Clifton ND Lea
CONSULTING INC.

INTEGRATED ENGINEERING SOLUTIONS

DOWNTOWN LRT FEASIBILITY STUDY

SUBMITTED TO:

CITY OF CALGARY
TRANSPORTATION PLANNING DIVISION

SUBMITTED BY:

CLIFTON ND LEA

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SUPPLEMENTARY INFORMATION

Southeast LRT Functional Planning Study, Phase III Glenmore Trail to Elbow River, by Clifton – ND Lea, January 2004

Downtown Transit Study – Review of Transit Modes, by Clifton – ND Lea, July 2004

Southeast Mass Transit Corridor Strategic Planning Study, Calts 128, by Reid Crowther & Partners, January 1987

1. INTRODUCTION

LRT network planning has identified the need for three additional LRT lines to be built before the city reaches the 1.5 million-population horizon. The purpose of this report is to examine the feasibility of alignments required to complete the connection of Southeast LRT to the downtown and to examine the implications of planning for the West and North-Central lines.

1.1 Southeast LRT

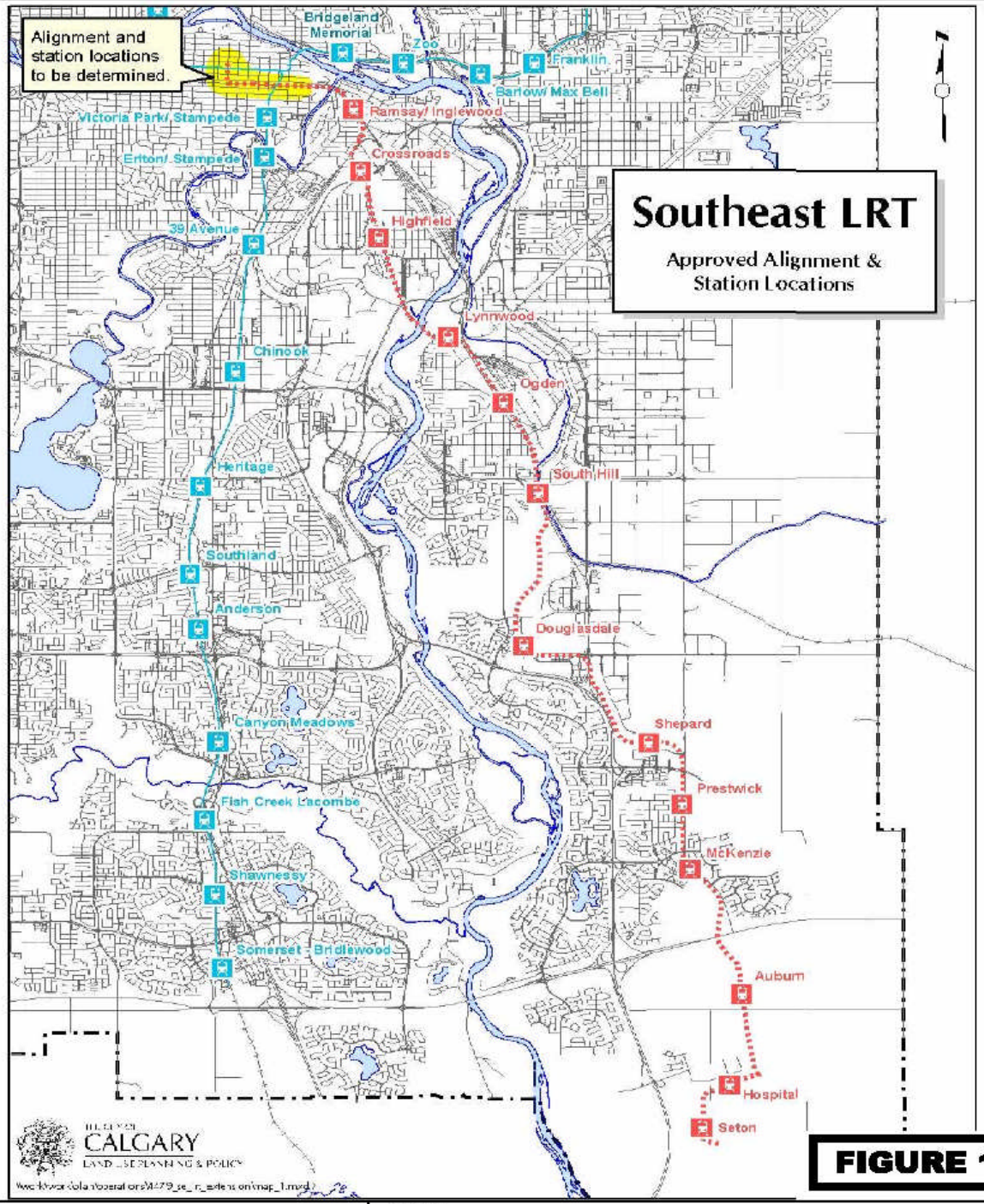
A downtown alignment for Southeast LRT is required to complete the planning for this future line. An approved alignment for Southeast LRT extends from south of Highway 22X to the Elbow River, just south of 9 Avenue SW (see Figure 1) Alignment options have been developed to complete this future line into the heart of the downtown.

1.2 North-Central LRT

A North-Central line is required to serve future communities north of Stoney Trail in North Central Calgary. A review has been conducted to confirm the feasibility of connecting a potential Nose Creek alignment for a North-Central LRT line with the current Northeast LRT line at the Deerfoot Trail / Memorial Drive interchange. Planning for this connection was done as part of the interchange and Northeast LRT construction.

1.3 West LRT

An alignment and functional plan for West LRT was approved in 1983 and updated in 1988. However, in the west end of the downtown there have been changes in land use and future roadway design issues have emerged. It is necessary to confirm the feasibility of the approved alignment and explore additional options for West LRT to extend from the current terminus of LRT on 7th Avenue to the Bow Trail corridor at Crowchild Trail.



Clifton ND Lea CONSULTING INC.		PROJECT: LRT FUNCTIONAL PLANNING STUDY
DESIGN BY	OFFICE FILE NO: 11047	
DRAWN BY RB	SCALE NTS	TITLE SHEET: SOUTHEAST LRT APPROVED ALIGNMENT & STATION LOCATIONS
CHECKED BY		
DATE JUNE '05	DRAWING NO. FIGURE 1	

2. Future LRT Network and Downtown LRT Operating Requirements

As Calgary grows, the downtown will continue to be a significant employment centre. It is projected that 25,000 additional downtown jobs will be added by the time the city reaches a total population of 1.25 million. However, other employment areas, notably the Southeast, are projected to grow at a faster pace. Despite a shrinking percentage of the city's overall employment, there will be increasing demand for transit service to the downtown due to the high concentration of jobs and limited roadway and parking capacity. In fact, increased transit service capacity is critical to continued employment growth in the downtown.

Population and employment growth projections indicate that new LRT lines will be require to serve the Southeast, North and West areas of the city before Calgary reaches the 1.5 million-population horizon. Planning studies have identified alignments for the West and Southeast lines outside of the downtown. A right of way for a North-Central line has been reserved north of Beddington Trail and a likely location for this line has been identified within the Nose Creek valley. A review of Downtown LRT routing concepts and operating requirements is required to determine the final section of the Southeast line and to examine the implications of adding a North-Central line.

Downtown LRT Capacity

The following table and drawing illustrates the projected future peak hour / peak direction passenger demand and the number of trains required (based on 3, 4 or 5 car trains) on each LRT line entering the downtown at the 1.5 million population horizon. It has been determined that the maximum achievable capacity of 7th Avenue is approximately 36 trains per hour in each direction. This is based on factors including station dwell times, distance between stations, train acceleration / deceleration characteristics, and optimum downtown traffic signal timing.

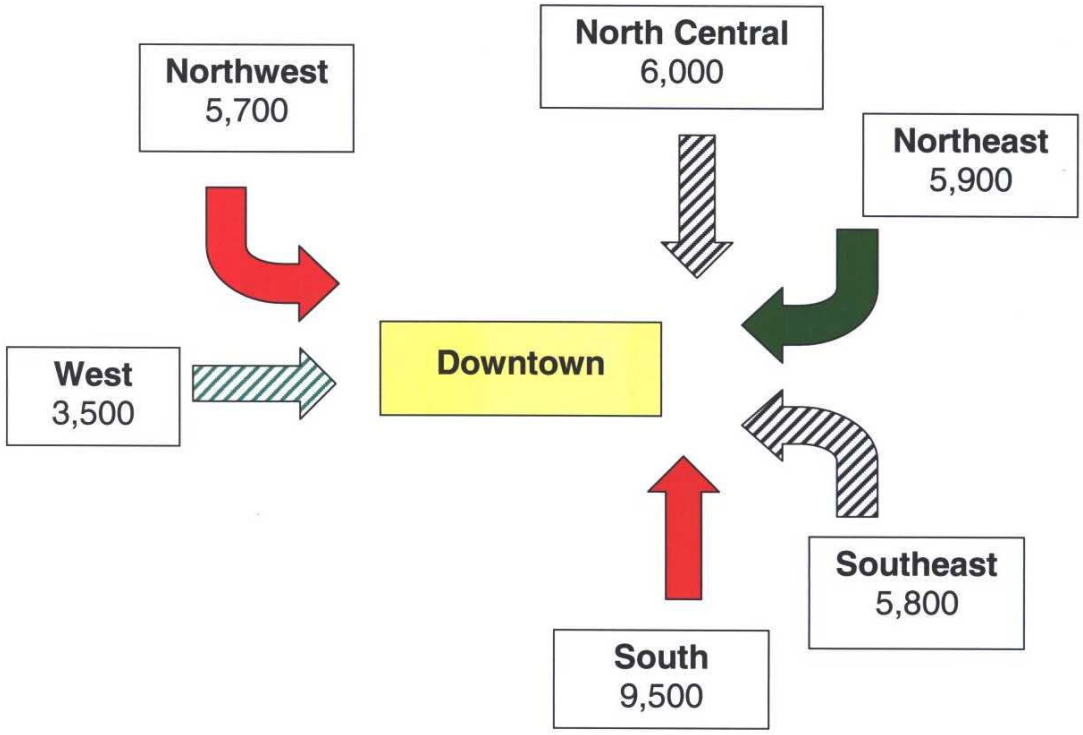
The current (2005) C-Train schedule has a total of 26 - 3 car trains on the South and Northeast lines that enter the downtown from the east during the a.m. peak hour carrying over 11,000 people. Based on the capacity of 7th Avenue, 10 additional 3-car trains can be added during the peak hour. Construction has commenced to expand stations on all lines (beginning in the downtown) to enable service with 4-car trains. Ultimately, the system can be expanded to 5-car train operation.

Projected AM Peak Hour / Peak Direction LRT Ridership and Train Requirements Entering Downtown

1.5 million Population Horizon

Entering Downtown From East	Existing (am peak)	Future Demand (am peak)	Future Train Volumes by Train Length (cars)		
			3	4	5
South	6,600	9,500	18	14	11
Northeast	4,700	5,900	11	9	7
Southeast	Future	5,800	11	9	7
North Central	Future	6,000	12	9	7
Total Peak Direction	**11,300**	**27,200**	**52**	**41**	**32**
From West					
Northwest	3,400	5,700	11	8	7
West	Future	3,500	7	5	4
Total Peak Direction	**3,400**	**9,200**	**18**	**13**	**11**

Average per hour capacity per car = 180



Note: - practical CTrain car capacity is 180.

- ridership projections are for peak hour inbound trips.

The current LRT network has two lines entering / exiting the downtown via switch control at both ends of 7th Avenue (east = S+NE, west = NE+NW). Transit network planning has identified the need for two additional LRT lines to serve the Southeast and North-Central corridors. These new lines will enter the downtown from the east while the future West line will operate as an extension of the Northeast LRT from its current terminus at the west-end of 7th Avenue. Therefore the issue of 7th Avenue capacity is related to the addition of the Southeast and North-Central lines entering and exiting the east-end of the downtown.

Assuming that all lines will operate in the future with 4 or 5-car trains the total number of peak hour / peak direction trains on 7th Avenue would be approximately 41 and 32 respectively. With the addition of the Southeast and North-Central lines to 7th Avenue and with 4-car train operation, the capacity of 7th Avenue would be exceeded. Even with 5 car trains the peak hour train volume is still approaching the capacity limitation of 36 trains per hour leaving little room for adding capacity. Based on this analysis, it is concluded that there is not sufficient long-range capacity for all future LRT lines to operate on 7th Avenue.

As a result of this analysis, it is concluded that LRT planning must consider that:

- There is sufficient capacity on 7th Avenue to add only one new LRT line at the east end of the downtown.

- Either the future Southeast or North-Central lines will require an independent connection into the downtown. In this scenario the total number of peak direction trains on 7th Avenue would be 32 and 25 for 4 car and 5 car trains per hour, respectively.

- Ultimately it will be necessary to operate at least the South line on a separate downtown right of way although this could be delayed with the operation of 5 car trains. It should be noted that there may be operational limitations with 5 car train operation that require resolution (e.g. switch clearance time, downtown block lengths, station dwell time, etc).

8th Avenue Downtown Subway

The South and Northwest LRT lines were constructed with the long term view that they could ultimately be shifted to a subway running under 8th Avenue SW. A tunnel has been constructed under the Municipal Building to permit a connection from the South line. As well, there is sufficient room in the 9th Street SW right of way to connect Northwest LRT to an 8th Avenue tunnel. Construction of an 8th Avenue subway will have a significant cost (at least $500 million in 2005 dollars). Based on the above discussion, this shift is not likely needed to address LRT capacity requirements until beyond the 1.5M population horizon.

3. Southeast LRT

Background

The Southeast LRT Corridor has been identified through the Calgary Transportation Plan process (GO Plan) as a future LRT Corridor extending from the downtown through the Southeast industrial area to McKenzie Town and then south of Marquis of Lorne Trail (Hwy 22X), to serve new development lands.

A Transportation Department report completed in 1987[1], evaluated various options for creating a mass transit corridor to serve this large residential and industrial growth area. Recent forecasts for the ultimate build-out of the area (beyond the City's 1.25 million-population horizon) now project a population of 225,000 and employment of 108,000. When this development is realized, the potential weekday demand for transit travel to / from the downtown is estimated at 46,000 to 56,000 trips. The report concluded that a separate LRT line is required to serve the Southeast corridor. The report also demonstrated that a spur line from the existing South LRT line to serve this area would overload the South LRT Line without major upgrading.

To date, there are three approved functional planning studies for different segments of the future Southeast LRT line:

- "South East LRT Functional Planning Study (South Hill)" by Reid Crowther & Partners Ltd (Earth Tech Canada Inc.), approved 2000 February TTP99-69
- "Southeast LRT 52nd Street SE Functional Planning Study" by Earth Tech Canada Inc, approved 2002 April TTP2002-10
- "Southeast LRT Functional Planning Study - Glenmore Trail to Elbow River", by Clifton ND Lea. approved 2004 April LPT2004-17

These studies provide functional alignments and station locations for SE LRT from the Elbow River to the Marquis of Lorne Trail. The alignment and station locations for south of the Marquis of Lorne Trail have been incorporated into recently approved land use policy plans including the proposed regional hospital (Figure 1).

A primary purpose of this study is to examine options and recommend a route alignment for Southeast LRT to access the downtown. Selection of the downtown alignment of Southeast LRT takes into account LRT operating requirements, land use, and community planning, urban design, the roadway network and area redevelopment planning studies in East Victoria, the Beltline, East Village and Downtown.

[1] "Southeast Mass Transit Corridor Strategic Planning Study, Calts 128", Reid Crowther & Partners Ltd for City of Calgary Transportation Department, January 1987.

3.1 SE LRT Downtown Study Process

The final phase of the Southeast LRT study involved examining potential routes to connect the end of the approved Southeast LRT alignment (east of the Elbow River) with the downtown core. The study area included a number of inner city and downtown communities. Within the areas examined for potential routes, several planning studies, each with established stakeholder groups, were well underway. During 2003, 2004 and 2005, Transportation Department representatives met with these groups on a number of occasions to discuss LRT route options and to obtain feedback. Input received from these groups has been incorporated into the design and evaluation of the alignment alternatives. Stakeholder groups included in these discussions were:

- Downtown Urban Structure Plan
- Victoria Crossing BRZ
- Calgary Downtown Association (CDA)
- Beltline Communities (Beltline ARP)
- Building Owners and Managers Association of the Greater Calgary Area (BOMA-Calgary)
- East Victoria Redevelopment Study

The input received from these groups has focused on a desire to integrate the SE LRT line and stations with the existing and future streetscapes, minimize impact of LRT on traffic and enhance mobility within the downtown and inner city. The preference of these groups is for low floor LRT cars which would reduce the scale of the station platforms to that of enhanced sidewalks.

A preferred alignment for SE LRT, with two construction options that would utilize a portion of 10th Avenue SE, has been incorporated into the recommended Beltline ARP. This alignment is consistent with the recommendations of this study.

The following sections of the report outline the basis for selecting this preferred alignment.

3.2 SE LRT DOWNTOWN NETWORK CONCEPTS

3.2.1 Overview

This section outlines the criteria used as the basis for developing downtown LRT concepts for Southeast LRT.

Section 3.2.2 outlines the implications of different vertical configurations with the LRT being either at-grade or grade separated.

Section 3.2.3 outlines the operating characteristics of existing and potential Light Rail Vehicles (LRVs) based on current LRT design standards and vehicle characteristics of alternative LRT trains examples of which are produced by Bombardier and Siemens.

