bicycle parking and improve cycle-transit integration. In the Greater Toronto and Hamilton Area, the Toronto Transit Commission (TTC) and GO Transit have invested significantly in bicycle parking facilities. In 2008, TTC subway stations boasted 1,192 short-term spaces and GO Transit rail stations 579 spaces (Pucher & Buehler, 2009, p.93). A 2000 survey indicated that many of these facilities were at capacity (City of Toronto, 2015a). The City of Toronto notes on its website that Union Station, the downtown transit hub, has 120 bicycle rack spaces and a changing room with key card access, which is being expanded to allow for 220 spaces and shower facilities. These lockers are available at a cost of $10 per month. The City has also installed 230 bicycle lockers at strategic locations, each of which can only be opened with a unique key. There is a waiting list for this service, indicating that many bicyclists are willing to pay for improved security (City of Toronto, 2015b and 2015c).

Toronto has also published draft guidelines for planners, developers, and property managers on the design of bicycle parking facilities, acknowledging that with just 1% of commuters traveling by bicycle in 2006, improvements to infrastructure – along with a host of other measures – are needed to increase the bicycling mode share (City of Toronto, 2008, p.1). Among the guidelines identified as key to high quality parking facilities are accessibility, convenience, and security. For long-term parking, Toronto recommends the installation of lockers that store bicycles individually, or restricted-access bicycle cages, indoor garage space, or bicycle rooms. These areas should be monitored with surveillance (City of Toronto, p.3-4, p.7-10, p.20).

Calgary released a guide to bicycle parking in 2008 directed primarily at developers, observing that unsatisfactory parking facilities hamper the uptake of bicycling as a mode of transportation (City of Calgary, 2008, p.3). In their overview of the various types of parking, they note that longer-term class 1 facilities, which offer protection from vandalism, weather, and theft, are highly suited to major destinations such as light rail stations and
downtown parking garages (p.4). The guide notes that a key advantage of subscription-based models of parking space delivery is that space availability is guaranteed to the bicyclist. Lockers are usually rented for between $10 and $15 per month, significantly less expensive than car parking spaces (p.7). Limited-access bicycle cages are a higher-capacity alternative, and when monitored offer an equivalent standard of security (p.8). The report underlines that irrespective of the type of parking, it should be in a well-lit and highly visible location, and should be closer to the main entrance than car parking (p.15).

In Vancouver, TransLink, has installed bicycle racks at all SkyTrain (light metro) and West Coast Express (commuter rail) stations. In 2008 there were 660 bicycle rack spaces and 400 bicycle locker spaces (Pucher & Buehler, 2009, p.88-89). Bicycle lockers were predominantly used for commuting, representing 84% of all uses (TransLink, 2009, p.42). The city has also taken a strong stance on bicycle parking facilities in new developments. Since 1995 they have had to adhere to minimum requirements for bicycle rooms, garages, compounds, or lockers, which must be indicated on development application drawings. The design supplement further specifies that facilities’ location must not be below the first complete parking level, and security features such as tamper-proof hinges and motion-activated lights (City of Vancouver, 2001, p.1-2).

Transport for London (TfL) published guidelines for bicycle parking at businesses, institutions, and transit stations, aimed at accommodating present and future demand, in response to the widespread perception that “there is nowhere, or nowhere safe to leave the bike” (2005). TfL notes that bicyclists are less likely to use facilities more than 50 metres from their destination for short-term parking, or indeed any facility that requires an inordinately early transition to walking. Smaller, spread-out facilities in larger numbers therefore have greater utility than larger, concentrated ones, and public transit stations should provide parking at each entrance. TfL encourages care in the arrangement and condition of facilities and the state of the surroundings, as these factors influence bicyclists’ willingness to park. Another key factor is availability of spaces. Working with survey data, TfL created a typology of station types and recommended bicycle parking standards for each.

Security is a major public concern in London: police estimate that 60,000 bicycles are stolen annually. Policymakers ought to be concerned as well, because 24% of theft victims abandon bicycling altogether. Since 1998, TfL has been involved in the national Secure Stations Scheme, aimed at setting standards for station security. Factors identified as instrumental for station bicycle parking include visibility, lighting, CCTV coverage, personal safety, distance from curb, lack of obstruction, and weatherproofing. Parking facilities may include lockable compounds and use smart card technology, but TfL offers few details on how it decides which to implement (Transport for London, 2005).

These practices also align broadly with best practices in bicycle parking security outlined in industry literature, such as the publications of the Association of Pedestrian and Bicycle Professionals (APBP) and Transit Cooperative Research Program (TCRP). The APBP provides detailed recommendations relating to the types and placement of short-term and long-term parking facilities (2010). The TCRP encourages bicycle parking be located in
will-lit areas as close to station entrances as possible, taking advantage of passive surveillance from station personnel or pedestrian traffic, and also that parking be located where weather protection is available where possible (2012, p.73).

The Netherlands has invested heavily in bicycle parking facilities at train stations. As Martens (2007) notes, increasing the capacity and quality of secure parking facilities at train stations has become a national priority. This has led both to improved bicyclist satisfaction and to a significant rise in commutes that involve some measure of bicycling. According to Dutch standards, parking facilities – secured and regular – must have 20% spare capacity even at peak times (p.330). The result has been a proliferation of parking facilities (Gemeente Amsterdam, 2014).

The integral nature of bicycling for commuters was further reflected in the study of Dutch railway stations performed by Keijer and Rietveld (2000). On the home end of commutes, over one in three passengers used a bicycle to reach the station in 1994, a remarkable figure by any North American standard. By 2009 this figure increased to 40% of the daily 1.2 million daily railway commuters in the Netherlands (Geerdink et al., 2010, p.26). A key implication of the study is that a smaller number of spaces is required at the activity end of commutes, as most travelers walk that final distance. The authors emphasize that the Dutch experience is not directly transferable to other contexts, but in instances where transit users reside within bicycling distance of transit stations, the provision of adequate bicycle parking should be a priority.

The benefits of bicycle parking investments can be better assured through supportive policy measures. In San Francisco, for instance, BART has published an extensive set of recommendations. These include the promotion of bicycle access ridership use through information campaigns and advertising, as well as improved wayfinding tools such as station area maps with recommended bicycle routes. The recommendations underline the importance of frequent maintenance and the prompt removal of vandalized bicycles and leftover locks (Bay Area Rapid Transit, 2012a, p.15, p.43-51).

These precedents reveal a broad consensus that providing attractive bicycle parking at transit stations merits attention and investment. The scholarly literature supports this view, as do the examples provided by a range of cities. Municipalities stand to gain from increased cycling rates and transit ridership, along with the wide range of associated health, environmental, and mobility benefits identified by previous public health and planning research. Ottawa would not be amiss in following domestic and international initiatives in this area.

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1 See also the Government of the Netherlands webpage concerning this topic (Rijksoverheid, 2014).
4. BASELINE STATION

4.1 Ottawa Context

Ottawa is Canada’s capital, located in the province of Ontario. Directly across the Ottawa River is Gatineau, Quebec. In 2006, Ottawa’s population was 812,129, and the population of the Ottawa-Gatineau census metropolitan area was 1,130,761, the fourth-largest in the country (Statistics Canada, 2007b and 2007c).

Public transit service in Ottawa is provided by OC Transpo, which today has over 900 buses in its fleet, nearly half of which are the high capacity articulated or double-decker models. OC Transpo also owns six diesel-powered light rail trains that serve the 8-kilometre Trillium Line. Bicycles can be transported seasonally on racks affixed to the front of many buses as part of the Rack and Roll program, and may also be brought on board Trillium Line trains year-round (OC Transpo, 2015c).

Baseline Station is a major rapid transit station 10 kilometres southwest of Ottawa’s downtown core. It is adjacent to Woodroffe Avenue about 300 metres south of Baseline Road, both major arteries.

4.2 Station Background

Ottawa was an early adopter of the bus rapid transit (BRT) model of public transit. Until the eleven constituent municipalities and townships were amalgamated in 2000, the Regional Municipality of Ottawa-Carleton (RMOC) was the upper-tier municipal government body responsible for the provision of transit service in the Ottawa region. In 1978, the RMOC outlined a $200 million plan for the development of exclusive transit corridors to connect downtown Ottawa to secondary urban areas. Future development was to be concentrated along these corridors, which became known in Ottawa as the Transitway. Baseline Station, in the municipality of Nepean, was the terminus of the Southwest Transitway. It was located less than 500 metres from Nepean’s planned future civic centre.2

On December 12, 1983, the partly-completed Baseline Station was opened for passenger service, along with six other stations and the first sections of the Transitway. The occasion marked a key first step in the RMOC’s transit plan for the Canadian capital region (OC Transpo, 2015a).3

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2 In 1988, the Nepean Civic Centre was completed, housing a council chamber, theatre, and library. It has since been renamed Ben Franklin Place.
3 In 1996, the last sections of the 31-kilometre busway approved in 1978 were completed.
In this first iteration, Baseline Station was an island platform station about 150 metres long. It offered seating and sheltered waiting areas with heating available in the winter. A convenience store was located at its southern end. The station became a major transfer point in western Ottawa.

By the late 2000s, network capacity shortfalls had led to planning for the incremental conversion of Ottawa’s BRT network to light rail, to be known as the Confederation Line. As construction of the first phase of this LRT began, detailed planning commenced for the second phase, which was to include a western extension to Baseline Station.
In a separate development, a 2007 agreement between the City of Ottawa and Algonquin College saw Baseline Station rebuilt about 80 metres west to make way for a new college building. The new station differs markedly from the original. The island platform was replaced by two side platforms over 200 metres long, which are separated by four busway lanes. A median barrier discourages pedestrians from crossing between platforms outside the designated crosswalks at each end. The new station no longer features a convenience store, and the new shelters do not run the full length of the platforms and are no longer heated during the winter. This facility is considered a temporary arrangement.

With LRT expansion in mind, and recognizing the long-term plan for the development of an integrated town centre near the station, the City of Ottawa approved the excavation of a trench between the sites of the original station and the newer station to the west. It is the future site of the Baseline LRT station.

4.3 Existing Conditions

Land Use and Demographics

Land uses adjacent to the station are diverse, including residential, institutional, commercial office, retail, and service designations. Four stable residential communities fall within the proposed Baseline Station bicycle catchment area outlined in section 4.5:

1. Briargreen-Centrepointe, located between Baseline Road, the CN rail corridor, Greenbank Road, and Woodroffe Avenue.
2. Woodvale-Craig Henry-Manordale-Estates of Arlington Woods, located between the CN rail corridor, Hunt Club Road, Greenbank Road, and Woodroffe Avenue.
3. Crestview-Meadowlands, located between Baseline Road, the CN rail corridor, Woodroffe Avenue, and Merivale Road.
4. Tanglewood, located between the CN rail corridor, Hunt Club Road, Woodroffe Avenue, and Merivale Road.

According to the national census, the combined population of these neighbourhoods was 30,800 in 2006.

The immediate 500 metre radius of the station is host to most of the non-residential uses in the area. Notable institutional uses nearby include Ben Franklin Place, which houses a satellite office of the City of Ottawa, a public library branch, and the Centrepointe Theatre; Sir Guy Carleton High School; and the municipal archives and library materials centre. Major commercial uses include the College Square power centre, which is anchored by a supermarket and hardware retailer, as well as three office buildings, the largest of which has over 380,000 square feet of rentable space. Surface parking lots for these buildings are considerable. Combined they offer well over 2,000 spaces (Arnon, 2015).
The main campus of Algonquin College, adjacent to the station, straddles both sides of Woodroffe Avenue with a pedestrian bridge crossing the artery. In 2004, over half the student population used transit as their primary mode of transport to and from school. In the fall of 2014, Algonquin students and the city agreed to a universal transit pass to be implemented in 2015. This is likely to increase the transit mode share among the 16,000 students as the transit pass will be included in tuition costs, rendering car use a comparatively costlier proposition (City of Ottawa, 2005; Algonquin Students Association, 2014).

According to the City of Ottawa’s employment survey, 7,858 jobs were located within a 600 metre radius of Baseline Station in 2012, up more than 5% from the 2006 level (City of Ottawa, 2013c).
Today Baseline Station is served by a wide array of bus routes. Most notable are the two 90-series rapid transit lines, including the 95, OC Transpo’s busiest and most frequent service. It operates all day throughout the week, with peak hour headways as low as 60 seconds.

According to city staff, Baseline Station ridership averaged 13,000 boardings and 13,000 alightings on workdays in 2014. The data do not differentiate between initial boardings and transfer boardings (City of Ottawa planner, email correspondence, February 2, 2015).

Baseline Station offers park and ride facilities accommodating 276 cars directly south of the platforms, accessible via Woodroffe Avenue. Parking requires a permit on weekday mornings, which costs $23.50 per month. OC Transpo indicates that the Baseline lot usually reaches capacity on workdays by the end of the morning peak (OC Transpo, 2015b). The transit agency’s 2013 performance report notes that citywide, demand for park and ride spaces is trending upward (OC Transpo, 2014, p.14-15).

**Bicycling Context**

Some measures to support bicycle access ridership currently exist at Baseline Station. The station offers sheltered bicycle parking facilities, and is one of ten Transitway stations, all located in predominantly residential areas, to do so (City of Ottawa, 2011). These are a recent introduction, absent from the original, pre-2009 station. There are two sheltered racks with space for seven bicycles each, and three unsheltered racks with space for three bicycles each, for a total of 23 spaces. The facilities are not attended, but are located in easy view on the platforms and are well-lit. All are O-ring racks, a type suitable for short-term parking (Association of Pedestrian and Bicycle Professionals, 2010).

Baseline Station is connected to nearby areas through roadside bicycle lanes and mixed-use pathways that permit pedestrian, bicycle, and other non-motorized modes such as inline skating. The proposed catchment area of the station features about 2.5 kilometres of bicycle lanes and 10 kilometres of mixed-use pathways. Moreover, the Ottawa Cycling Map indicates a Suggested Routes network that runs along roads with lower traffic speeds (City of Ottawa, 2011).