Section 3.2.4 describes the potential routing of the 3 basic concepts to connect the SE LRT into the Downtown. It identifies the key features of the alignment and provides commentary on routing, LRT operations and potential impacts.

Section 3.2.5 provides a basis for comparison of the 3 concepts and provides a recommendation to develop the preferred concept.

Section 3.2.6 outlines the characteristics and issues of the concepts recommended for further evaluation.

3.2.2 LRT Design Options

This overview lists the implications of various LRT design options that were considered when evaluating alternatives for this line within the downtown and adjacent communities.

<u>SE LRT At-Grade System</u>

- Lowest capital cost.
- Greatest potential to impact traffic and transit capacity.
- Priority for LRT will increase traffic delay as lines and train frequencies increase.
- There are impacts to existing and future developments and access points
- Low floor light rail vehicle technologies are more attractive than current high floor vehicles for new LRT lines in terms of station and platform design but they are precluded from operating on 7th Avenue with existing trains.
- For on-street running, dedicated lanes are required for LRT– these may be bus lanes as well.

- North / south at-grade operation in the downtown is limited to 3 car trains due to block lengths.

SE LRT Elevated System

- More expensive than at-grade (~2X)
- Elevated stations have access limitations
- Visual impact perceived as undesirable in some locations
- Potential conflicts with +15 crossings requires integration
- Minimal impact on traffic and transit capacity / delay
- Does not limit train length in the downtown

SE LRT Underground System

- Highest capital costs (~6X)
- Potential issues with ground water levels
- Impacts to underground utilities and existing South LRT tunnel
- Potential impacts to building foundations
- Does not impact traffic and transit capacity and delay
- Does not limit train length in the downtown
- Underground stations present access limitations
- Cut and cover construction is more economical than tunnel boring

In order to maintain future capacity of the system, 4 or 5 car trains are optimal and therefore the downtown segment of the line will need to be fully grade separated if it has a north/south alignment. The east/west segments could be at grade or grade separated.

3.2.3 Geometric Characteristics and Constraints

Current High Floor LRT

- Minimum turning radius: 60 m
- Maximum gradient: 6.0%
- Platform height 0.9 m

Low Floor LRT

- Minimum turning radius may be under 20 m (2 articulations \ car)
- Typically 20-40 m (1 articulation \ car)
- Maximum gradient: 8.0%
- Platform height 0.36 m

Grade separations will require a portal or ramp. The length for minimum clearance for the LRT of 4.6m (or 4.5m for a roadway) with a 2.0m structural depth is:

- 180m for a 60 kph design using a 6% maximum gradient.
- 135m for a 40 kph design using a 6% maximum gradient
- 106m for a 40 kph design and an 8.0% gradient (maximum gradient practical for rail, ideal conditions)

3.3 Potential Routing Options

This study identified and examined 3 base concepts for SE LRT routing options in the downtown (see Figure 2). Each starts from the terminus of the approve alignment at the Elbow River, just south of the CPR.

1. Concept 1 connects the new SE LRT line to 7th Avenue via the East Village.
2. Concept 2 is an independent SE LRT line connecting to the Downtown via the Beltline, entering the downtown on a north / south alignment via either 2nd or 6th Street SW.
3. Concept 3 is an independent SE LRT line connecting to the Downtown via 9th Avenue with a north / south Downtown alignment on Centre Street.

KEY:

- CONCEPT 1A – SE LRT conn. to 7 ave. via 6 st./Fort Calgary. Exist. south LRT tunnel into new 8th ave tunnel.
- CONCEPT 1B – As above. SE LRT TO 7 ave. conn. via 4th street (east village).
- CONCEPT 2A – Two way SE LRT line on 10 ave into downtown via 2nd st. W.
- CONCEPT 2B – SE LRT line on 10th and 11th ave one way couplet into downtown via 2nd st. W.
- CONCEPT 2C – SE LRT line on 11th and 12th ave one way couplet into downtown via 2nd st. W.
- CONCEPT 2D – Two way SE LRT into DT via tunnel on 10th ave. starting @ 1st E. into DT via 2nd st. W.
- CONCEPT 2E – LRT into DT via 2 way operation on 10th ave. into DT via 6th st. W.
- CONCEPT 2F – SE LRT line on 10th and 11th ave one way couplet into downtown via 6th st. W.
- CONCEPT 2G – SE LRT line on 11th and 12th ave one way couplet into downtown via 6th st. W.
- CONCEPT 3A – Two way SE LRT into DT via 9th ave SE., into DT via Center St. LRT crosses over CPR tracks/Elbow river.
- WEST LRT OPTION

NOTE:

STATION LOCATIONS ARE CONCEPTUAL, AND ARE ARE BASED ON CURRENT LAND USE. FURTHER WORK IS REQUIRED AS PART OF DETAILED AREA PLANNING STUDIES IN ORDER TO DETERMINE EXACT STATION LOCATIONS. VARIOUS STATION LOCATIONS ARE POSSIBLE DEPENDING ON THE NEED OF THE AREA.

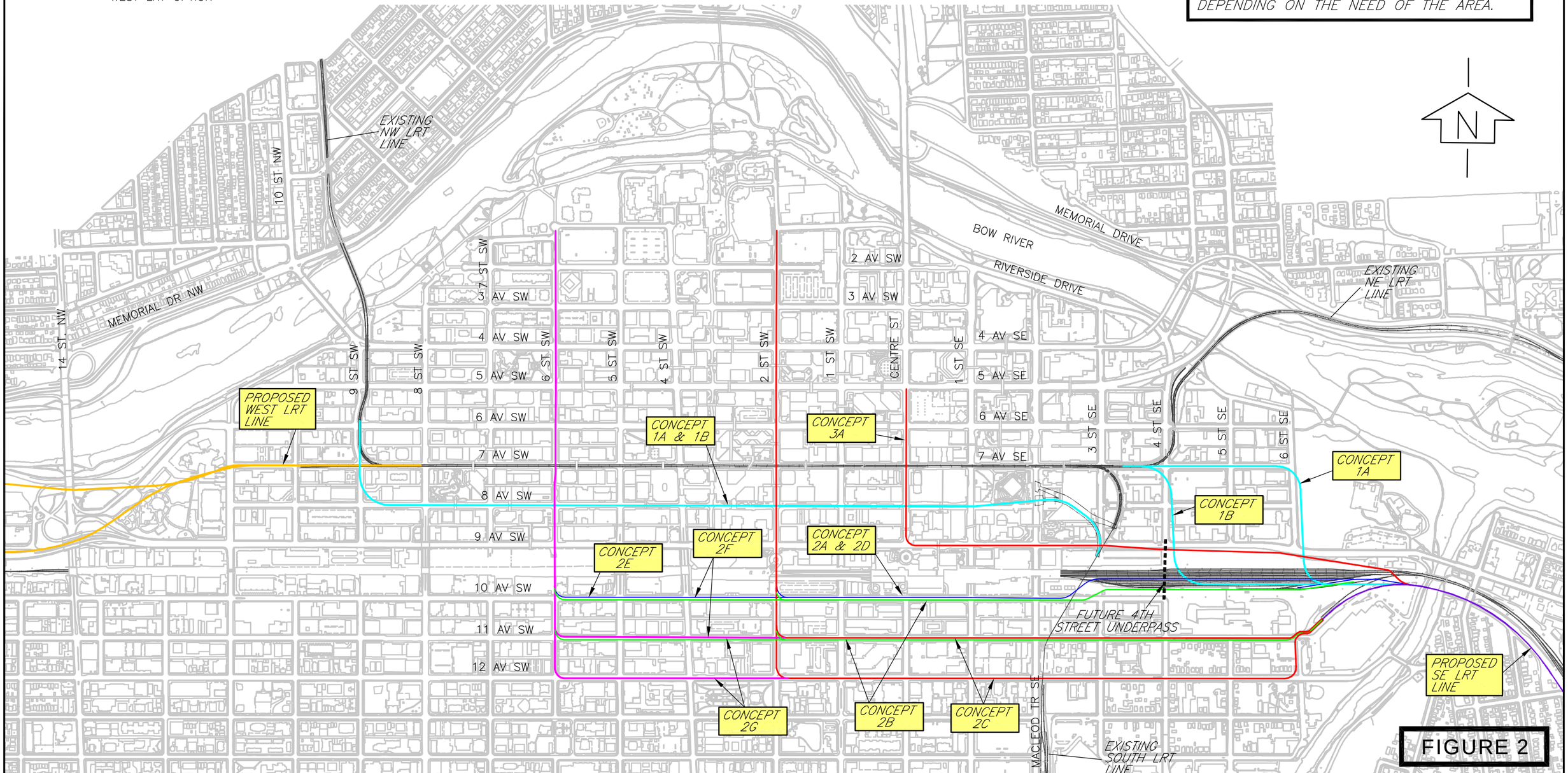


FIGURE 2

	DATE: JUNE '05 SCALE: 1:10 000 (11x17) DWG NO.: FIGURE 2 – final design	Clifton ND Lea CONSULTING INC.	PROJECT: CITY OF CALGARY LRT FUNCTIONAL PLANNING STUDY	TITLE: SOUTHEAST LRT DOWNTOWN OPTIONS

3.3.1 Concept 1 - 7th Avenue

The SE LRT line would continue from the previously approved alignment just west of the Elbow River. There are two feasible options for Concept 1 and each requires a connection of the Southeast line to LRT on 7th Avenue. Concept 1A connects with 7th Avenue via 6th Street SE while Concept 1B connects via 4th Street SE. Both options require an elevated crossing of the CPR tracks with approach structures approximately 200m in length on both sides of the CPR tracks. Essentially, an elevated structure would extend from the Elbow River with a return to grade just before entering 7th Avenue. There is no opportunity to provide a station within the East Village area and these concepts are not reflective of the current East Village plan.

There is a limit to the number of trains that can ultimately utilize 7th Avenue (see Section 2). Since Concept 1 alignments require a connection of the SE line to 7th Avenue, construction of either of these alignments would require that the existing South line be relocated to an 8th Avenue subway much sooner than with the other options to address 7th Avenue capacity constraints.

3.3.2 Concept 2 - Beltline

A total of seven Concept 2 alternatives were developed within the Beltline area. These options begin at the end of the previously approved alignment just west of the Elbow River and would move onto either 10th, 11th or 12th Avenues via some combination of the CPR right of way or City owned land east of 6 Street SE. Each of the options would turn northward, via tunnel, into the downtown under either 2nd or 6th Streets SW. Downtown stations would be underground to permit longer trains to stop between the avenues.

Low floor LRT technology is required for each of these options due to the need for shorter turning radii in order for the tracks to remain within the existing roadway rights of way. As well, low platform LRT stations along on-street segments, made possible by use of low floor LRT vehicles, would allow stations to be integrated into the streetscape and adjacent development. Essentially, an enhanced sidewalk would be the station platform.

A reserved lane would be required to allow LRT to operate at-grade in mixed traffic. This is necessary to provide transit priority and to ensure that multi-car trains are able to move into the next block. Regular traffic movements across the LRT track at driveways and intersections would be permitted.

Currently this area has relatively low traffic volumes with manageable access conflicts across the proposed at-grade LRT operation. Future development of the area will be significant; however, this development could be designed to fit with the requirements of a future LRT line.

For all Concept 2 options, stations would be located in the vicinity of 4th Street SE, 1st Street SW and (if the line enters the downtown via 6th Street SW) 4th Street SW.

10th Avenue / 11th Avenue Options

Concepts 2A, 2B, 2D and 2E are alternative routings that would utilize 10th Avenue or a combination of 10th and 11th Avenues.

- Concept 2A would see a two-way, at grade LRT operation along the curb lanes of 10th Avenue. The centre lanes of 10th Avenue would continue to be used by normal traffic with no restrictions on vehicles crossing LRT tracks. In concept 2A, LRT would enter a tunnel just west of 1 Street SW to pass under the CPR and remain underground with subway stations in the downtown under 2nd Street SW. Concept 2E is the same as 2A except it would enter the downtown via tunnel to a 6th Street SW alignment.

- Concept 2D follows the same alignment as Concept 2A but it would be in a longer tunnel that would start west of MacLeod Trail after passing over the existing South LRT tunnel. Similar to Concept 2A, the tunnel would continue into the downtown via 2nd Street SW. To minimize the impact of the tunnel portal west of MacLeod Trail, LRT would operate in the centre lanes of 10 Avenue between 3rd Street SE and MacLeod Trail. The station at Centre Street S would be underground. This option was developed in order to minimise the conflicts between LRT and driveway accesses, and also to reduce the impact to traffic on 10th Avenue. It is the most expensive of the Beltline options because it requires a longer tunnel section.

- Concepts 2B and 2F are one way couplet systems that would see LRT operate in the south curb lane on both 10th and 11th Avenues. The south curb lane is required to provide an adequate turning radius where the line turns north into the downtown. Trains would run opposite to the direction of traffic to provide greater operational safety. Ideally, to optimize traffic capacity, these concepts would require the remainder of the street to operate with one-way traffic for the section shared with LRT. Concept 2B and 2F would enter the downtown in a tunnel on 2nd Street SW and 6th Street SW respectively. These options would minimize potential conflicts between LRT and regular traffic, particularly for the lands along the north side of 10th Avenue where access is already restricted by the railway tracks and road subways on the north/south streets. Traffic access to local driveways along the south side of 10th Avenue could be redirected to the lane that runs between 10th and 11th Avenues. There is no mid block lane between 11th or 12th Avenues to permit redirection of driveway access from 11th Avenue.

11th and 12th Avenue Options

- Concepts 2C and 2G are one way couplet systems that would occupy the south curb lanes of 11th and 12th Avenues. LRT would operate opposite to the direction of traffic to provide for greater operational safety. There is no mid block lane between 11th or 12th Avenues to permit redirection of driveway access.

3.3.3 Concept 3 - Centre Street

Concept 3 involves an elevated crossing of the CPR tracks with approach structures approximately 200m in length on both sides of the CPR tracks. The line would run along the south side of 9th Avenue opposite Fort Calgary. An at-grade station between 6th and 5th Street SE is feasible with a pedestrian overpass connection over 9th Avenue SE to the future development in the East Village.

The alignment enters private property west of 6th Street SE and into a very deep tunnel to go under the future 4th Street SE underpass and beneath the existing South LRT tunnel. The alignment remains in tunnel turning northward under Centre Street, terminating in an under ground station on Centre Street S. between 7th and 5th Avenue.

The purpose of investigating a Centre Street alignment was to facilitate a possible future northward connection. However, it has been determined that it would be very difficult to continue this line further north due to the impact on buildings in Chinatown, the Centre Street Bridge and communities north of the Bow River.

3.3.4 Other SE LRT Concepts

The possibility of the Southeast LRT line entering the heart of the downtown via the CPR right of way was explored. CPR has indicated that their long-term plan is to expand from two to five railway tracks across the Elbow River. There is room to accommodate six railway tracks through the Palliser Square and Gulf Canada complex. This would limit SE LRT to one directional LRT track within the CPR right of way. CPR has advised that they would prefer to keep their future mainline options open to accommodate future capacity requirements including a possible High Speed Rail Station in the vicinity of Palliser Square. Therefore, it is not possible to locate SE LRT within the CPR right of way west of 4th Street SE.

3.4 Preliminary Screening of SE LRT Downtown Concepts

Each of the Concepts described above were evaluated and compared on the basis of LRT operations, transportation network, land use/urban design, environmental and capital costs. The evaluation criteria and brief description is indicated in Table 1, and a comparison of concepts is shown in Table 2.

TABLE 1
Preliminary Screening Criteria for SE LRT Downtown Concepts

Category	Criteria	Description
LRT Operations	LRT System Connectivity	How well does this option allow the LRT lines to function as a system with good connectivity between LRT lines in the downtown
	Future LRT Capacity	Impact on the flexibility and capacity for handling future LRT system capacity
	Travel Time	Relative measure of train operating speed and travel time
	Service Area	LRT service area accessible from station areas including the core employment area of the downtown
Transportation Network	Roadway Capacity	Impact on adjacent roadway capacity within the Beltline and downtown
	Safety/Operating Conflicts	Number of potential conflict points between train and other traffic or pedestrians
Land Use / Urban Design	Impact on Redevelopment	Potential to influence land use that is supported by City of Calgary and local community planning objectives
	Pedestrian Environment	Potential to provide a high quality pedestrian environment within the streetscape
	Property Access	Impact on access to adjacent lands - number of driveway and alley crossings that would be subject to control
	Business Impact	Minimize constraints and maximize business opportunities
	Residential Impact	Minimize impact and maximize benefits to adjacent residents
Environmental		Impact on natural and urban environment
Costs		
	Land	Number and size of land parcels required for the project including city owned land
	Infrastructure	Includes structures, track and signaling, power, stations and related roadway / traffic control modifications.