At 2% in 2011, bicycling accounts for a small proportion of daily trips citywide, though it represented an increase of half a percentage point from 2005. This compares to mode shares of 15.5% for transit and 71.5% for car users (City of Ottawa, 2013b).

Census data for the selected Baseline Station catchment area show that in 2006, only 315 residents commuted to work by bicycle. Most – 10,565 – reached their workplace destination by car, truck or van (1,135 of whom were passengers), 3,565 used public transit, and 555 walked (Statistics Canada, 2007a).
4.4 Future Conditions

In the context of the Western LRT Corridor Study process, the City confirmed in 2013 that the Confederation Line will reach Baseline Station (City of Ottawa, 2013d). This extension is expected to be complete by 2023. Ottawa’s regional traffic model anticipates that by 2031, the station will see nearly 1,900 initial boardings – out of a total of over 13,000 boardings – during the morning peak hour (between 6:30 and 8:59) (City of Ottawa planner, email correspondence, February 2, 2015).4

By 2031, the population of Ottawa is expected to grow by 30%, and the Baseline Station area is also set to experience significant change (City of Ottawa, 2015c). Most of the lands in the station’s 600 metre radius fall into the Mixed Use Centre designation under the city’s Official Plan. This designation permits a diverse range of uses. Focal points for development in Ottawa, the Mixed Use Centre designation aims to create livable and intensified communities that offer opportunities for work, living, and recreation (City of Ottawa, 2012a).

The direction of the Official Plan is given finer detail in the Baseline and Woodroffe Secondary Plan and the Centrepointe Town Centre Concept Plan. These plans indicate intensification will occur on the surface parking lots west of the station. Office, residential, and mixed-use buildings will be concentrated in these lands, which satisfy the Transit-Oriented Development objectives the City has outlined for lands near rapid transit stations (City of Ottawa, 2008; City of Ottawa, 2012b).

Recognizing this development potential, the Ottawa Cycling Plan defines the Algonquin College/Constellation area as one of five key employment nodes outside the downtown core within whose four-kilometre radiuses bicycling improvements will be prioritized. Given the central location of Baseline Station in this precinct, such investments can be assumed to also facilitate bicycle access ridership (City of Ottawa, 2013a, p.59).

More broadly, the Cycling Plan encourages taking advantage of areas with excellent transit access to encourage the Bike-Ride-Walk model for trips. Acknowledging that the introduction of light rail will force some transit users into transferring between buses and trains, the Plan proposes supporting direct bicycle access to LRT stations as an alternative. To this end, it calls for improved connectivity in the bicycling catchment area, or bike shed, of new stations. It also indicates that bicycle racks offering 600 spaces will be installed across the 13 stations of the first phase of light rail – representing an average of 46 spaces per station – and commits to sheltering at least 40% of these, and locating them in well-lit areas close to the station entrances. The Plan indicates funding will be provided for a transit station bicycle locker pilot project, though no time frame is offered (City of Ottawa, 2013a, p.35, 36, 47).

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4 Initial boardings exclude boardings that represent bus-to-bus connections.
All Confederation Line trains will allow on board access for bicycles. This may encourage some bicyclists to both start and finish their commutes by bicycle. It remains unclear whether bicycles will be permitted on light rail trains all day or only during off-peak hours.

4.5 Proposed Bicycle Catchment Area

A key variable is the approximate distance bicyclists can be assumed to travel in order to reach Baseline Station. While this clearly varies by person, this report considers several factors to propose realistic parameters for a catchment area:

- **The quality of the bicycle network** - While Dutch researchers have found that bicyclists can routinely be expected to travel upward of 3.5 kilometres to access stations, differences in bicycle infrastructure warrant the use of a more conservative catchment estimate. A 2.5 kilometre catchment radius, representing the average distance covered by a typical bicyclist in ten minutes, is common in transportation planning (see Chapter 3) and was the starting point used for this analysis. The effective distance traveled is usually larger than the direct distance given the reality of the bicycling network.

- **Route obstacles** - Where they do not run in the trip direction, arterial roads with few crossings represent obstacles that are likely to reduce the attractiveness of Baseline Station as a destination for bicyclists.

- **The relative location of other rapid transit stations and the dominant direction of travel** - Passengers are more likely to travel to a station that is closer to them than one farther than them in the event that their starting point falls in both stations’ catchment radiiues. Areas north of Baseline Road are presumed to be within the catchment area of Iris Station. A small portion of these areas are closer to Baseline Station, but this study assumes that the dominant direction of travel is toward downtown and that passengers are less likely to travel to a station that requires bicycling in the reverse direction of their trip.

These factors are reflected in the proposed Baseline Station bicycle catchment area (Figure 4, following page). Notably, the relative quality and quantity of bicycle parking spaces at other transit stations in the OC Transpo network are absent from consideration. This report assumes that bicycle parking facilities will also be upgraded at the other stations along the LRT corridor.
Figure 4 – Proposed Baseline Station bicycle catchment area and existing bicycling network (Google, 2015)
5. CASE STUDY: BAY AREA RAPID TRANSIT

5.1 Background

Bay Area Rapid Transit, or BART, is a 44-station heavy rail rapid transit system that operates in the San Francisco Bay Area. Transportation researchers John Pucher and Ralph Buehler consider it a particularly successful example of cycle-transit integration (2009, p.85-87). BART encourages bicycling to its stations for a range of reasons – to increase ridership, reduce car access rates to stations to avoid the costs of new car parking, and help produce the public health, economic, and environmental benefits associated with bicycling. From 1998 to 2008, bicycle access to BART stations increased 69%, while daily ridership grew 27%. In 2010, 4.1% of passengers arrived at stations on bicycle. BART aims to increase this to 8% of all trips by 2022. To accomplish this, BART employs a wide-ranging bicycling strategy, outlined in the agency’s Bicycle Plan (Bay Area Rapid Transit, 2012a).

BART has found that investments in secure parking and increases in bicycle access rates are highly correlated. Various types of bicycle parking are available at nearly all of its stations. In 2011, total supply was nearly 4,600 spaces, of which nearly two-thirds was in the form of bicycle racks. Almost 700 spaces were available at attended or controlled-access bicycle stations. A similar number of keyed lockers are being replaced by electronic lockers. Electronic locker spaces use smart cards, permitting more efficient use than keyed lockers tied to a single renter. In 2015, the number of electronic lockers was over 1,100 (Bay Area Rapid Transit, 2008, 2012a, and 2015b).

In addition to increasing bicycle access rates, secure bicycle parking is targeted at passengers who would in its absence bring their bicycles on board the trains, decreasing the trains’ passenger capacity. For decades, BART prohibited bicycles during peak hours, but in 2013 these blackout periods were lifted, subject to certain limits.5 Even before this development, more than one in two passengers that took their bicycle to a station brought it on board the train (Bay Area Rapid Transit, 2012a).

As part of its bicycling promotion strategy, BART offers bicycle parking security tips on its website and partners with Bike East Bay, a bicycling advocacy group, on theft prevention. The authority also used its police force to place hang tags on parked bicycles featuring instructions on how best to deter thieves and what to do in the event theft does occur (Bay Area Rapid Transit, 2015b; 2012a, p.15).

BART has found through focus group research that the relative cost and availability of car parking has a significant impact on bicycle access rates. Some passengers turned to bicycling to stations after experiencing full car parking lots. Increases in the cost of car parking – or, for that matter, shifting from free to paid parking – corresponded to the largest increases in bicycle access (Bay Area Rapid Transit, 2012a, p.25).

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5 One such limit is that bicycles may not be brought into crowded train cars.
5.2 Bicycle Parking Requirement Assessment Method

To determine the most appropriate bicycle parking facilities for its stations, BART uses a spreadsheet-based Bicycle Investment Tool developed by Fehr & Peers, a transportation consulting firm (Bay Area Rapid Transit, 2012b). The Tool assists policymakers by providing for inputs on a range of variables. These include the allocated capital and operating budgets for bicycle facilities, facility costs, the station environment, daily station ridership, as well as characteristics such as nearby population, quantity and type of existing bicycle parking spaces, their perceived security, peak occupancy, and public preferences as to the various types of bicycle parking.

![Figure 5 – Bicycle Investment Tool interface (Bay Area Rapid Transit, 2012b)](image)

The Bicycle Investment Tool operates under certain key assumptions: that investments in a type of bicycle parking where its peak occupancy is less than 85% will not attract additional bicyclists; that investments in a type of bicycle parking ranked by respondents to their public opinion survey as inferior to existing facilities will not attract additional bicyclists where existing peak occupancy is less than 85%; that where peak occupancy is greater than 85%, investment in any type of additional parking will attract additional...
bicyclists; and that investments in a type of bicycle parking not currently present but ranked as superior to existing facilities will attract additional bicyclists.

Recognizing the limits of the ability of bicycle parking facilities to increase bicycle access ridership, BART introduced a supply ceiling, reflecting maximums based on the Tool designers’ professional observations and judgment. Once a given type of bicycle parking is increased past its individual threshold, or the combined threshold of parking of similar types, additional supply stops increasing bicycle access rates, though the facilities’ capital and operation costs are still calculated.

The designers of the Tool also introduced a diminishing returns mechanism, reflecting the observed lower occupancy of oversupplied parking types at BART stations, and the attractiveness of choice to bicycle access users. The first quartile of bicycle parking spaces between the existing supply of a given type of bicycle parking and its supply ceiling carries the full ridership-increasing effect. The effectiveness of additional parking drops to 75%, 50%, and 25% of its full potential, once the quantity of that type of parking enters following quartiles. This means that as more of an individual type of parking is provided, further investments of that type of parking produce a lower increase in ridership.

The Bicycle Investment Tool does not suggest a single preferred approach to the quantity and type of bicycle parking, but it can assist in the evaluation of a range of potential parking scenarios, based on combinations of bicycle parking types. It proposes the most beneficial ratio of short-term to long-term parking consistent with Association of Pedestrian and Bicycle Professionals (APBP) standards, and indicates the changes to bicycle access ridership and the capital and operating cost of those facilities that each approach is likely to produce. This allows for easy comparison of the merits of various options at achieving bicycle access ridership growth within a fixed budget envelope.

BART extrapolated the desirability of various types of bicycle parking facilities from survey responses collected in San Francisco. It is possible that in particular locations within this or other cities, potential bicycle access transit users would have different preferences. However, the results do appear to correspond to the results of a survey conducted by TransLink (2009, p.49), which presented similar bicycle parking options and asked respondents to rate their level of security. Similarly, facility cost data collected in San Francisco may not be reflective of cost elsewhere, but it appears likely that at a minimum their relative cost would be similar.
6. CASE STUDY: METROLINX / EGLINTON CROSSTOWN

6.1 Background

Like Ottawa’s Confederation Line, the Eglinton Crosstown is a LRT line currently under construction. It will run along a 19 kilometre corridor, of which 10 kilometres will be underground, and will feature 25 stops and stations upon its scheduled service start in 2020 (Metrolinx, 2015a). The $5.3 billion project is funded by the provincial transportation agency for the Greater Toronto and Hamilton Area, Metrolinx, which is also overseeing its construction, but once complete the Crosstown will be turned over to the Toronto Transit Commission (TTC) for operation.

In 2001, Toronto’s Bicycle Plan called for the city to become more bicycle friendly, promoting bicycling as a means of everyday transportation with the objective of doubling the number of bicycle trips within ten years. Noting that when “bikes and transit work as a team, they make a formidable alternative to the car,” the Plan also called for improved cycle-transit integration. In the intervening years, the city has implemented a range of measures to improve cycle-transit integration, focusing on improved bicycle accommodation on transit vehicles, bicycle parking at transit stations, and bicycle network access to the stations (City of Toronto, 2001, 8-1 & 8-2). Bicycle stations, racks, and lockers have been installed (see Chapter 3), and bicycles can now be mounted on most of the TTC’s buses through the Rack It and Rocket program and may also brought on board subway trains on weekends and off-peak hours on weekdays (City of Toronto, 2015d; Toronto Transit Commission, 2015).

The bicycle parking facilities at the Eglinton Crosstown’s stations cannot yet be evaluated, but the approach taken can still be instructive as a contemporary comparison. Gaps in Toronto policies relating to the quantity and type of bicycle parking at new transit stations forced the designers of the Crosstown to develop a new approach. A description of the method developed to determine the bicycle parking requirements was published in 2014 by engineers attached to the project (Gough & Walker, 2014). It is elaborated in the following section.

6.2 Bicycle Parking Requirement Assessment Method

To permit longer-term growth in demand, rough figures for bicycle parking supply requirements were determined based on the peak demand forecast per station for 2051. The engineers followed the supply recommendations of the Association of Pedestrian and Bicycle Professionals’ (APBP) Bicycle Parking Guidelines reference, which states, in “Urbanized or High Mode Share Areas,” there should be long-term spaces for 7% of projected morning peak period ridership, and short-term spaces for 2% of the same. In less highly urbanized areas, the publication suggests long-term and short-term parking be determined on the basis of 5% and 1.5% of morning peak ridership, respectively (2010, Chapter 3, p.3-6). The engineers applied the higher, urban rates to all Crosstown

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6 In the Eglinton Crosstown context, stations are underground and stops are at-grade.
underground stations. A lower rate of 2% was used for the Crosstown surface stops in view of the stops' location in the centre of the roadway and duly constrained workable area.\(^7\) These calculations indicated a need for about 300 outdoor spaces and 800 indoor spaces (Gough & Walker, 2014, p.4).

\begin{quote}
The designers interpreted short-term parking as free parking facilities located outdoors, sheltered where possible, easy to access, well lit, and with active and passive surveillance provided by cameras and pedestrian traffic. The precise form of these spaces remains to be determined. By contrast, they assessed the optimal long-term facilities as two-tier parking bays located in indoor, paid-access facilities, more removed from pedestrian traffic. Bicycle lockers were ruled out largely because of their relatively higher space requirements.