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TABLE 2
Preliminary Screening Comparison for SE LRT Downtown Concepts

Category	Criteria		Comparative Score			
			Concepts			
			1 (7th Ave)	2 (Beltline)		3 (9th Ave Centre Street)
				To 6th Street SW	To 2nd Street SW	
LRT Operations	LRT System Connectivity	*	Very good	Fair	Very good	Fair
	Future LRT Capacity		Poor	Best	Best	Best
	Travel Time	*	Best	Poor	good	Poor
	Downtown Service Area		Poor	Very good	good	Poor
Transportation Network	Roadway Capacity		Very good	Fair	good	Best
	Safety/Operating conflicts	*	good	Fair	good	Very good
Land Use/Urban Design	Impact on Redevelopment	*	Poor	Very good	good	Poor
	Pedestrian Environment		Poor	Very good	Very good	Poor
	Property Access		Fair	Fair	good	good
	Business Impact	*	good	good	Fair	Very good
	Residential Impact		Poor	good	good	Very good
Environmental	Natural		Fair	Best	Best	Fair
Costs	Land		good	Fair	good	Poor
	Infrastructure	*	Poor	good	Very good	Fair
	Fixed facility costs, $M Comparative Costs		800	150-213	132-185	218
	Overall Ranking		**4th**	**2nd**	**1st**	**3rd**

* Indicates a critical element

3.4.1 Summary of Evaluation

Concept 1 ranked last in the preliminary screening comparison for the following reasons:

- Impacts to the East Village where land use planning does not include a provision for LRT.
- Impacts to the Fort Calgary historical site for concept 1A.
- A high profile elevated structure across the CPR tracks and 9th Avenue at the entrance way to the downtown is not seen as a desirable feature.
- This option limits the ultimate LRT capacity in the downtown and therefore there is no reserve LRT capacity beyond the 1.5 million population horizon.
- Has the highest capital cost due to the requirement for an earlier relocation of the South LRT line and construct the 8th Avenue subway tunnel. The 8th Avenue tunnel has an estimated capital cost of $500M (2004)
- There is no opportunity to provide an LRT station in the East Village.

Concept 3 ranked second last in the preliminary screening comparison for the following reasons:

- A high profile elevated structure across the CPR tracks and 9th Avenue at the entrance way to the downtown is not seen as a desirable feature.
- This concept would severely impact developable land on the south side of 9th Avenue between the Elbow River and 4th Street SE.
- Does not serve the core employment area of the downtown.
- A bored tunnel with significant construction cost is required to avoid a conflict with the existing South LRT line tunnel near 3rd Street and 9th Avenue SE

Concept 2 options ranked first and second in the preliminary screening since they have the potential to serve a greater region of the downtown on both the north and south sides of the CPR tracks. These routings leave significant future residual capacity for the LRT on 7th Avenue. Low floor LRT cars are required and this technology results in at-grade stations that can be integrated with the pedestrian facilities and adjacent development. Low floor LRT cars are also advantageous along the remainder of the Southeast line, particularly in the planned development south of Highway 22X.

Concepts involving a 2nd Street SW connection to the downtown core are ranked higher than those using 6th Street SW for the following reasons:

- 2nd Street, SW is better able to serve the central core of downtown employment with a station adjacent to the 7th Avenue LRT station at 3rd Street, SW.
- Minimizes travel times to downtown
- Minimizes impacts to roadway and land use
- Minimizes construction and operating costs
- Maximizes interchange between LRT lines

The greatest perceived impacts are to traffic since two dedicated lanes will be required for LRT on either 10th, 11th or 12th Avenues in the Beltline.

Following this evaluation and review by stakeholder groups, a review was conducted on the following options (shown on Figure 3).

2A – 10th Avenue, 2 - way LRT

2B – 10th & 11th Avenue, LRT one way couplet

2C – 11th & 12th Avenue, LRT one way couplet

2D – 10th Avenue, 2 - way LRT, Underground

3.5 Preferred SE LRT Option

The following discussion details the advantages and drawbacks of the Concept 2 options for the SE LRT alignment. These alignments have been given consideration relative to the ongoing land use and redevelopment planning in this area of the Beltline. As well, these options have been designed in association with planning for the proposed 4th Street SE underpass. Conceptual station locations have been developed for each option and are indicated on the drawings (see Appendix A) for each of the four options. Station details are subject to area redevelopment plans. Downtown stations on 2nd Street SW are common to all concepts. Two underground stations are proposed - one between 7th and 5th Avenue providing for a pedestrian interchange with the 7th Avenue LRT Line and a terminal station located between 3rd and 1st Avenue near Eau Claire.

For each downtown station, two concepts are proposed: one with offset station heads located on land adjacent to the street and one with in-street station heads located in the road right of way. In-street station heads on 2nd Street SW are preferred since they simplify pedestrian access to the underground platforms and they do not require additional property. The advantage to the offset station head layout is that through traffic lanes on 2nd Street can be maintained. Provision for station links from adjacent property should be obtained as part of future development.

As described previously, at-grade, on street LRT operation in the Beltline will require a reserved lane. The track bed would be raised 75mm to 100mm above the adjacent roadway by means of a mountable curb and gutter. The LRT right of way would also be delineated from the adjacent sidewalk with curb and gutter. The surface colour and texture would further delineate the LRT lane from the roadway and sidewalk areas. Access to driveways would be permitted across the LRT; however, they should be consolidated or redirected to the back lane or side street as part of future development planning wherever feasible. Emergency vehicles could also run on the LRT right of way. LRT vehicles would be low floor vehicles similar to the examples provided in Appendix D. This would enable the integration of the sidewalk and the station platform areas with adjacent development. Connecting buses could also use the LRT in-street right of way and operate using the same station platforms.

The following photos are from Denver, Colorado, showing the operation of their LRT in the Downtown which is designed based on the above principles.

The above photo shows a typical downtown in-street LRT operation in Denver. The LRT trains are running counter flow to the direction of traffic on a one way street. Note the combined lighting/catenary poles, and physical differentiation between the LRT right of way and the adjacent roadway and sidewalk.

The photo above shows a typical station in downtown Denver where the platform is integrated with the sidewalk. Note that since the Denver LRVs are not true low floor cars (they have steps inside the cars) there is a need for a ramp to provide handicapped access to the head end of the train. It is intended that low floor LRVs for the SE line would be fully accessible and this type of facility would not be required. Overall the station platform amenities are very modest.

The photo on the next page shows a typical parkade exit/entrance in downtown Denver where vehicles are permitted to cross the LRT right of way with minimal protective devices. Warning signs are posted inside the parkade and just prior to the road crossing. Note that this driveway crossing is also in a track turnout area.

KEY:

- CONCEPT 2A – Two way SE LRT line on 10 ave into downtown via 2nd st. W.
- CONCEPT 2B – SE LRT line on 10th and 11th ave one way couplet into downtown via 2nd st. W.
- CONCEPT 2C – SE LRT line on 11th and 12th ave one way couplet into downtown via 2nd st. W.
- CONCEPT 2D – Two way SE LRT into DT via tunnel on 10th ave. starting @ 1st E. into DT via 2nd st. W.
- WEST LRT OPTION
- S INDICATES PROPOSED STATION LOCATION, COLOUR CODED TO VARIOUS CONCEPTS
- ALT. S INDICATES PROPOSED ALTERNATIVE STATION LOCATION, COLOUR CODED TO VARIOUS CONCEPTS

NOTE:

STATION LOCATIONS ARE CONCEPTUAL, AND ARE ARE BASED ON CURRENT LAND USE. FURTHER WORK IS REQUIRED AS PART OF DETAILED AREA PLANNING STUDIES IN ORDER TO DETERMINE EXACT STATION LOCATIONS. VARIOUS STATION LOCATIONS ARE POSSIBLE DEPENDING ON THE NEED OF THE AREA.

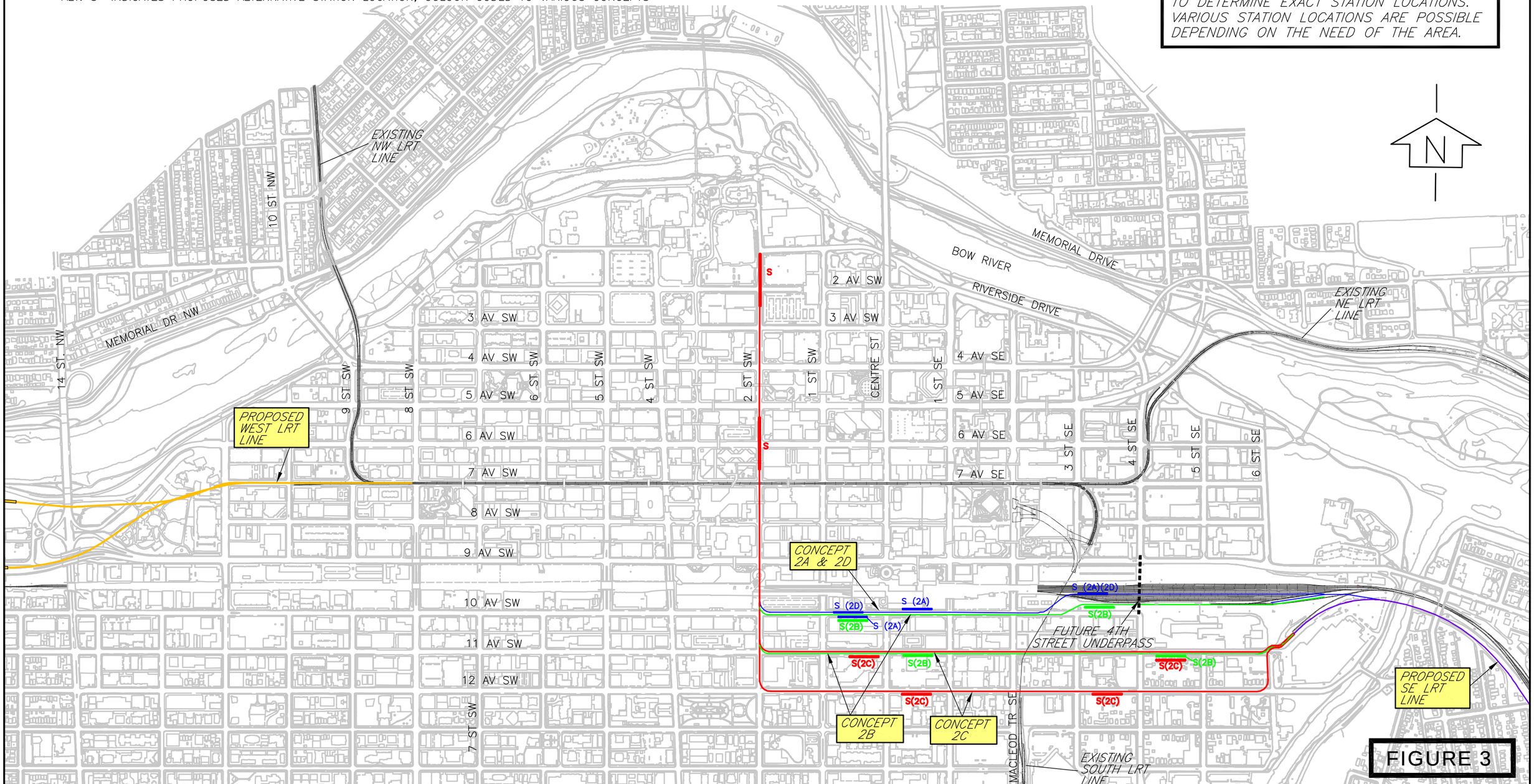


FIGURE 3

DATE: JUNE '05 SCALE: 1:10 000 (11x17) DWG NO.: FIGURE 3 – final design	Clifton ND Lea CONSULTING INC.	PROJECT: CITY OF CALGARY LRT FUNCTIONAL PLANNING STUDY	TITLE: SOUTHEAST LRT PREFERRED DOWNTOWN OPTIONS

3.5.1 Details of Concept 2A – 10th Avenue, 2 way LRT

Concept 2A would operate at grade from a crossing of the Elbow River to 2nd Street SW where it enters into a cut and cover tunnel on 2nd Street SW into the downtown. See Appendix A for detailed drawings and cross sections. The alignment is largely within the CPR right of way east of 4th Street SE and in the 10th Avenue road right of way west of 4th Street SE to 2nd Street SW. In the downtown it is in a cut and cover tunnel with underground stations between 7th and 5th Avenue SW and a terminal station between 3rd and 1st Avenue SW (Eau Claire). On 10th Avenue, LRT would operate in exclusive curb lanes, with the flow of traffic at up to 40 kph.

This alternative enters 10th Avenue west of 4th Street SE. Desired station locations at 4th Street SE and 3rd Street SE and at Centre Street S. The station location at 4th Street SE is subject to the final design for the proposed 4th Street SE underpass and redevelopment of the adjacent land.

With LRT operating in the curb lane, driveway accesses would not be restricted from crossing the LRT. For the land on the south side of 10th Avenue, driveways should be redirected to the lane between 10th and 11th Avenue SW where feasible to minimize potential LRT / traffic conflicts.

For all Concept 2 options the tunnel required to enter the downtown via 2nd Street SW goes under the current access ramp to the Gulf Canada Parkade. This will require that the ramp be demolished and then rebuilt. The parkade access on 10th Avenue is not affected

In summary the implications of Concept 2A on 10th Avenue are:

- Reduces 10th Avenue capacity and function to one lane in each direction, however, preliminary design work for the proposed 4th Street SE underpass indicates that the connection of 10th Avenue with 4th Street SE may be restricted or closed resulting in reduced traffic.

- Access for emergency vehicles needs to be managed in conjunction with the reserved curb lane for LRT. Access for new buildings can be arranged to respect future LRT requirements. Most south driveway accesses can be redirected to the lane; however there will be some LRT driveway conflicts.

- On street parking on 10th Avenue would not be permitted.

- As well, a major watermain located within the 10th Street right of way will require shifting to permit LRT to enter the tunnel section on 10th Avenue S.

3.5.2 Details of Concept 2B – 10th & 11th Avenue, LRT one way couplet

Concept 2B would operate at grade from the Elbow River crossing to 2nd Street SW where it enters into a cut and cover tunnel on 2nd Street SW for access into the downtown. Concept 2B involves a one way couplet system operating in the south curb lanes of both 10th and 11th Avenues. LRT must be located on the south side of 11th Avenue to maximize the turning radii for the 90 degree turn to 2nd Street SW. Current LRT double articulated car technology permits reduced radius turns of 25 metres or less resulting in reduced property impacts. This geometry will allow this tunnel to be constructed without impact to Lewis Lofts (historic building) located very close to the NE corner of 11th Avenue and 2nd Street SW.

The LRT would operate on 10th and 11th Avenue opposite to the flow of traffic at up to 40 kph. This counter flow LRT movement improves traffic safety for traffic turning movements. Driveway accesses would not be restricted from crossing the LRT, but, they would be redirected to the lane between 10th and 11th Avenue SW or to the side street where feasible.

The west bound LRT approach alignment to 10th Avenue is very similar to concept 2A, with LRT entering the 10th Avenue road right of way west of 4th Street SE. For this option it is recommended that 10th Avenue be converted to a one-way

operation. Alternately 10th Avenue could remain as a two-way street with a counter flow lane. East of 6th Street SE the east bound LRT alignment connects with the Elbow River crossing along the north boundary of the Calgary Transit Victoria Park Garage.

Tunnel approaches for both LRT alignments would be located on 11th and 12th Avenues west of 1st Street SW to eliminate traffic conflicts at 2nd Street. The downtown segment of the LRT alignment is the same as Concept 2A. The downtown segment of the LRT alignment is the same as Concept 2A.

The recommended stations on 10th and 11th Avenues would be located at 4th Street SE and Centre Street S. The location of the westbound 4th Street SE station at 4th Street is subject to the final design of the 4th Street SE underpass. This station can be incorporated into the redevelopment of the adjacent lands.

In summary, the implications of Concept 2B on 10th and 11th Avenues is as follows:

- LRT is in the south curb of each roadway, operating opposite to traffic flow.
- Traffic capacity of 10th and 11th Avenue is reduced from 4 lanes to 3 lanes.
- Recommended conversion of 10th Avenue to one-way traffic operation in this area.
- 11th Avenue to remain as one-way in the area common to LRT operation.
- On street parking would be limited to the north curb lanes on each avenue.
- Most driveway accesses on the south side of 10th Avenue can be redirected to the lane; however there will be some LRT driveway conflicts on 11th Avenue.
- Some land is required from the Calgary Transit Victoria Park Garage site and this may require the construction of a parkade if the garage is to remain here.
- As well, a major watermain located within the 10th Street right of way will require shifting to permit LRT to enter the tunnel section on 10th Avenue S.

Concept 2C Details – 11th & 12th Avenue, LRT one way couplet

Concept 2C would operate at grade system from the Elbow River crossing to 2nd Street SW where it enters into a cut and cover tunnel on 2nd Street SW into the downtown. It is a one way couplet system operating in the south curb lane of 11th Avenue, and the south centre lane of 12th Avenue. LRT must be located on the south side of 11th Avenue to maximize the turning radii for the 90 degree turn that provides access to and from the downtown on 2nd Street SW. Current LRT double articulated car technology permits reduced radii turns of 25 metres or less resulting in reduced property impacts.

There are numerous driveways that access both 11th and 12th Avenue. A continuous mid block lane to provide alternative access is not available therefore, the potential to mitigate driveway conflicts is limited. To minimize driveway conflicts, the LRT alignment would occupy the 2nd traffic lane. In blocks where stations are located the station platform/sidewalk would extend into the curb lane. This results in more generous platform areas. The capacity of 12 Avenue would be reduced by 2 lanes but the south curb lane can be designated for right turns with some off-peak parking.

LRT would operate in a dedicated lane on 11th and 12th Avenue opposite to the flow of traffic at 40 kph. This counter flow LRT movement improves traffic safety for turning movements of opposing traffic. Driveway accesses would not be restricted from crossing the LRT. They would however be redirected to the side street where feasible.

The east and west bound LRT alignment runs along the north boundary of the Calgary Transit Victoria Park Garage and enters 11th and 12th Avenue at 6th Street SE. Similar to 2B, this would require construction of a parkade. This alignment would have a greater impact on bus operations at the Victoria Park Garage due to the increased right of way width.

Tunnel approaches for both LRT alignments would be located on 11th and 12th Avenues west of 1st Street SW to eliminate traffic conflicts at 2nd Street. The downtown segment of the LRT alignment is the same as Concept 2A.

The recommended stations on 11th and 12th Avenues would be located at 4th Street SE and Centre Street S. and these stations can be incorporated into the redevelopment of the adjacent lands.

In summary the implications of Concept 2C on 11th and 12th Avenues is as follows:

- LRT is on the south side of each roadway, operating opposite to traffic flow
- The traffic capacity of 11th and 12th Avenue is reduced to 3 and 2 lanes respectively, from 4 lanes.
- 11th and 12th Avenues to remain as one-way traffic operation in this area.
- Multiple mid block driveway conflicts
- Complex traffic operation on 12th Avenue.
- South curb lane parking would be eliminated on 11th Avenue and restricted on 12th Avenue.
- Functionality of the Calgary Transit Victoria Park Garage may be compromised if it is to remain here.
- Some property required along 6th Street SE

3.5.3 Concept 2D Details – 10th Avenue, 2 way LRT, Underground

Concept 2D is similar to Concept 2A except that the LRT tracks would be located in the centre lanes of 10th Avenue east of MacLeod Trail. This is to facilitate access to the tunnel that begins just west of MacLeod Trail. An underground station is feasible between Centre Street and 1st Street SW.

East of MacLeod Trail, LRT tracks in the centre of 10th Avenue is less desirable from a traffic and LRT operational standpoint.

In summary the Implications of Concept 2D on 10th Avenue are:

- There is less reduction in 10th Avenue traffic capacity and function compared to Concept 2A – fewer blocks with an in-street LRT operation.
- Most south accesses can be redirected to the lane between 4th Street SE and 1st Street. SE, where this option enters into a tunnel.
- Least number of potential conflicts between LRT and current driveways compared to Concepts 2A, 2B and 2C.
- Some property impacts for the under ground station on 10th Avenue at Centre Street
- A major watermain located within the 10th Street right of way will require shifting to permit the LRT to enter the tunnel section at MacLeod Trail.
- Significantly higher capital cost than Concepts 2A, 2B or 2C.

3.5.4 Traffic Impact

A traffic analysis was conducted by the City of Calgary Transportation Department to compare the impact of options 2A, 2B and 2D on the local street network, east of MacLeod Trail during the PM peak period on weekdays for the year 2013. The area for analysis is common to all alternatives. Concept 2C was not analysed since it scored lowest in other evaluation criteria. The following observations were noted:

- No significant differences in travel times along the MacLeod Trail and 1st SE corridors were observed between the options.
- No significant difference in travel time along 12th AV S was observed between the options.
- Concepts 2A and 2D exhibited increased travel times for westbound traffic resulting from traffic diverted from 10th AV S.
- Concepts 2A and 2D exhibited a significant improvement in travel time for southbound traffic on 4th ST SE (a reduction of at least 1 minute) due to

better signal coordination without the constraint of accommodating LRT operation through the intersection.

- In general, concepts 2A and 2D have less impact on local traffic travel times and levels of congestion compared to option 2B.

A summary of the evaluation of the Concept 2 options is provided in Table 3.

Table 3

Evaluation of Concept 2 Options

Criteria	2A	2B	2C	2D
Impact to Property Access	Moderate	Moderate	Worse	Better
Property Requirement	Some	Some	More	More
Traffic Impact	Moderate	Poor	Poor	Better
LRT Operations	Good	Good	Poor	Better
Cost*	$250M	$287M	$277M	$312M
Overall	1	2	4	3

* Major exclusions: property, LRV's, control/maintenance centre

3.5.5 Conclusion

Concepts 2A, 2D (10th Avenue), and Concept 2B (10th and 11th Avenue one way couplet) are the most feasible options for the connection of Southeast LRT to the downtown. This conclusion is based on considerations of LRT operations and service, street network operation and capacity, and cost.

Concepts 2A / 2D operating on 10th Avenue have less impact on local traffic and are the preferred options from a land use planning perspective. Therefore, Concepts 2A and 2D have been included as the preferred options for Southeast LRT in the Beltline ARP document.

Concept 2A is the recommended alignment option. Concept 2D may be considered in the future when this project is ready for detailed design.

4. North Central LRT

The Calgary Transportation Plan indicates the need for a high capacity transit service from future development in the North Calgary area to the Downtown. The Transportation Department has estimated the demand for transit service options based on population and employment projections and several long range transit service options have been examined.

In North Calgary, an LRT right of way has been reserved in the median of Harvest Hills Boulevard from Beddington Trail to the north City Limits. South of Beddington Trail there is a need to finalize an alignment for this line, particularly the connection into the downtown. It is acknowledged that there is potential for a central, in-community LRT line along either Centre Street, or Edmonton Trail. However, such alignments would have significant community impacts with reduced LRT operating capabilities. As well, there is a need to consider a potential bus / LRT terminal in conjunction with a future high speed rail station proposed just south of 96th Avenue / Airport Trail adjacent to the CP Rail line. A right of way for a North-Central LRT link to the downtown is being planned along the railway corridor within Nose Creek valley. A functional study, complete with examination of these options, community consultation and public engagement is required for the North-Central line.

Preliminary analysis has been concluded that:

- In order to meet the demand of the growing North Calgary area, and to meet the goals of Calgary Transportation Plan, transit service must be frequent and competitive in terms of cost and travel times with the private automobile.

- The projected ridership from this area will be more than adequate to support an LRT line to the downtown at the 1.5 million population horizon for the City of Calgary.

- Bus Rapid Transit (BRT) service on Centre Street will be effective as an interim measure to serve this corridor prior to the need for LRT.

- Beyond the 1.25 million population horizon (or when significant development occurs north of Stoney Trail), an LRT line located within the Nose Creek valley can accommodate the needs of the developing and future communities north of Beddington Trail.

As part of this study to identify downtown LRT connectivity options, three possible downtown links for the North-Central line were evaluated assuming that the most likely route will be via the Nose Creek valley.

4.1 North-Central LRT Connection Options to Downtown

As noted above, a potential route alignment for North-Central LRT would follow the Nose Creek valley adjacent to or within the current CPR right of way. Three options have been identified to connect this line to the downtown. These options are shown on Figure 4 and described below.

Option 1

Option 1 parallels the CPR tracks from the Bow River to the east limit of the downtown where it connects to 7th Avenue via 6th Street SE. It requires:

- Relocation of the CPR tracks north of Memorial Drive to permit LRT to be located along the east side of Nose Creek,
- Construction of a new LRT bridge across the Bow River parallel to the existing CPR bridge,
- Use of the utility right-of-way on the west side of the CPR tracks from the Bow River to 9th Avenue SE,
- A long diagonal structure crossing of the Elbow River, and 9th Avenue extending through East Village to 7th Avenue (similar to Concept 1 for SE LRT),
- Acquisition of property on the east side of 6th Street SE between 9th and 7th Avenues. Impact to Fort Calgary property and some additional property is also required along the south side of 9th Avenue from the Elbow River to 6th Street,
- The extension of LRT tracks on 7th Avenue from 4th Street SE to 6th Street SE within the East Village.

Option 2

Option 2 ties the North-Central LRT to the Northeast LRT east of the Zoo Station. The Memorial Drive / Deerfoot Trail interchange was designed to permit this connection. The alignment and profile are detailed on the drawing NC-OPT2 in Appendix B. The following is required:

- Relocation of the CPR tracks north of Memorial Drive to permit LRT to be located along the east side of Nose Creek,
- Modification of sub structure elements of the existing underpasses is required for Memorial Drive westbound and the inbound Northeast LRT structures.

There is sufficient space east of the zoo station to allow for trains to wait for switching operations. Inbound trains may have to stage for access to the Northeast line and Zoo station at a location north of Memorial Drive and the 6% vertical gradient.

Option 3

Option 3 ties the North-Central LRT to the Southeast LRT at the future Ramsay\Inglewood Station. This alternative is similar to Option 1 above. It also requires:

- A significant overpass of the CPR tracks immediately west of 11th Avenue SE
- A slight realignment of the Southeast LRT between 11th Avenue SE and the Elbow River
- Relocation of the future Ramsay\Inglewood station to 100 m west of the proposed site to permit a junction of the lines east of the station and to provide train storage on flat grades for switching operations.

Discussion

Option 2 is recommended since it is the least costly alternative and also provides commuters with the most direct and fastest route to the downtown. It is acknowledged that the connection to Northeast LRT requires the North-Central line to utilize the existing high platform LRT vehicle technology.

Option 3 is a viable alternative that would allow the use of low floor LRVs on the North-Central LRT line. It also permits transfers between Southeast and Northeast LRT without going through the downtown. Finally, it would further delay the need to construct an 8th Avenue subway. The drawbacks of Option 3 are the required land acquisition between 9th Avenue SE and 11th Street SE, significant construction costs related to required structures and that this route is 1.5 km longer than Option 2 resulting in higher operating costs and travel times.

Option 1 is the most costly alternative; it impacts developable land along 9th Avenue SE, impacts the East Village, Fort Calgary, and has longer travel times to the downtown similar to Option 3.

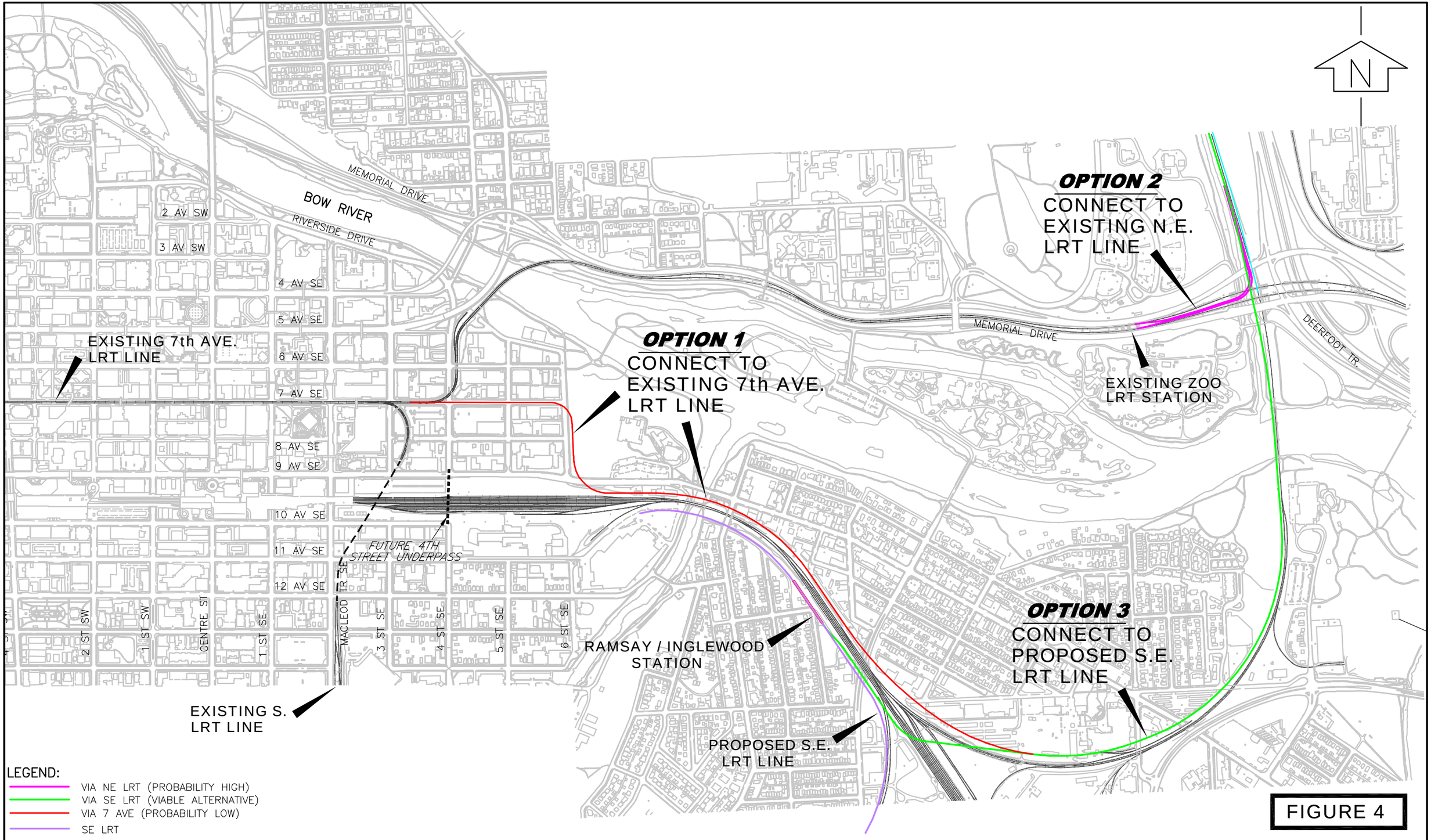


FIGURE 4

	DATE JUNE '05 SCALE 1 : 10000 DWG NO. FIGURE 4 – final design	Clifton ND Lea CONSULTING INC.	PROJECT: CITY OF CALGARY SOUTHEAST LRT FUNCTIONAL PLANNING STUDY	TITLE: DOWNTOWN LRT PLANNING STUDY NORTH – CENTRAL LRT OPTIONS

5. West LRT

Current Conditions and Existing Plans

Currently, the Northeast LRT line terminates at a centre-loading platform located between 9th and 10th Streets SW. Plans have been approved to link a future West LRT line to 7th Avenue from this location. A number of alignments for West LRT, between 11th St. SW and Crowchild Trail have been developed over the years in an attempt to minimize impacts of the west extension on land use and to accommodate planned roadway improvements.

The original alignments for West LRT in the west downtown area were developed as part of the Bow Trail Connector Study in 1981. The functional planning study for West LRT approved in 1983. The study was updated in February of 1985 to define the LRT right of way from 9th Street SW in the downtown west to 37th Street SW. This study recognized the Bow Trail Connector preliminary design study completed in 1981. The approved LRT alignments are subject to the approved roadway improvements being implemented.

The City Calgary approved another update of the West LRT alignment in 1988. This update confirmed the Bow Trail Connector Study of 1981. Therefore, the West LRT alignment between 9th Street SW and Crowchild Trail requires implementation of the Bow Trail Connectors.

The 1981 Bow Trail Connector study modifies key arterial connections to the downtown core from the west. Bow Trail currently directs eastbound traffic to the downtown core via 9th Avenue while westbound traffic is linked to 4th and 6th Avenues. Ultimate plans are for these connections to be realigned to provide an expanded westbound link to 4th Avenue and a new eastbound link to 5th Avenue. The new links would be aligned parallel to and south of the existing Bow Trail \ 4th Avenue westbound alignment. The 9th Avenue is significantly widened to become a feeder to the downtown core consisting of two lanes in each direction and a median to accommodated West LRT.

Construction of these links requires significant additional roadway and structures with impacts to adjacent land use. Currently the Bow Trail Connector plan is under review by The City of Calgary. It is acknowledged that the approved plan for this segment of West LRT will likely require revision given changing land use and transportation network revisions.

The purpose of this study is to examine alternate alignments for West LRT between the current Northeast LRT terminus on 7th Ave. and Crowchild Trail with and without implementation of the Bow Trail Connectors.

5.1 West LRT Options in the Downtown

5.1.1 Historic West LRT Alignments

Figure 5 illustrates various alignments for West LRT that were examined in 1981 in conjunction with the development of the Bow Trail Connector roadway plans and again in 1983 and 1988. Figure 5 also illustrates two additional alignment options based on current land use. All alignments share a common connection with the median of Bow Trail just east of Crowchild Trail. The following is a description of these alignments.