Specific designs for the facilities were also informed by the principles of Crime Prevention Through Environmental Design.
\end{quote}

These figures were then adjusted for station-specific factors likely to encourage or discourage bicycle access, such as the station or stop type,\(^8\) its connectivity to bicycle routes and proximity to other bicycle facilities, and the type of nearby land uses.\(^9\) This sometimes required the input of representatives from the City of Toronto. Recognizing that space at each station was limited, and other priorities, such as pedestrian movement and retail uses, required space of their own, additional compromises and modifications to the distribution of spaces between indoor and outdoor parking spaces were made (Crosstown engineer, email correspondence, January 26, 2015; Gough & Walker, 2014, p.1). This represented the addition of a qualitative dimension to the initial quantitative analysis. With each Crosstown station assessed on these attributes, recommendations were tailored to reflect their respective needs and constraints.

The parking recommendations changed significantly as a result of these adjustments. While the total supply of bicycle parking spaces was increased 14%, the composition of parking between short-term and long-term spaces was reversed: long-term spaces fell to 410, while short-term spaces rose to 844. Indoor space constraints were cited as the key factor behind this shift. Nonetheless, the short-term parking spaces were often improved, for instance with weather protection, that brought them closer to long-term parking standards set out by the Association of Pedestrian and Bicycle Professionals.

\(^7\) An exception was made for the Victoria Park Stop, where significant intensification was predicted to increase demand.

\(^8\) For instance, interchange stations that connect with other services, such as commuter rail, may attract cyclists that would not be accounted for under the Eglinton Crosstown demand forecasts.

\(^9\) Outdoor parking was prioritized, for instance, in areas with greater pedestrian activity – or "eyes on the street" – providing passive surveillance.
7. DISCUSSION

Baseline Station’s particular characteristics – including a location that strongly favours bicycle access, combined with ample space to permit innovative station design – suggest excellent potential to increase the number of transit users accessing the station by bicycle. The BART and Metrolinx models provide useful guidance regarding the number of parking spaces and the types of facilities required for the city to translate this potential into reality by 2031, by which point the light rail extension to Baseline Station will be complete and ridership levels will have matured over several years.10

7. 1 Number of Spaces

OC Transpo does not track bicycle access ridership at its stations, though it does periodically count the number of bicycles parked at these locations. While bicycle parking at Baseline Station falls during the winter months, use of the facilities is evident year-round (City of Ottawa planner, email correspondence, February 2, 2015). This was confirmed during visits to the station during the months from July, 2014, to April, 2015. During the workweek, parking occupancy was often observed to exceed 100% in the summer and fall of 2014 and the spring of 2015 with a spillover of some bicycles locked to the station perimeter fence, sign posts, and trees.

Figure 6 – Sheltered and unsheltered bicycles at Baseline Station, August 28, 2014, and November 17, 2014 (author)

As noted, the City of Ottawa Cycling Plan indicates that bicycle racks offering 600 spaces are to be distributed across the 13 stations included in the first phase of light rail – an average of about 46 spaces per station – with a minimum of 40% of these spaces designated as sheltered. In addition, the Plan indicates funding will be provided for a pilot project to evaluate the impact of installing bicycle lockers at transit stations (City of Ottawa, 2013a, p.35, 36, 47). The City has yet to determine the site of the bicycle locker pilot project. Likewise, the number of bicycle parking spaces to be allocated to the stations in the second phase of light rail, including Baseline Station, is not yet clear.

10 The 2031 timeframe was also used because that was the year for which City of Ottawa ridership projections were available.
The City of Ottawa’s current policies do not indicate a precise bicycle access target for its public transit stations. The case studies of BART and Metrolinx’s Eglinton Crosstown project, presented in earlier sections of this report, both offer guidance. By applying to Baseline Station basic assumptions underpinning each of these models, and validating the results with 2006 Census data regarding the previously defined bicycle catchment area, this report presents two potential scenarios for bicycle parking demand at Baseline Station in 2031.

The first scenario is based on the case of Toronto, where the total number of recommended bicycle parking spaces (that is, long-term and short-term facilities combined) at the Eglinton Crosstown stations was calculated as 9% of morning peak ridership. At Baseline Station this would translate into 170 parking spaces, based on City of Ottawa projection of 1,885 morning peak initial boardings in 2031 (City of Ottawa planner, email correspondence, February 2, 2015).

The second scenario relates to the experience in San Francisco. Though, as noted in Chapter 4, the BART Investment Tool itself does not make recommendations regarding number of spaces for individual stations, the stated goal for BART is to increase the proportion of transit riders biking to stations to 8% of all trips because of rapid growth in ridership and the prohibitive cost of expanding station car park and ride lots. BART recognizes that reaching the aggressive 8% target requires responsiveness to the needs not only of users who arrive by bicycle and park at the station, but also of users who continue their journey by bicycle after their transit trip. In view of this, BART has implemented a cycle-transit interface strategy aimed at accommodating demand for bicycle parking facilities, as well as on board transportation of bicycles. The latter part of the strategy has been very successful, with over half of bicycle access users of the BART network now bringing their bicycles with them on the trains.

Ottawa presently does not have such a specific commitment to increasing ridership by encouraging on board transportation of bicycles. Though light rail trains will be equipped to accommodate bicycles, it remains to be seen how the City will respond to potential demand for on board bicycle accessibility and whether capacity will meet demand (City of Ottawa, 2015b). Regardless, as a strategy for increasing bicycle access to transit, on board transportation is entirely distinct from bicycle parking. For this reason, and since in San Francisco on board bicycle transportation represents over half the ridership accessing transit by bicycle, it is appropriate to reduce significantly the San Francisco target when focusing solely on a bicycle parking strategy in the Ottawa context. At the same time, it should be recognized that the San Francisco target is set for the entire network, which includes locations that are not as conducive to bicycle access as Baseline Station, which is situated in an unusually bicycle-friendly location. For this reason, this report considers a bicycle access target of 4% to represent a reasonable adjustment of the San Francisco target in the context of Baseline Station. On the basis of a conservative estimate of 5,467 average weekday peak period initial boardings at Baseline Station in 2031, a demand of
219 spaces may be projected for a second scenario.\textsuperscript{11} This is acknowledged to be only a rough estimate, which on the one hand is based on a calculation that excludes the currently unavailable off-peak period demand requirements, and on the other hand does not adjust for user turnover, or the portion of spaces used by more than one person during the course of a day. More precise tracking of ridership patterns would be needed to address these issues. The Presto smart card payment system used by OC Transpo may be able offer a solution as it could represent a rich dataset from which trips may be assessed in terms of their location, route, and time.

Despite these limitations, analysis of census data indicates that the scenarios developed above are not unreasonable. As noted previously, 10,565 residents who live within the proposed Baseline Station bicycle catchment area (see Chapter 4) commuted to work by car, truck, or van in 2006.\textsuperscript{12} The 170 to 219 proposed bicycle parking spaces could be filled by persuading just 1.6\% to 2.1\% of these commuters to bicycle to, park, and board transit at Baseline Station. These percentages will decrease as intensification planned for the Centrepointe area takes place.

These analyses and comparisons suggest that, based on currently available data, the number of spaces that will be required at Baseline Station by 2031 runs from 170 to 219 spaces. These may be conservative estimates, as capital projects are often designed to accommodate longer-term demand projections.