Option A. 1981 – (Bow Trail Connector Study)

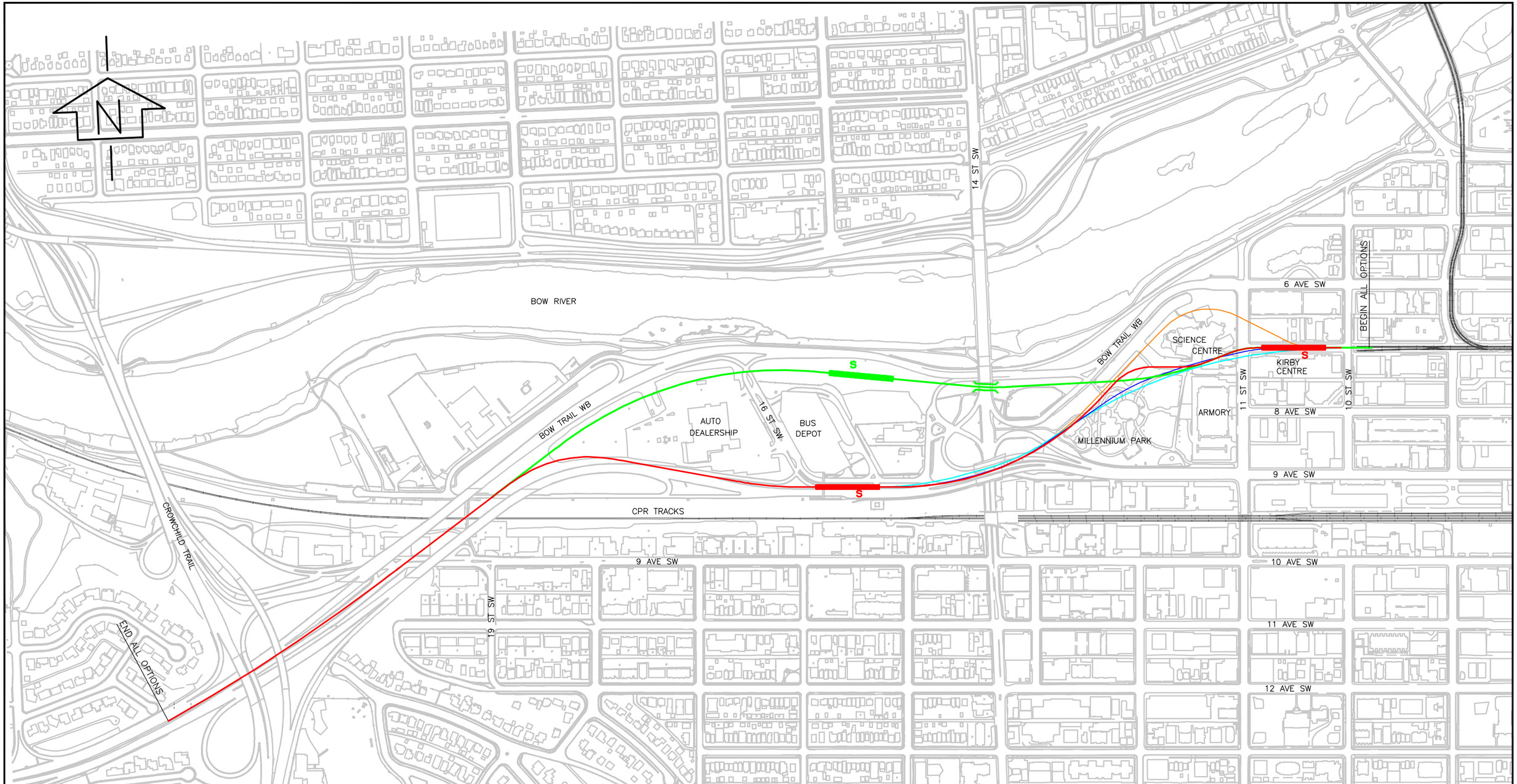
Immediately west of 10th Street this LRT alignment curves northward from 7th Avenue crossing 11th Street near the mid-block alley. The alignment then curves back to the south, passing north of the Science Centre and heads southwest to parallel a new Bow Trail Connector roadway to link 6th and 9th Avenues. At 14th Street the alignment curves to the west and goes along the north edge of 9th Avenue. This alignment is far enough north to impact a significant part of the bus depot and GSL auto dealership properties. The alignment then bends to the north and a station is located in the vicinity of the existing auto dealership building before the alignment bends back to the south to cross over the CPR tracks and enter the median of Bow Trail east of Crowchild Trail.

The bus depot and circulation roads were constructed on 9th Avenue at 16th Street SW after the development of this plan. If the cross section proposed in the 1981 study is retained and the bus depot and its circulation roads are not to be impacted, then 9th Avenue must be altered. To accommodate this plan, 9th Avenue must be realigned to the south, impacting the electrical transmission towers and requiring the acquisition of a strip of land parallel to 9th Avenue.

Option B. 1983 – West LRT Functional Study

The 1983 West LRT Functional Study resulted in a modification of the LRT plan to avoid impacts to the north side of 7th Avenue between 10th and 11th Streets. The LRT line was changed to bend to the south with a westbound platform located between 9th and 10th Avenues and an eastbound platform located between 10th and 11th Avenues.

This option has West LRT going though a corner of the Kerby Centre building and the Science Centre parkade. It then cuts through Millennium Park in a south-westerly direction, significantly segmenting the park. Millennium Park was constructed after this alignment was approved. The alignment continues southwest over 14th Street at 9th Avenue and then follows along the north side of 9th Avenue, similar to Option A. A station is located adjacent to the GSL auto dealership. West of the station the alignment continues adjacent to 9th Avenue until it cross over the CPR track.



KEY:

- OPTION A (1981 alignment)
- OPTION B (1983 alignment)
- OPTION C (1988 alignment)
- OPTION D (minimize impact to park)
- OPTION E (no bow trail connector)
- S INDICATES PROPOSED STATION LOCATION, COLOUR CODED TO VARIOUS CONCEPTS

FIGURE 5

	DATE JUNE '05 SCALE 1 : 6000 DWG NO. FIGURE 5 – final design	Clifton ND Lea CONSULTING INC.	PROJECT: CITY OF CALGARY DOWNTOWN LRT FUNCTIONAL PLANNING STUDY	TITLE: WEST LRT OPTIONS

Option C. 1988 – West LRT Functional Study

In 1988, the proposed West LRT alignment was modified to avoid impacting the Kerby Centre and adjacent properties. While the building was not impacted, its frontage and sidewalks must still be revised to allow for the broad curvature of the LRT alignment. The Science Centre parkade and access are also significantly impacted. Eastbound and westbound LRT platforms are relocated to the west side of 11th Street, impacting the Science Centre building. The rest of the alignment is similar to Option B, with Metawa Stadium (now Millennium Park) being segmented, a new station being located adjacent to the GSL auto dealership, and the alignment following 9th Avenue on the north and crossing over the CPR tracks.

7th Avenue LRT Station Reconstruction & Pedestrian Environment Upgrades

A plan to reconstruct the current 7th Avenue LRT platforms to accommodate 4-car LRT operation was approved in 2004 October. The plan calls for an immediate extension of the 7th Avenue LRT tracks with a double side loading platform to be constructed just east of 11th St. SW. This plan requires a modification of the future West LRT connection to 7th Avenue and a minor change to the LRT alignment west of 11th St. through the current Science Centre site.

5.1.2 Additional Options

For the purpose of this study, the above plans were reviewed and two additional options were developed to reflect current circumstances. Plans were developed to minimize the impact of LRT and to recognize the likely requirement to modify the Bow Trail Connector plans.

Option D. Minimum Impact

This option minimizes impacts to the streetscape adjacent to the Kerby Centre, the bus depot, and Millennium Park. It does, however, require three low speed LRT track curves (to minimize impact to the Science Centre) and may require property acquisition adjacent to 9th Avenue.

The West LRT alignment is kept on 7th Avenue between 10th and 11th Streets SW. In compliance with the recently approved 7th Avenue station plans, platforms are located in both directions on this block and are located as far to the east as possible. A minimum radius ‘S’ curve is located at the west end of the block and through the Science Centre parkade to align the LRT parallel to 7th Avenue west of the Science Centre building. The alignment proceeds directly west then bends with a third minimum radius curve to follow the proposed Bow Trail Connector right-of-way to 14th Street SW.

The alignment is pushed south to avoid impacting the bus depot. This requires additional property on the south side of 9th Avenue to provide for the connecting roads inherent in the current Bow Trail Connector plan. Widening 9th Avenue to the south will in turn require relocation of the existing power transmission towers.

A station is located adjacent to the bus depot, which could also serve the Sunalta community via a pedestrian overpass of 9th Ave. SW and the CPR. From this location westward the alignment is similar to Option B.

Option E. No Bow Trail Connector

This option minimizes the land use impacts associated with the West LRT and maximizes LRT operating speed. The West LRT alignment is kept on 7th Avenue between 10th and 11th Streets SW. In compliance with the recently approved 7th Avenue station plans, platforms are located in both directions on this block and are located as far to the east as possible. A large radius 'S' curve is located at the west end of the block passing through the Science Centre parkade to align the LRT parallel to 7th Avenue west of the Science Centre building. The alignment proceeds directly west to 14th Street SW, passing over the roadway and then parallels the existing westbound lanes of Bow Trail past the north side of the bus depot and GSL auto dealership. An elevated station is proposed on the north side of the bus depot. The alignment then bends to the southwest, following Bow Trail westbound and crosses over the CPR tracks.

This alignment requires that West LRT is elevated continuously from west of the Science Centre to the CPR crossing due to the frequency of intersecting roadways and the desire to locate an LRT station close to the Bus Depot. It is not possible to locate a 5-car station at grade due to horizontal and vertical geometric constraints between 14th Street and the CPR elevated crossing.

5.1.3 Discussion

The following factors should be noted in evaluating these options:

- Property impacts related to the 1981 and 1983 alignments (Options A and B) are significant.

- If the Bow Trail Connector system is not constructed as currently planned then Option E appears to be the most viable. It minimizes impacts to various lands by paralleling the existing westbound Bow Trail. Impact to Millennium Park is moderate. The alignment will require modification of the Science Centre parkade and entrance but the building itself can be retained.

- Construction of Option E is more costly since it must be elevated.

- Options C and D are both viable if the Bow Trail Connector plan is constructed. Both options will require modification of the Science Centre parkade and building entrance.

- Option C provides a higher speed of operation while Option D has three minimum radius curves and thus a lower LRT operating speed. Also, Option C does not require revision to the plans for the approved Bow Trail Connector

roadway plans, the corresponding relocation of electrical transmission towers or the acquisition of additional right-of-way.

Option C has a number of disadvantages when compared to Option D:

- It impacts the area around the Kerby Centre.
- The station immediately west of 11th Avenue will likely impact on the Science Centre building as well as its elevated deck. It may be necessary to relocate the LRT station to retain the building to make this option comparatively viable.
- It segments a greater portion of Millennium Park.
- It requires significant alteration of the bus depot and its access and circulation roads.

Recommendation

Option D and E are the most feasible options. Option D is preferred since it most closely follows the currently approved LRT alignment and Bow Trail Connector plan for this area. As well Option D provides a station location that can be designed to serve the area on both the north and south sides of 9th Avenue SW / CPR tracks. It is recommended that these design concepts be considered as part of the feasibility study required to update the Bow Trail connector plans between Crowchild Trail and 11th Street SW.

6. Study Conclusions and Recommendations

This study has explored alignment and downtown connectivity options to facilitate long range expansion of the LRT network. The conclusions of this analysis are:

- Despite significant employment growth in other areas, the downtown will continue to grow and attract a high concentration of trips from growth in the West, Southeast and North-Central corridors. Growth in these corridors will require LRT lines to meet the demand for transit travel.
- An alignment has been approved for West LRT and a Southeast LRT route has been approved as far as the Elbow River. A functional study is required to finalize the location of North-Central LRT and preliminary planning has identified the Nose Creek valley as the most likely route for this line.
- West LRT can connect directly to 7th Avenue and operate as a continuation of Northeast LRT line similar to how the Northwest and South LRT lines provide a continuous service. Minor variations to approved West LRT alignment are

required to construct LRT between the current west LRT terminus and the approved Bow Trail alignment west of Crowchild Trail.

- In the future, the Southeast and North-Central LRT lines will approach the downtown from the east. Connection of both of these lines to 7 Avenue is not feasible due to anticipated capacity constraints.

- The North Central LRT can enter the downtown via the Northeast LRT line via a connection east of the Calgary Zoo station.

- Southeast LRT can enter the central area of the downtown via a separate alignment that utilizes the CPR rail right of way, 10 Avenue S. and a subway beneath 2 Street SW.

- Ultimately, the downtown LRT network will require the construction of an 8th Avenue subway for the combined operation of the South and Northwest lines.

7. Recommendations

- That the recommended alignment for Southeast LRT is Concept 2A that utilizes a portion of 10 Avenue S. Concept 2D, which requires a longer tunnel section and an underground station at Centre Street within the 10th Street S right of way, is feasible and may be considered when this project is ready for detailed design prior to construction.

- That a feasibility planning study be conducted to identify the requirements for a future North-Central LRT line to utilize the Nose Creek valley between Harvest Hills Bv / Beddington Tr. Connection to the Northeast LRT just east of the Calgary Zoo Station is feasible and is the best option for connecting North Central LRT to the downtown.

- That Option D is the preferred alignment for West LRT between 11th Street and Crowchild Trail SW. This alignment requires some modifications to the approved alignment. A functional study is required to update the approved plans for West LRT and the Bow Trail Connectors due to changing land use in this area.

- The recommended downtown LRT network plan is illustrated on Figure 6. This network identifies the long term requirement for an LRT subway under 8 Avenue S for the operation of the Northwest and South LRT lines.

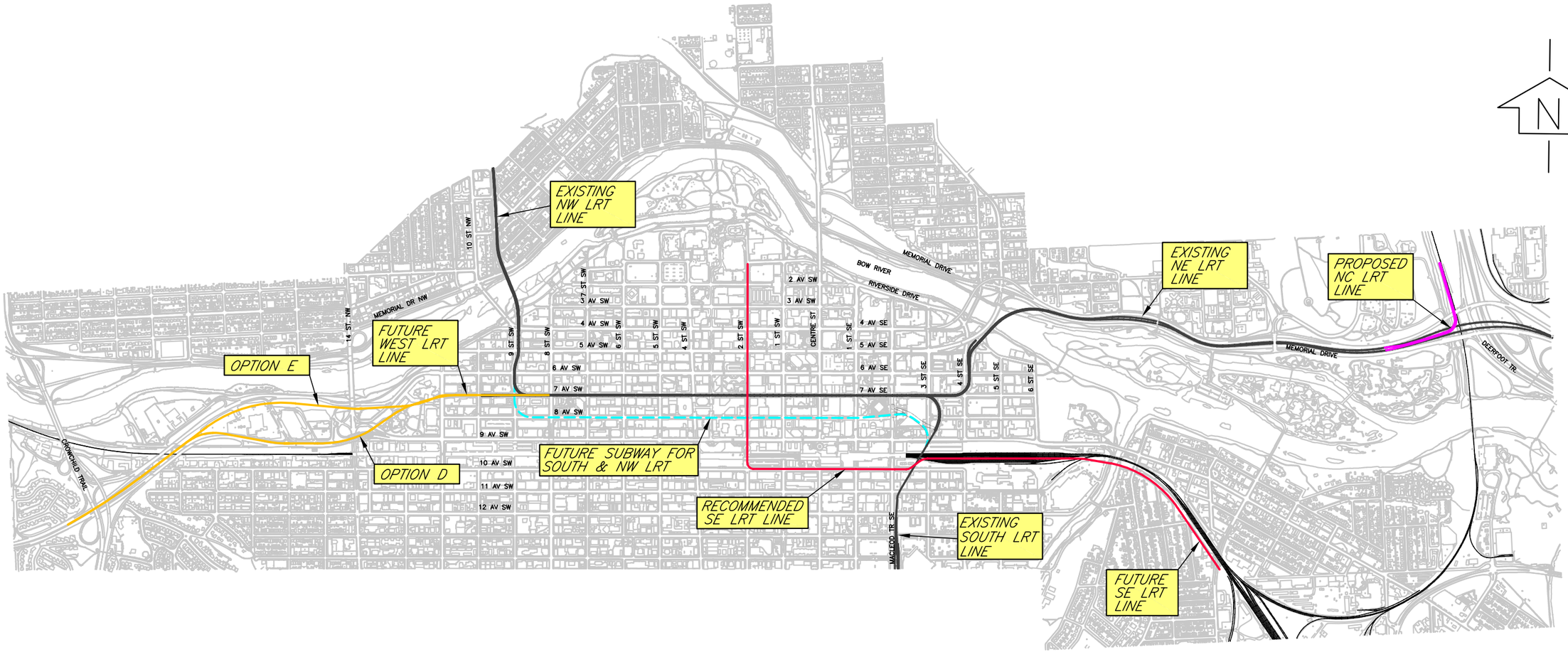


FIGURE 6

	DATE: JULY '05 SCALE: 1:20 000 (11x17) DWG NO.: FIGURE 6 – final design	Clifton ND Lea CONSULTING INC.	PROJECT: CITY OF CALGARY LRT FUNCTIONAL PLANNING STUDY	TITLE: PROPOSED LRT CONFIGURATION IN THE DOWNTOWN

APPENDIX A

PREFERRED SOUTHEAST LRT OPTIONS IN THE DOWNTOWN

DOWNTOWN CALGARY LRT STUDY

CONCEPT 2A - 10th AVE./2nd ST. SW OPTION

CONCEPT 2D - 10th AVE./2nd ST. SW OPTION

CONCEPT 2A	CONCEPT 2D
10 AVE/2 ST SW 2 WAY CURB	10 AVE/2 ST SW UNDERGROUND
CONCEPT 2A/2D – SHEET 1	CONCEPT 2A/2D – SHEET 1
CONCEPT 2A – SHEET 2	CONCEPT 2D – SHEET 2
CONCEPT 2A – SHEET 3	CONCEPT 2D – SHEET 3
CONCEPT 2A – SHEET 4	CONCEPT 2D – SHEET 4
CONCEPT 2A/2D – SHEET 5	CONCEPT 2A/2D – SHEET 5
CONCEPT 2A/2D – SHEET 5 (ALTERNATE)	CONCEPT 2A/2D – SHEET 5 (ALTERNATE)
CONCEPT 2A/2D – SHEET 6	CONCEPT 2A/2D – SHEET 6
CONCEPT 2A/2D – SHEET 6 (ALTERNATE)	CONCEPT 2A/2D – SHEET 6 (ALTERNATE)

NOTE:

STATION LOCATIONS ARE CONCEPTUAL, AND ARE BASED ON CURRENT LAND USE. FURTHER WORK IS REQUIRED AS PART OF DETAILED AREA PLANNING STUDIES IN ORDER TO DETERMINE EXACT STATION LOCATIONS. VARIOUS STATION LOCATIONS ARE POSSIBLE DEPENDING ON THE NEED OF THE AREA.

Clifton ND Lea
CONSULTING INC.