\textbf{7.2 Short-Term Parking and Long-Term Parking}

Though local conditions sometimes required adjustments, engineers for the Crosstown project for the most part followed the recommendations of the Association of Pedestrian and Bicycle Professionals (APBP), giving preference to long-term facilities over short-term facilities, respectively calculated as space for 7\% and 2\% of morning peak ridership.

Similarly mirroring the guidelines of the APBP, the BART Investment Tool recommends parking facilities weighted towards long-term parking, at 77\%, against short-term parking, at 23\%.

\textsuperscript{11} A projection for full-day initial boardings in 2031 was unavailable. However, City projections anticipate 1,885 initial boardings and 3,582 final alightings at Baseline Station in the 2031 morning peak (City of Ottawa planner, email correspondence, February 2, 2015). Assuming that most passengers take return trips, the daily total station ridership for initial boardings in 2031 will at a minimum include the sums of the initial boardings and final alightings projected for the morning peak period. This means that a conservative projection of daily initial boardings in 2031 at Baseline Station is 5,467. Notably, this estimate does not account for trips that occur during off-peak hours.

\textsuperscript{12} While this figure includes persons employed in locations not serviced by transit, as well as those who are unable to commute by transit, this estimate excludes the population of individuals outside the labour force that make non-discretionary trips, such as those made by students to secondary or postsecondary institutions. These are important limitations.
Table 1 summarizes the breakdown of short and long-term parking facilities recommended on the basis of the Crosstown and BART models, as applied to the space requirement scenarios developed for Baseline Station. A midrange option of 195 spaces corresponds to the midpoint of the previous two scenarios.

Table 1 – Estimated Demand for Short-Term and Long-Term Bicycle Parking Spaces at Baseline Station by 2031

<table>
<thead>
<tr>
<th>Total Number of Bicycle Parking Spaces Required</th>
<th>Metrolinx / Eglinton Crosstown Approach</th>
<th>Bay Area Rapid Transit (BART) Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short-term</td>
<td>Long-term</td>
</tr>
<tr>
<td>170 (Lower range estimate)</td>
<td>38</td>
<td>132</td>
</tr>
<tr>
<td>195 (Mid-range estimate)</td>
<td>44</td>
<td>151</td>
</tr>
<tr>
<td>219 (High range estimate)</td>
<td>49</td>
<td>170</td>
</tr>
</tbody>
</table>

Application of the Metrolinx and BART case study approaches signals that a credible bicycle parking strategy requires serious investments to deliver on Baseline Station’s bicycle access ridership potential.

7.3 Parking Facility Types

The case studies illustrate that options for long-term bicycle parking facilities often require adaptation to a station’s local context. The Eglinton Crosstown designers at times faced practical challenges linked to limited spaces in highly urban settings, fostering a preference for compact facilities. Parking options that fared worse in this respect, like bicycle lockers, were inevitably rejected. This does not mean that bicycle lockers should not be a potential option for Baseline Station. In fact, given that the station is to be rebuilt in a spacious area, the design process should be unhampered by the usual complexities and limitations of squeezing new facilities in existing settings.

The BART Investment Tool is particularly helpful for determining the most cost-effective composition of bicycle parking spaces within a given budget envelope. The set of required data inputs, tailored to Baseline Station, are outlined in the Annex.

As previously indicated, the BART investment tool has two limitations worth noting. First, though many of the tool’s key data inputs are location specific, BART extrapolated the desirability of various types of bicycle parking facilities from survey responses collected in San Francisco. Though it is not clear that Ottawa respondents would have distinct preferences, it is possible that this would be the case. Validation of the result in Ottawa would require that the extensive survey be repeated in this city’s context, and that the BART tool be fine-tuned, as appropriate, on the basis of the findings. Second, the Tool’s assumptions about facility costs are based on information obtained in San Francisco. Costs in Ottawa may not be identical. The objective of the discussion below is to illustrate potential application of the BART tool, and in the absence of contrary information, it will be assumed that relative facility preferences and costs are similar in Ottawa and San
Francisco. It is recommended that both information gaps be closed before final investment decisions are made in the Ottawa context.

For the purpose of illustrating the application of the BART Investment Tool in the assessment of facility type options, the midrange bicycle parking space requirement of 195 will be used. Table 1 indicates that this total number of spaces should be divided between about 45 short-term spaces and 150 long-term spaces. Short-term parking options embrace a range of bicycle rack types. The literature suggests that in the case of short-term parking it is most important that it offers convenience and ease of use. The APBP underlines that it should be located in areas with pedestrian traffic to provide passive surveillance and that it be resistant to cutting and vandalism and permit the locking of bicycles’ frames and at least one wheel with a standard U-lock (2010, p.2-2).

BART’s facility cost assessment shows that wave racks, which each offer space for seven bicycles, are the most cost-efficient, with a capital cost in 2012 of $800 (USD) per unit.13 Seven wave racks would meet the goal of a minimum of 45 short-term bicycle parking spaces at a suggested cost of $5,600. The Tool suggests that such an investment would increase potential park and ride bicycle access ridership to 103 users per day.

In contrast to short-term parking, the APBP emphasizes that long-term parking facilities require improved security and weather protection and, crucially, must prevent public access to the bicycle. Meeting this standard requires lockers or paid-access or valet bicycle cages (2010, p.1-2). The four primary long-term parking options proposed by the BART investment tool are listed in Table 2 and include self-serve bicycle stations, attended bicycle stations, electronic lockers, and bicycle cages.14

Scenarios 1, 2, 3(a) and 4(a) reflect various long-term parking facility options – or, in the case of 3(a), a combination thereof – each with a minimum of 150 spaces. The capital cost and annual operating cost of each, as proposed by BART, is indicated, along with the net increase in park and ride bicycle access ridership.

As explained in Chapter 4, built into the BART Bicycle Investment Tool’s algorithm is a cap reflecting the maximum ridership-increasing potential of each type of long-term parking. Scenarios 3(a) and 4(a) involve numbers of electronic lockers surpassing this limit. Scenarios 3(b) and 4(b) show that the numbers of these lockers can be reduced considerably without decreasing ridership impact. The resulting number of long-term parking spaces, however, is less than optimal in terms of meeting the target number of 150 long-term spaces.

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13 Double-decker racks, while comparatively expensive, may be prudent where available space is limited.
14 This analysis excludes the cheaper but increasingly obsolete reserved-key lockers. It also excludes the BART Investment Tool option of bicycle racks inside the gates, since Baseline Station may not have gates, and relatively open access would not meet the APBP criteria for long-term parking.
Table 2 – Sample Long-Term Parking Scenarios and Ridership Projections for Baseline Station for 2031, based on the BART Investment Tool

<table>
<thead>
<tr>
<th>Parking facility option</th>
<th>Total long-term spaces</th>
<th>Estimated capital cost (USD)</th>
<th>Estimated annual operating cost (USD)</th>
<th>Projected park and ride bicycle access ridership increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 One self-serve bicycle station of 150 spaces</td>
<td>150</td>
<td>$470,870</td>
<td>$43,200</td>
<td>245</td>
</tr>
<tr>
<td>2 One attended bicycle station of 150 spaces</td>
<td>150</td>
<td>$470,870</td>
<td>$93,600</td>
<td>293</td>
</tr>
<tr>
<td>3 (a) One bicycle cage of 40 spaces plus electronic lockers totalling 112 spaces</td>
<td>152</td>
<td>$302,000</td>
<td>$11,600</td>
<td>151</td>
</tr>
<tr>
<td>3 (b) One bicycle cage of 40 spaces plus electronic lockers totalling 100 spaces</td>
<td>140</td>
<td>$270,500</td>
<td>$10,400</td>
<td>151</td>
</tr>
<tr>
<td>4 (a) Electronic lockers totalling 152 spaces</td>
<td>152</td>
<td>$399,000</td>
<td>$15,200</td>
<td>76</td>
</tr>
<tr>
<td>4 (b) Electronic lockers totalling 100 spaces</td>
<td>100</td>
<td>$262,500</td>
<td>$10,000</td>
<td>76</td>
</tr>
</tbody>
</table>

The potential bicycle access ridership increases at Baseline Station calculated by the Tool indicate that of the options considered, the most expensive – the attended bicycle station – would render the highest potential ridership increase: almost 50 passengers more than the second option, the unattended self-serve bicycle station, which has the same capital cost but a significantly lower operating cost. The options that combined electronic lockers with a bicycle cage arrived with a bicycle access ridership increase of 151 at a low to medium cost. The options that focused exclusively on electronic lockers produced a more modest ridership increase of 76 despite significant costs.
Bicycle parking in all forms is cheaper than car parking. This should be underlined when facility investments at transit stations are considered for increasing bicycle access ridership. Nonetheless, it may be informative to assess the relative cost-effectiveness of each option based on relative capital and operating costs and projected ridership benefit over a five-year horizon. These calculations appear in Table 3, along with the monthly user cost that would be required to cover the cost should users be asked to shoulder the total expenditures. As these calculations assume full occupancy, the figures should be understood to be minimum costs.

Table 3 – Financial Analysis of Sample Long-Term Parking Scenarios

<table>
<thead>
<tr>
<th>Parking facility option</th>
<th>Five-year cost per new bicycle park and ride user (USD)</th>
<th>Monthly user cost over five-year horizon (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2,804</td>
<td>$47</td>
</tr>
<tr>
<td>2</td>
<td>$3,204</td>
<td>$53</td>
</tr>
<tr>
<td>3(a)</td>
<td>$2,384</td>
<td>$40</td>
</tr>
<tr>
<td>3(b)</td>
<td>$2,136</td>
<td>$36</td>
</tr>
<tr>
<td>4(a)</td>
<td>$6,250</td>
<td>$104</td>
</tr>
<tr>
<td>4(b)</td>
<td>$4,112</td>
<td>$69</td>
</tr>
</tbody>
</table>

Of the six options presented above, some are plainly inefficient, requiring large user fees or subsidy. But others demonstrate that even high-end long-term parking facilities – like an attended station – are not necessarily prohibitively expensive propositions, and deserve careful consideration.

These analyses illustrate the potential usefulness of the BART and Metrolinx approaches to station bicycle parking facilities in the Ottawa context.
8. RECOMMENDATIONS

Cycle-transit integration is good public policy. It allows transit to attract more riders through bicycle access, and encourages the uptake of bicycling as a viable travel mode. The major capital works associated with the introduction of higher-order transit represent a unique opportunity to build the station infrastructure to deliver on this potential, a chance that major transit agencies seize. The following recommendations outline a forward-looking cycle-transit integration strategy for the Baseline LRT station.

8.1 Bicycle Parking Quantity

- Make provision for future bicycle parking expansion at early stages of station design to avoid rendering it prohibitively costly when it becomes warranted. Demand is likely to increase in view of the population and employment growth projected for the Baseline Station area over the coming decades, and outlined in the approved vision for the Centrepointe Town Centre. Parking facilities should anticipate and accommodate future growth in bicycle access ridership.

- Fine-tune projections for bicycle parking requirements as planning for the western light rail extension progresses. The BART and Metrolinx approaches to determining bicycle parking requirements reach similar conclusions when applied to the Baseline Station context. Based on projected growth in peak period initial boardings, they indicate that conservative estimates of bicycle parking requirements in 2031 range from 170 to 219 spaces.

- Monitor bicycle parking facilities to ensure spare capacity is available at all times. Fully-occupied parking, as seen in station observations today, deters bicycle access ridership. Parking scarcity introduces uncertainty for bicyclists about their likelihood of finding a space. Facilities should be built to accommodate peak parking demands.

8.2 Bicycle Parking Types

- Ensure the appropriate mixture of short-term and long-term parking. The Baseline Station area is developing into a major mixed-use node that is best served by a combination of the two. But long-term parking needs are greater than short-term needs. The BART and Metrolinx case studies, supported by professional standards, suggest that the optimal composition of parking of roughly 22% short-term and 78% long-term facilities would produce the greatest bicycle access ridership increases.

- Do not use short-term bicycle parking facility types to meet long-term parking requirements. Commuters and long-term users are more likely to access transit stations where they can park their bicycles at single-user bicycle lockers, multiple-
user bicycle cages, or attended bicycle stations. Publicly accessible bicycle racks, by contrast, are only suitable for short-term parking.

- Close key information gaps to better adapt the BART Bicycle Investment Tool to the Ottawa context. The capital and operating costs of the facility types should be assessed, potentially through a request for quotation (RFQ) process. A ranked-preference survey should be conducted among Ottawa bicyclists to determine whether the relative desirability of the various bicycle parking types aligns with the preferences determined by BART in San Francisco.

### 8.3 Bicycle Parking Security

- Allay fears of bicycle theft and vandalism by following best practices in facility security. Good security reduces a significant psychological barrier for prospective bicycle access transit users, and avoids ridership attrition among users who become victims of theft.

- Select bicycle parking that at a minimum permits locking of both the bicycle frame and at least one wheel. Long-term parking should limit access to bicycles, either through paid-access stations, attended parking, or lockers.

- Make effective use of passive surveillance by locating bicycle parking within sight of pedestrian traffic. However, bicycle parking should not unreasonably impede pedestrian traffic flow, nor conflict with car traffic.

- Maintain good lighting in bicycle parking facilities and surrounding areas. Install security cameras in key locations.

- Promptly remove vandalized bicycles and repair damage to bicycle parking facilities. Train Special Constables and vehicle operators to report damage. Place stickers with the OC Transpo contact information around parking facilities to encourage customers to report damage.

- Support year-round bicycle access ridership by locating bicycle parking facilities in sheltered areas. This is doubly vital in a winter city context.

- Locate bicycle racks in the attendant’s line of sight should a station booth be built at the Baseline LRT station.

### 8.4 Planning Context

- Ottawa should set a global target for increasing bicycle access ridership. Such policy direction would improve accountability and commit the City to taking serious steps to improving cycle-transit integration. Inaction has costs of its own: expansion of the Baseline Station car park and ride may be required, and some potential transit users may instead use less sustainable modes to reach their destinations.
- Bicycle access rates at major transit stations should be monitored and the success of investments in bicycle parking facilities evaluated.