SEE BELOW FOR CONTINUATION

9 AV SE

FUTURE CPR TRACKS

16.5m LRT RIGHT-OF-WAY

CONNECT TO PROPOSED S.E. LRT

9 ST SE

9 AV SE

SW14-24-1-5

20.3m FROM CPR NORTH TRACK PROPOSED LRT RIGHT-OF-WAY

CANADIAN PACIFIC RAILWAY

NOTE: EXISTING CPR TRACK CONFIGURATION IS NOT EXACTLY AS SHOWN

FUTURE ROAD DEVELOPMENT

16.5m LRT RIGHT-OF-WAY

RAMP

STATION

FUTURE

22.0m LRT RIGHT-OF-WAY

16.5m LRT RIGHT-OF-WAY

STATION LOCATION
NOTE: THE LOCATION OF THE STATION AND PEDESTRIAN ACCESS IS SUBJECT TO THE FINAL DESIGN OF THE 4TH STREET UNDERPASS.

vehicle lane
vehicle lane
vehicle lane
vehicle lane

ALLEY

OLYMPIC WY SE

DUSTY'S SALOON

11 AV SW

SW14-24-1-5

SEE ABOVE FOR CONTINUATION

NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

EX. TRAFFIC FLOW(STREET)
EX. STREET R.O.W.
EXISTING BUILDING
PROPOSED LRT TRACK C.L.
PROPOSED CONCRETE CURB
PROPOSED VEHICLE LANE
BUILDING/R.O.W. CONFLICT
PROPOSED TRAFFIC FLOW
PROTECTED LANE TURN
ELECTRICAL SUBSTATION E

DATE	JUNE '05
SCALE	1 : 1500
DWG NO.	

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2A/2D– 10th AVENUE S. TWO WAY
SHEET 1

9 AV SW

FUTURE OVERPASS
TO ACCOMMODATE
4 - CPR FREIGHT TRACKS
1 - HIGH SPEED RAIL TRACK
2 - LRT TRACKS

CPR

STRATA A

STRATA B

FUTURE ROAD DEVELOPMENT

16.5m LRT RIGHT-OF-WAY

new setback line - 2.13m from ex. p.l.

driveway

FUTURE

10 AV SE

LRT lane

vehicle lane

ALLEY

CUSTOMS BUILDING

BRAEMAR BUILDING

LOUISE BLOCK

RIBTOR

PARKING

11 AV SW

1 ST SE

MACLEOD TR SE

3 ST SE

OLYMPIC WY SE

MERCHANDIZING CENTER

CO-OP CENTER

ALMADINA CHARTER SCHOOL

NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

- EX. TRAFFIC FLOW(STREET)
- EX. STREET R.O.W.
- EXISTING BUILDING
- PROPOSED LRT TRACK C.L.
- PROPOSED CONCRETE CURB
- PROPOSED VEHICLE LANE
- BUILDING/R.O.W. CONFLICT
- PROPOSED TRAFFIC FLOW
- PROTECTED LANE TURN
- ELECTRICAL SUBSTATION (E)

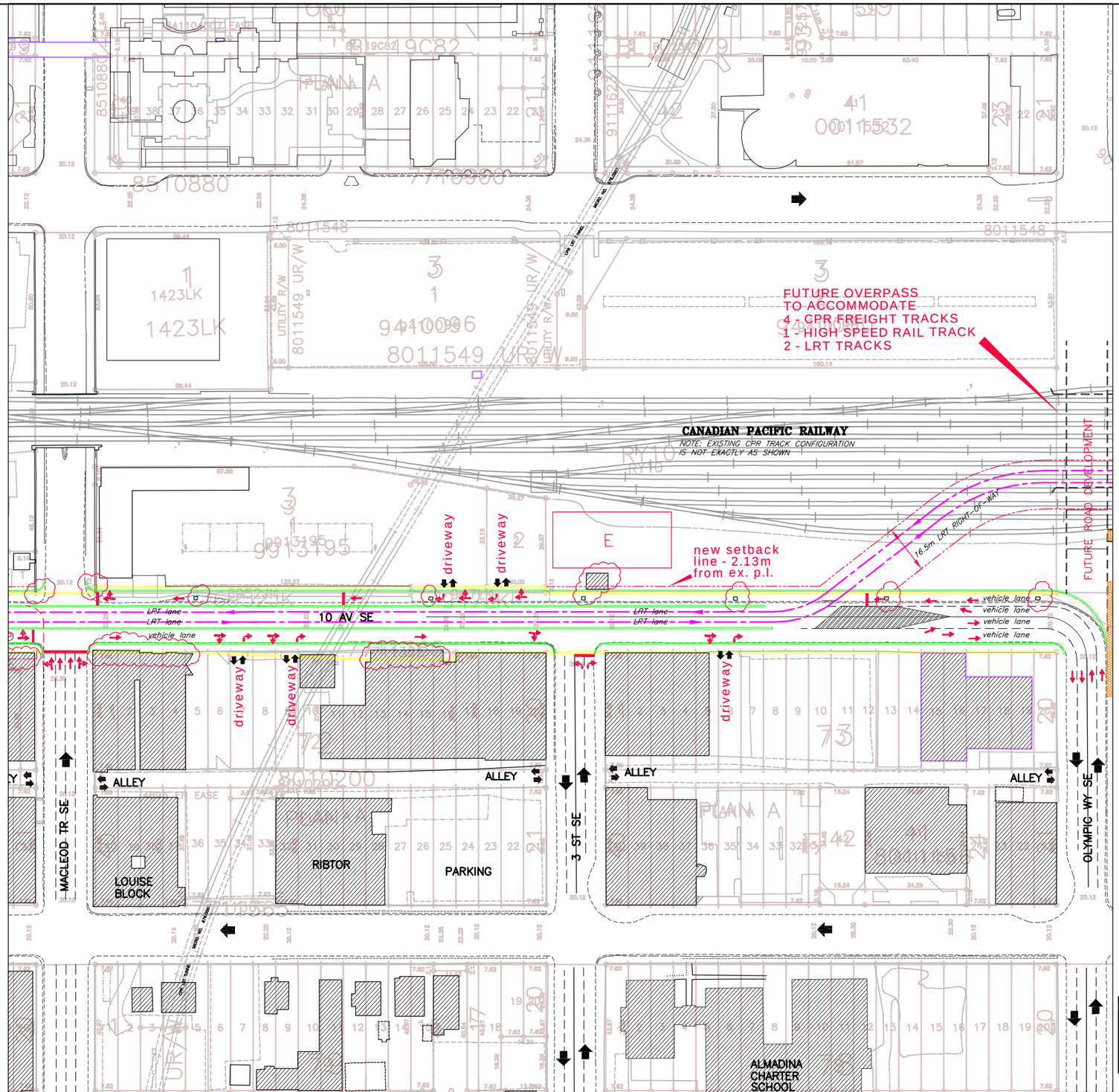
DATE	JUNE '05
SCALE	1 : 1500
DWG NO.	

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
SOUTHEAST LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2A– 10th AVENUE S. TWO WAY (curb)
SHEET 2



N

NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

- EX. TRAFFIC FLOW(STREET)
- EX. STREET R.O.W.
- EXISTING BUILDING
- PROPOSED LRT TRACK C.L.
- PROPOSED CONCRETE CURB
- PROPOSED VEHICLE LANE
- BUILDING/R.O.W. CONFLICT
- PROPOSED TRAFFIC FLOW
- PROTECTED LANE TURN
- ELECTRICAL SUBSTATION (E)

DATE	JUNE '05
SCALE	1 : 1500
DWG NO.	

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2D– 10th AVENUE S. TWO WAY
SHEET 2

EMERGENCY ACCESS
FUTURE CYCLIST CONNECTION
9 AV SW
PARCEL A 6384HL
6A 7610909
CPR
STRATA D
STRATA C
STRATA B
PALLISER SQUARE
new setback line - 2.13m from ex. p.l.
driveway
PORTAL
TUNNEL APPROACH
LRT lane
vehicle lane
STATION
FUTURE
ALLEY
CLENNAN SQUARE
VINTAGE
LEWIS LOFTS
PARKING
PARAMOUNT LIFE BUILDING
GOVERNMENT OF CANADA
SONY OF CANADA
CUSTOMS BUILDING
11 AV SW
CIBC SERVICE CENTER
IBM BUILDING
MANHATTAN LOFTS
ALBERTA POWER POOL
TRANSALTA PLACE 1
TRANSALTA PLACE 2
2 ST SW
1 ST SW
CENTRE ST S
1 ST SE
N

NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

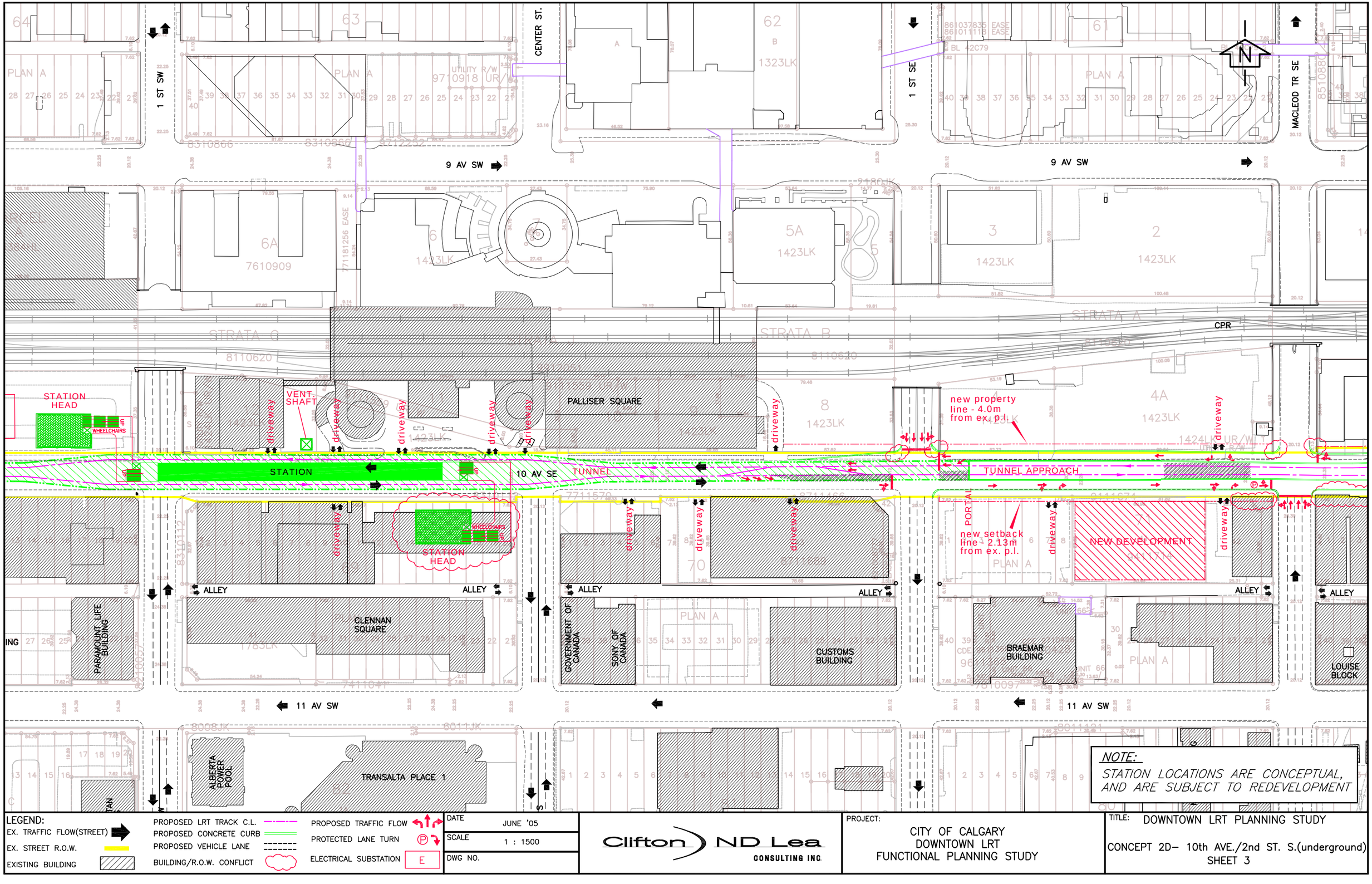
LEGEND:
EX. TRAFFIC FLOW(STREET)
EX. STREET R.O.W.
EXISTING BUILDING
PROPOSED LRT TRACK C.L.
PROPOSED CONCRETE CURB
PROPOSED VEHICLE LANE
BUILDING/R.O.W. CONFLICT
PROPOSED TRAFFIC FLOW
PROTECTED LANE TURN
ELECTRICAL SUBSTATION E

DATE JUNE '05
SCALE 1 : 1500
DWG NO.

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
SOUTHEAST LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY
CONCEPT 2A– 10th AVENUE S. TWO WAY (curb)
SHEET 3



NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

EX. TRAFFIC FLOW(STREET)	➡	PROPOSED LRT TRACK C.L.	— - —	PROPOSED TRAFFIC FLOW	↰↑↱
EX. STREET R.O.W.	▬	PROPOSED CONCRETE CURB	═	PROTECTED LANE TURN	Ⓟ
EXISTING BUILDING	▨	PROPOSED VEHICLE LANE	- - -	ELECTRICAL SUBSTATION	E
		BUILDING/R.O.W. CONFLICT	☁		

DATE JUNE '05
SCALE 1 : 1500
DWG NO.

Clifton ND Lea
CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY
CONCEPT 2D– 10th AVE./2nd ST. S.(underground)
SHEET 3

NOTE:

STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

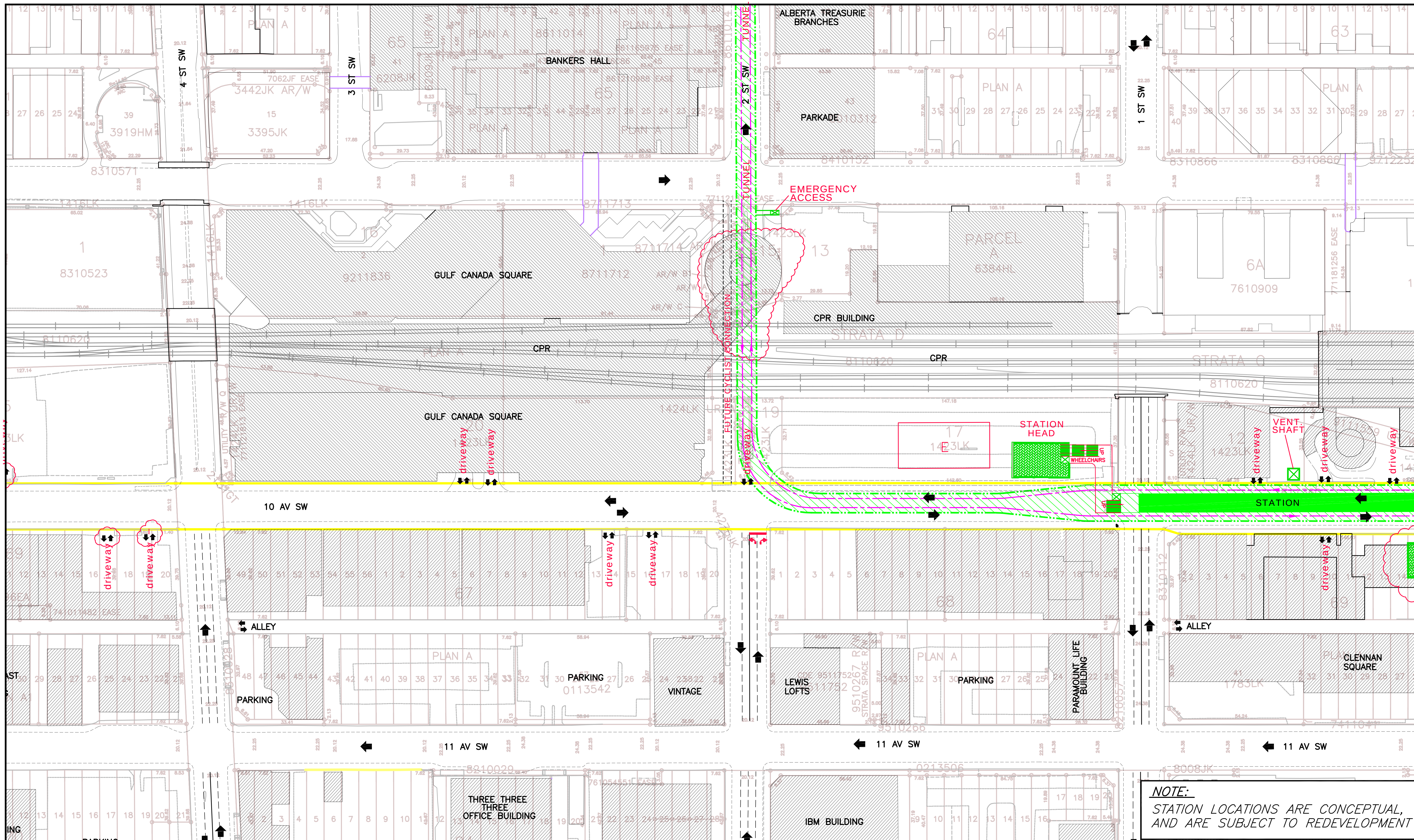
LEGEND:
EX. TRAFFIC FLOW(STREET) ➡
EX. STREET R.O.W. 🟨
EXISTING BUILDING ▨
PROPOSED LRT TRACK C.L. –·–·–
PROPOSED CONCRETE CURB 🟩
PROPOSED VEHICLE LANE - - - -
BUILDING/R.O.W. CONFLICT
PROPOSED TRAFFIC FLOW ↰↑↱
PROTECTED LANE TURN Ⓟ
ELECTRICAL SUBSTATION E

DATE JUNE '05
SCALE 1 : 1500
DWG NO.

Clifton ND Lea
CONSULTING INC.

PROJECT:
CITY OF CALGARY
SOUTHEAST LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY
CONCEPT 2A– 10th AVENUE S. TWO WAY (curb)
SHEET 4



ALBERTA TREASURIE BRANCHES
BANKERS HALL
PARKADE
4 ST SW
3 ST SW
2 ST SW
1 ST SW
TUNNEL
EMERGENCY ACCESS
GULF CANADA SQUARE
CPR BUILDING
CPR
FUTURE CYCLIST CONNECTION
STATION HEAD
WHEELCHAIRS
VENT. SHAFT
STATION
10 AV SW
11 AV SW
ALLEY
PARKING
VINTAGE
LEWIS LOFTS
PARAMOUNT LIFE BUILDING
CLENNAN SQUARE
THREE THREE THREE OFFICE BUILDING
IBM BUILDING
CIBC SERVICE
driveway
NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

EX. TRAFFIC FLOW(STREET)		PROPOSED LRT TRACK C.L.		PROPOSED TRAFFIC FLOW	
EX. STREET R.O.W.		PROPOSED CONCRETE CURB		PROTECTED LANE TURN	
EXISTING BUILDING		PROPOSED VEHICLE LANE		ELECTRICAL SUBSTATION	E
		BUILDING/R.O.W. CONFLICT			

DATE: JUNE '05

SCALE: 1 : 1500

DWG NO.

Clifton ND Lea CONSULTING INC.

PROJECT: CITY OF CALGARY DOWNTOWN LRT FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2D– 10th AVE./2nd ST. S.(underground)

SHEET 4

TORONTO DOMINION SQUARE

CADILLAC FAIRVIEW BLDG.

7 AV SW

6 AV SW

5 AV SW

4 AV SW

2 ST SW

STATION HEAD

VENT. SHAFT

WHEELCHAIRS

UP

STATION

TUNNEL

#6 TURNOUT

#6 TURNOUT

ALBERTA TREASURIE BRANCHES

EMERGENCY ACCESS

SCOTIA CENTER

PARKADE

PARKADE

STEPHEN AV SW

N

NOTE:

1. MINIMUM TWO TRAFFIC LANES ARE MAINTAINED IN 2ND STREET
2. STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

- EX. TRAFFIC FLOW(STREET)
- EX. STREET R.O.W.
- EXISTING BUILDING
- PROPOSED LRT TRACK C.L.
- PROPOSED CONCRETE CURB
- PROPOSED VEHICLE LANE
- BUILDING/R.O.W. CONFLICT
- PROPOSED TRAFFIC FLOW
- PROTECTED LANE TURN
- ELECTRICAL SUBSTATION E

DATE	JUNE '05
SCALE	1 : 1500
DWG NO.	

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2A/2D – 10th AVENUE S. TWO WAY
SHEET 5

TORONTO DOMINION SQUARE

CADILLAC FAIRVIEW BLDG.

6 AV SW

5 AV SW

4 AV SW

7 AV SW

TUNNEL

STATION HEAD

NO THROUGH TRAFFIC

STATION

2 ST SW

VENT SHAFT

#6 TURNOUT

#6 TURNOUT

ALBERTA TREASURIE BRANCHES

SCOTIA CENTER

STEPHEN AV SW

PARKADE

PARKADE

NO THROUGH TRAFFIC

NO THROUGH TRAFFIC

NOTE:

1. *LINE ACCESS TO 6TH AVE ARE MAINTAINED*
2. *STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT*

LEGEND:

- EX. TRAFFIC FLOW(STREET)
- EX. STREET R.O.W.
- EXISTING BUILDING
- PROPOSED LRT TRACK C.L.
- PROPOSED CONCRETE CURB
- PROPOSED VEHICLE LANE
- BUILDING/R.O.W. CONFLICT
- PROPOSED TRAFFIC FLOW
- PROTECTED LANE TURN
- ELECTRICAL SUBSTATION (E)

DATE: JUNE '05

SCALE: 1 : 1500

DWG NO.

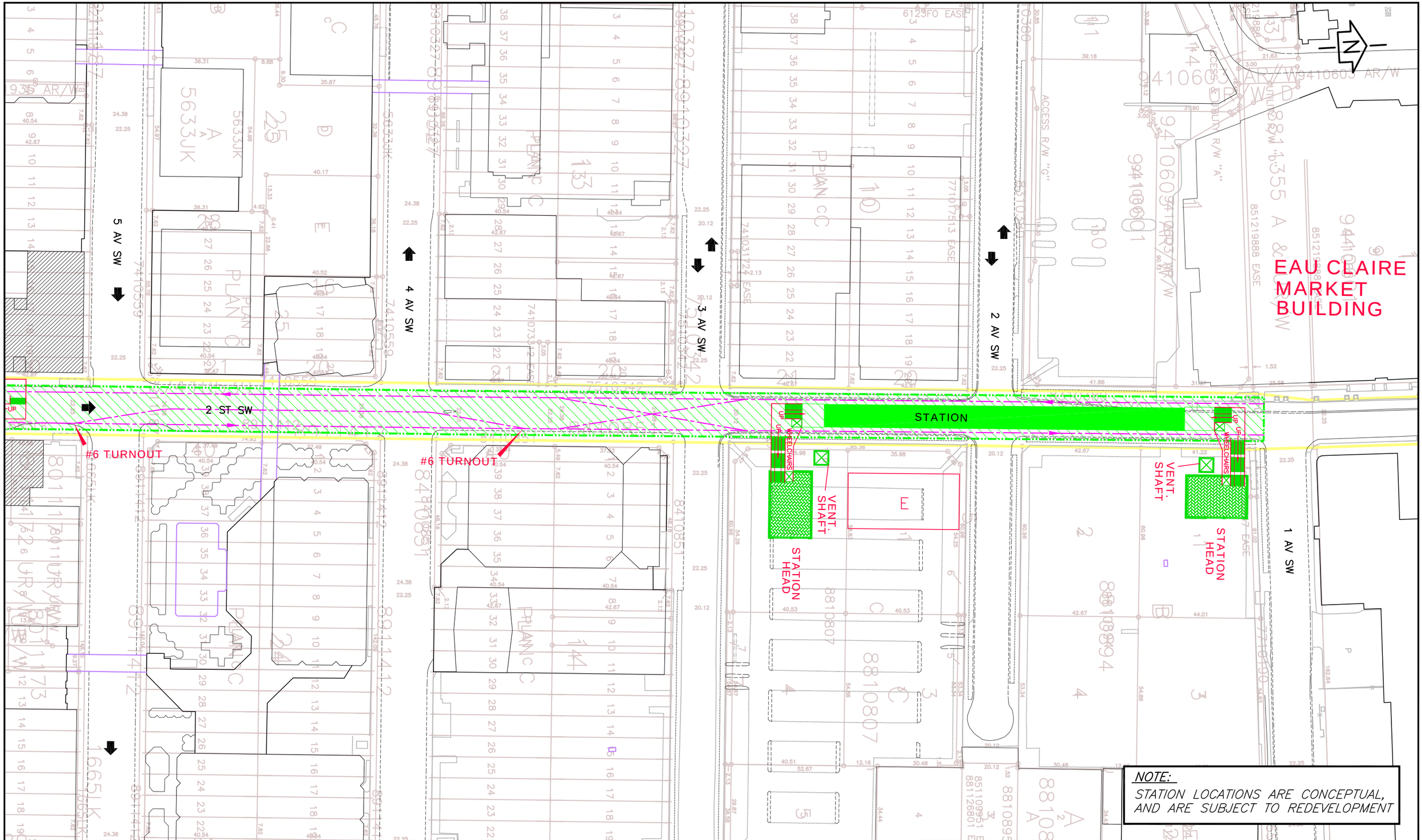
Clifton ND Lea CONSULTING INC.

PROJECT:

CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2A/2D – 10th AVENUE S. TWO WAY
SHEET 5 (ALTERNATE)



NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

- EX. TRAFFIC FLOW(STREET)
- EX. STREET R.O.W.
- EXISTING BUILDING
- PROPOSED LRT TRACK C.L.
- PROPOSED CONCRETE CURB
- PROPOSED VEHICLE LANE
- BUILDING/R.O.W. CONFLICT
- PROPOSED TRAFFIC FLOW
- PROTECTED LANE TURN
- ELECTRICAL SUBSTATION (E)

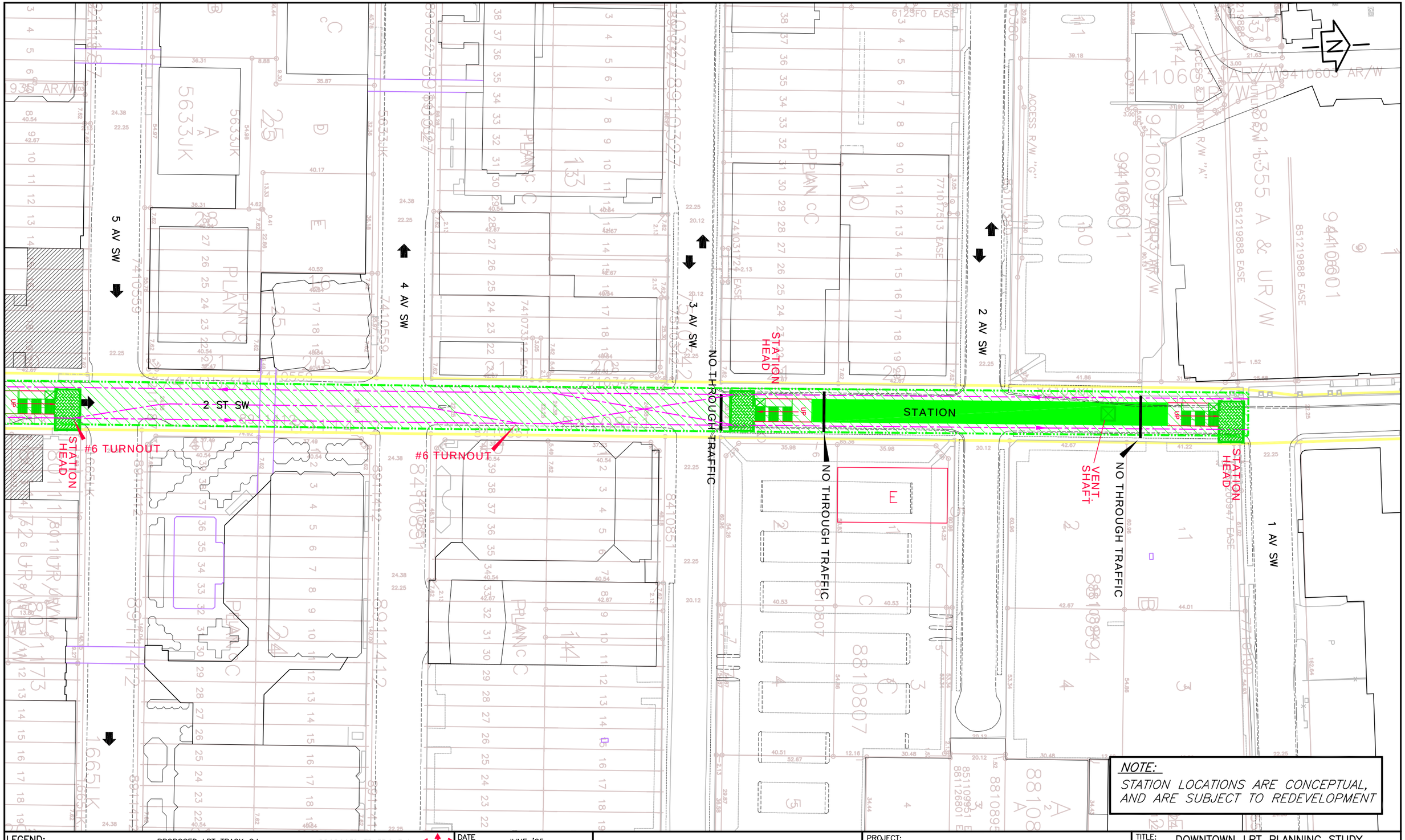
DATE	JUNE '05
SCALE	1 : 1500
DWG NO.	

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2A/2D – 10th AVENUE S. TWO WAY
SHEET 6



NOTE:
STATION LOCATIONS ARE CONCEPTUAL, AND ARE SUBJECT TO REDEVELOPMENT

LEGEND:

- EX. TRAFFIC FLOW(STREET)
- EX. STREET R.O.W.
- EXISTING BUILDING
- PROPOSED LRT TRACK C.L.
- PROPOSED CONCRETE CURB
- PROPOSED VEHICLE LANE
- BUILDING/R.O.W. CONFLICT
- PROPOSED TRAFFIC FLOW
- PROTECTED LANE TURN
- ELECTRICAL SUBSTATION (E)

DATE	JUNE '05
SCALE	1 : 1500
DWG NO.	

Clifton ND Lea CONSULTING INC.

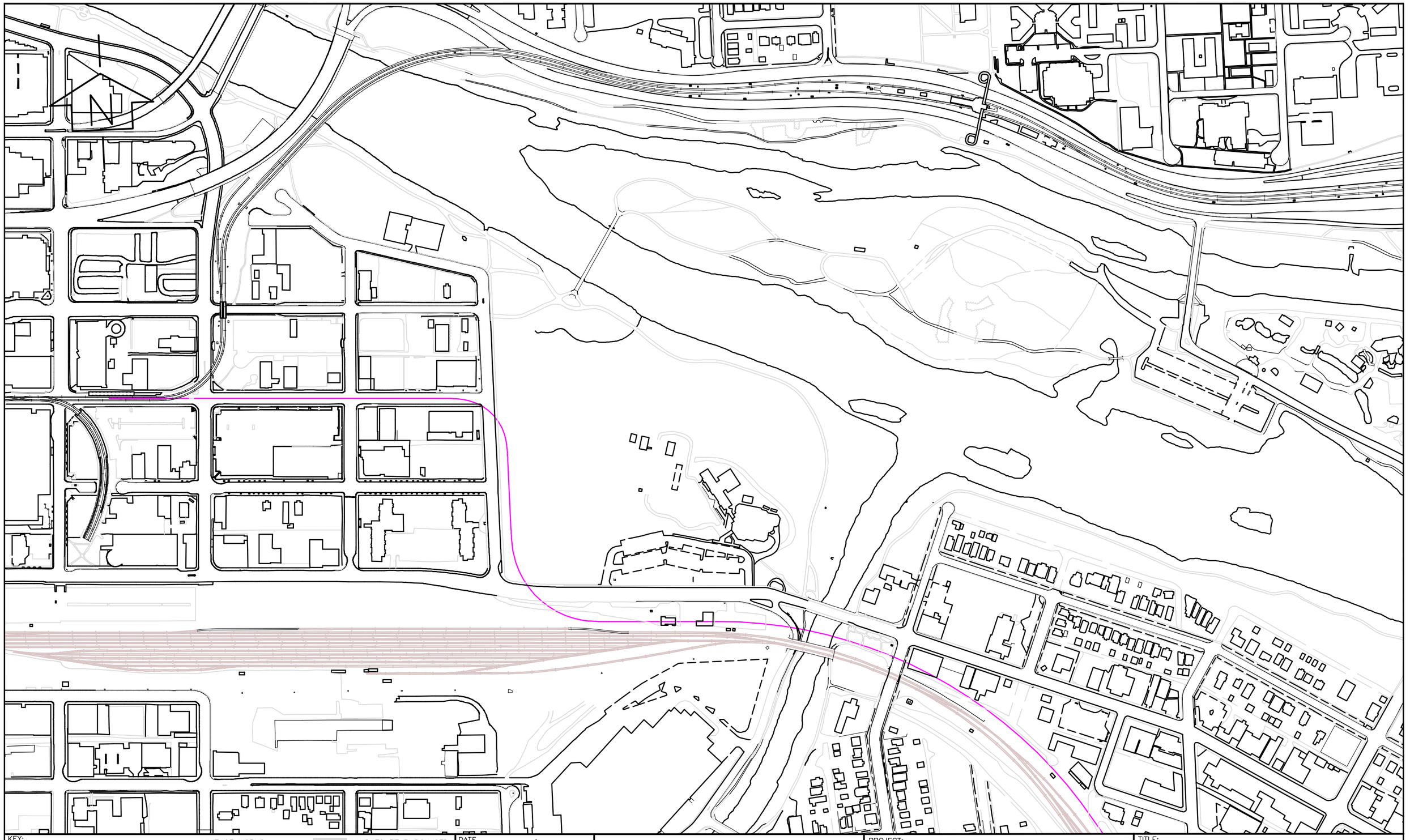
PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE: DOWNTOWN LRT PLANNING STUDY

CONCEPT 2A/2D – 10th AVENUE S. TWO WAY
SHEET 6 (ALTERNATE)

APPENDIX B

NORTH CENTRAL LRT OPTIONS



KEY:

- LRT CONTROL LINE
- E — ELECTRICAL SUBSTATION
- RETAINING WALL
- LIMIT OF WORKS
- ROAD REALIGNMENT
- PEDESTRIAN PATH
- LAND TO BE PURCHASED

DATE	JUNE '05
SCALE	1 : 4000 H 1 : 400 V
DWG NO.	11047–NC1

Clifton ND Lea CONSULTING INC.