- An amendment to the Ottawa Cycling Plan should clarify that long-term parking must prevent public access to parked bicycles. This means bicycle lockers, bicycle cages, or attended bicycle stations. The present Cycling Plan suggests sheltered bicycle racks are sufficient to meet long-term parking needs. Although more attractive to users than unsheltered racks, sheltered racks that remain publicly accessible are not suitable for long-term parking and do not meet industry standards.

- A survey of potential bicycle access transit users in Ottawa should be conducted to assess their willingness to pay for long-term parking. Results of this study should inform pricing strategies. Evidence shows that many bicycle access transit users are willing to pay for superior parking facilities, but willingness to pay is not universal, and a cautious approach is advised to avoid reducing the incentive to bicycling provided by secure parking. Encourage regular use of long-term parking facilities with discounted loyalty rates for monthly use. Significantly discount annual subscriptions to encourage continued use in the winter.

- Investigate the possibility of integrating parking payment with the existing Presto smart card system.

- Rates for the existing Baseline Station car park and ride users may be increased in peak periods to encourage bicycle access. This is likely to help bicycle parking improvements challenge car access ridership, avoid costly expansion of the car park and ride, and preserve car parking supply for users who are unable to use bicycles.

- Bicycle parking facilities should be tailored to the station environment. There is clear evidence of this from the literature and case studies. While it may seem expedient to allocate a fixed budget envelope equally between stations, each station deserves no more than is cost-effective, suggesting an uneven distribution of investments may be appropriate.

8.5 Considerations and Supporting Measures

- Evaluate the potential effect on bicycle access rates and parking needs of permitting bicycles to be brought on board light rail trains all day or only during off-peak hours. Precedents suggest that when allowed to do so, many commuters will board with their bicycle and take it to their final destination. This may reduce trains’ passenger capacity during busy periods. It may also lead some passengers who would normally park their bicycles at the home end of their trip to park at Baseline Station – even if it is the destination-end of their trip – if parking facilities are more attractive there. Bicycle blackout periods are likely to increase parking needs, but may also reduce
overall bicycle access rates by discouraging users who are unwilling to leave their bicycles at a station.

- Secure bicycle parking at Baseline Station may be occupied by the bicycles of students of adjacent Algonquin College if the station facilities are more attractive than those available on the campus. The City of Ottawa should consider collaborating with Algonquin College in evaluating and potentially improving the parking facilities at the College or accommodating its parking needs within the Baseline LRT station design.

- Ensure key bicycle access routes leading to Baseline Station, including bicycle paths, are prioritized for clearance following a snowfall to encourage year-round bicycle use.

- Locate bicycle parking near the bicycle access routes to the station, close to Baseline Station’s entrances to minimize the distance bicyclists must walk after dismounting.

- The introduction of improved bicycle parking facilities deserves public attention, and should be promoted before and after launch to increase the uptake of these facilities. An inexpensive approach would be to use empty advertising spaces on transit vehicles for this purpose. Such a campaign should be repeated with a common branding when other stations’ bicycle parking facilities are improved. These stations should be clearly distinguished on OC Transpo network maps.

- Improve customer awareness of bicycle security through the placement of information posters or hang tags on parked bicycles. These should cover best techniques in securing bicycles and deterring theft, and should encourage reporting of thefts and outline the process for doing so.

- Post station area maps near main entrances to Baseline Station indicating recommended bicycle routes and the location of bicycle parking facilities. Improved wayfinding can lower a barrier to cycle-transit use and act as a reminder to car park and ride users of an alternative access mode.

- Evaluate the provision of shower and changing rooms, facilities which can further increase the attractiveness of bicycle access ridership. Continue to encourage employers to provide shower facilities at workplaces.

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15 The Metropolitan Transportation Authority in New York City, for instance, regularly advertises improvements to its subway stations.
9. CONCLUSION

This report assessed the bicycle parking facilities that should be considered for Baseline Station in view of its planned conversion to a mixed LRT and BRT hub. Research covered the scholarly literature relating to bicycle parking provision as well as international precedents and best practices. Case studies of Bay Area Rapid Transit (BART) and Metrolinx’s Eglinton Crosstown project were presented, and their approaches adapted to the Ottawa context. On the basis of this analysis, the report developed recommendations for the City of Ottawa relating to the quantity and type of bicycle parking spaces, facility security, the planning context, and other considerations and supporting measures.

Bicycling is set to increase as a mode preference for Ottawa residents in upcoming years. This is encouraged by existing City policy. Implementation of the recommendations in this report would be consistent with this policy direction, and would increase transit ridership through bicycle access. The introduction of LRT represents a rare opportunity to redesign Baseline Station with bicycle infrastructure that supports the needs of today and tomorrow. Ottawa would be well-advised to seize it.
10. REFERENCES

Academic and Professional Literature


**Government Publications**


City of Toronto. (2015b). Bicycle Parking Stations: Union Station Bicycle Station. Retrieved from


Additional References


11. ANNEX

Additional BART Tool inputs used for Baseline Station application

The anticipated station ridership measures the number of passengers projected to board a bus or LRT at Baseline Station. This station functions as a major transfer point in OC Transpo’s hub-and-spoke network, with local feeder buses that serve nearby areas bringing passengers to the station. Transfer activity will be amplified by the extension of light rail to Baseline Station, which will necessitate connections for all passengers traveling to and from the outer suburbs and the city core. For the purposes of the BART Tool, transfer passengers are excluded from the station-access ridership measure, as these passengers are often arriving from areas outside the bicycle catchment area of the station, and inclusion would inflate the potential pool of cyclists.

In the absence of survey data for Ottawa, the lighting rating for Baseline Station is estimated as “good,” corresponding to a value of 3 on the 4-point scale, and the security rating is estimated as “adequate,” corresponding to a value of 2 on the 4-point scale.

For the station typology, “Balanced Intermodal” was selected for Baseline Station. The description offered by the Tool of this type of station was apt, underlining that it is well-served by transit and that car parking, while offered, fills early due to space limits.

The station population in a half-mile radius of the Baseline Station was 3,972 in 2006 (Statistics Canada, 2007a). BART found this was their most statistically significant measure of potential bicycle ridership. Given that the station area is expected to experience growth as a mixed-use node, this population is set to increase. As the extent of the increase hard to estimate, the values for 2006 are used for the scenario year.

Though the Confederation Line trains accommodate bicycles, it is not clear whether OC Transpo will permit bicycles at all times or merely during off-peak periods. Recognizing that many passengers will continue to access buses at Baseline Station even following the introduction of light rail, and that the bus fleet is only seasonally and at best partially (not all buses have bike racks) accommodating of bicycles (see Chapter 4), for the purpose of this exercise the non-bicycle blackout period (the proportion of transit vehicles that permit bicycles) in the Tool is estimated at 25%.

Like the projection for 2031 initial boardings (see footnote 12, page 27), the above inputs are deliberately conservative, which means that more aggressive approach is likely to be required to continue growth in bicycle access ridership in the longer term. Capital projects are usually designed to accommodate long-term demand projections to avoid costly expansion. For the Eglinton Crosstown, Metrolinx used a demand horizon of peak initial boardings in 2051 as a basis (Gough & Walker, 2014).