PROJECT:

CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:

NORTH–CENTRAL LRT
OPTION 1
PARALLELING CPR TRACKS

N

MEMORIAL DRIVE WESTBOUND

MEMORIAL DRIVE EASTBOUND

ZOO LRT STATION

1+664.703

1+600

1+500

1+400

1+300

1+200

R = 60 m

DEERFOOT TRAIL

DEERFOOT TRAIL

ZOO LRT STATION

1.0%

140m STORAGE

K = 12

NE LRT INBOUND

MEMORIAL DR. WESTBOUND

6.0%

4.6m CLEARANCE

K = 12.5

1.2%

K = 30

-0.75%

NOSE CREEK

1048

1044

1040

1036

DATUM ELEV 1034.000

1051.00 1051.00 1050.89 1050.52 1050.35 1050.00 1049.81 1049.65 1049.50 1049.50 1049.15 1049.26 1049.00 1048.88 1048.89 1045.02 1039.83 1036.50 1037.74 1039.66 1040.00 1040.00 1040.07 1040.06 1039.74 1039.26 1038.58 1038.57 1038.82 1039.09 1039.05 1039.10 1039.21 1039.30 1039.37

1+640 1+600 1+560 1+520 1+480 1+440 1+400 1+360 1+320 1+280 1+240 1+200 1+160 1+120 1+080 1+040 1+000

KEY:

DATE JUNE '05

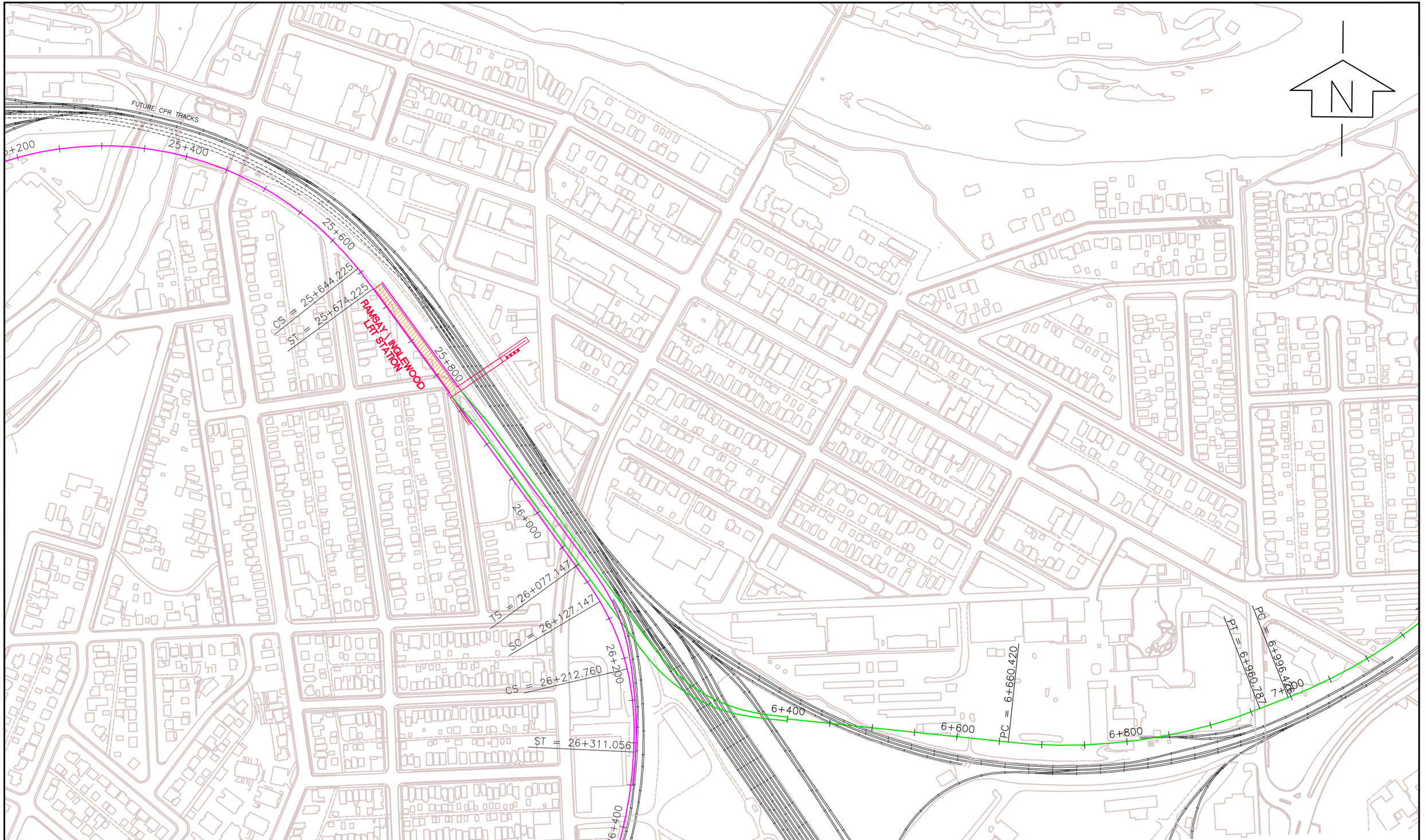
SCALE

DWG NO. 11047-NC-OPT2

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:
NORTH-CENTRAL LRT
OPTION 2
CONNECTION TO NE LRT



KEY:

- VIA NE LRT (PROBABILITY HIGH)
- VIA SE LRT (VIABLE ALTERNATIVE)
- VIA 7 AVE (PROBABILITY LOW)
- FUTURE CPR
- SE LRT

DATE	JUNE '05
SCALE	1:10 000 (11x17)
DWG NO.	NC–OPTION3

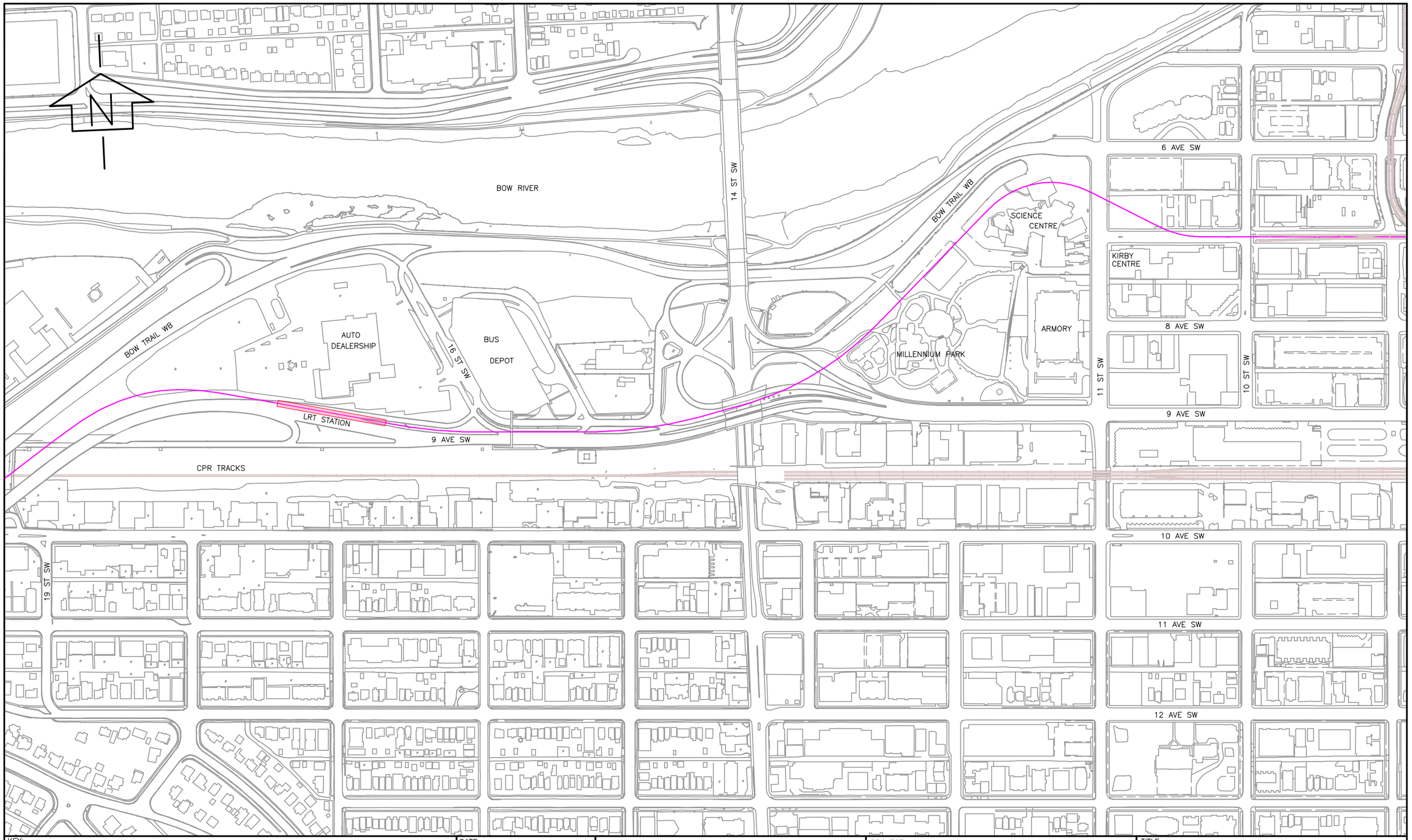
Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:
NORTH–CENTRAL LRT
OPTION 3
CONNECTING TO SE LRT

APPENDIX C

WEST LRT OPTIONS



KEY:
LRT CONTROL LINE

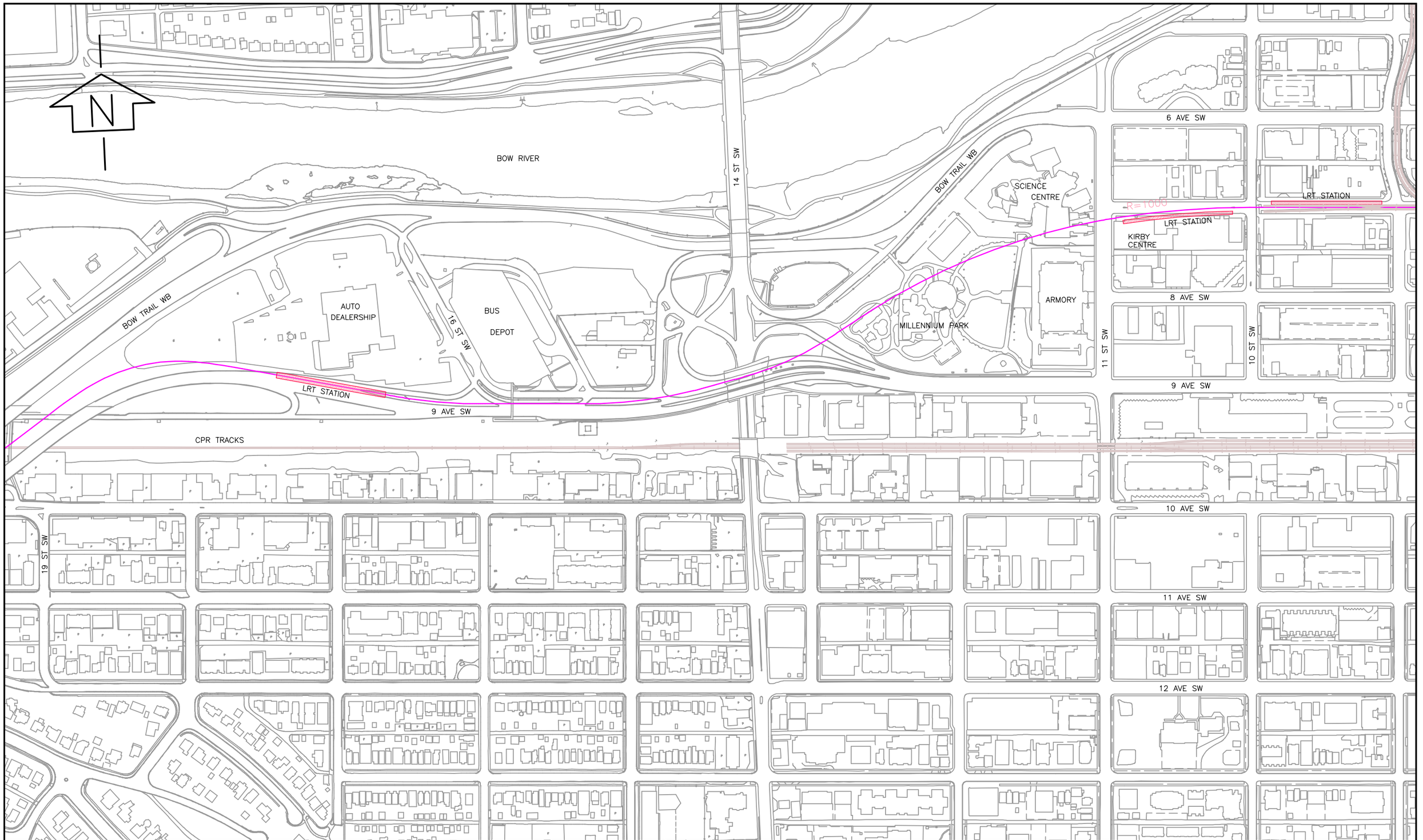
NOTES:
1. ALIGNMENT IMPACTS NORTH HALF OF 7 AVE. BETWEEN 10–11 STREETS.
2. LRT ALIGNMENT REQUIRES BOW TRAIL CONNECTOR

DATE	JUNE '05
SCALE	1 : 4000 H
DWG NO.	11047–OPTION A

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:
WEST LRT
OPTION A
1981 ALIGNMENT



KEY:
LRT CONTROL LINE

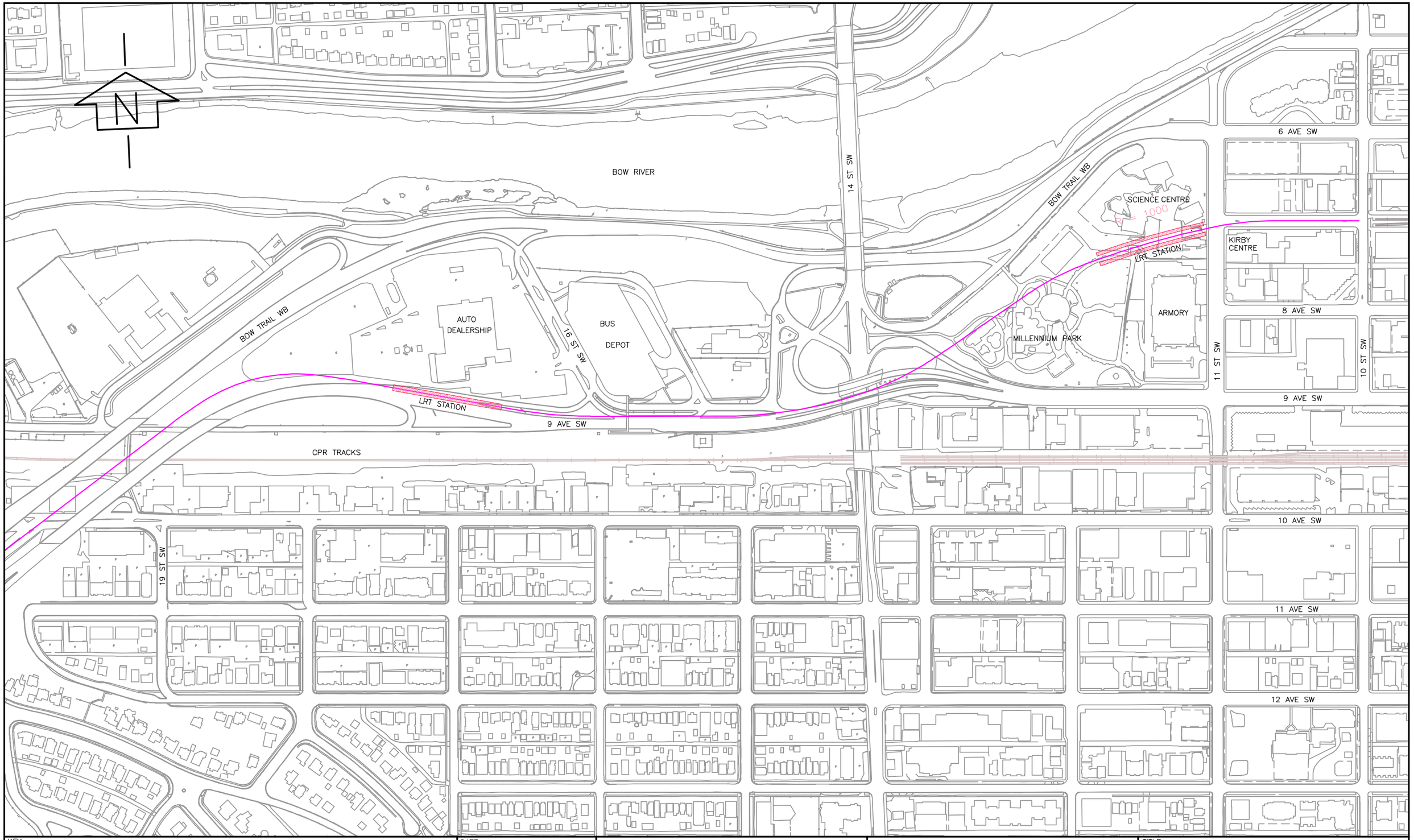
NOTES:
1. 11 AVE STATION IMPACTS KIRBY CENTRE
2. LRT ALIGNMENT REQUIRES BOW TRAIL CONNECTOR

DATE	JUNE '05
SCALE	1 : 4000 H
DWG NO.	11047–OPTION B

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:
WEST LRT
OPTION B
1983 ALIGNMENT



KEY:
LRT CONTROL LINE

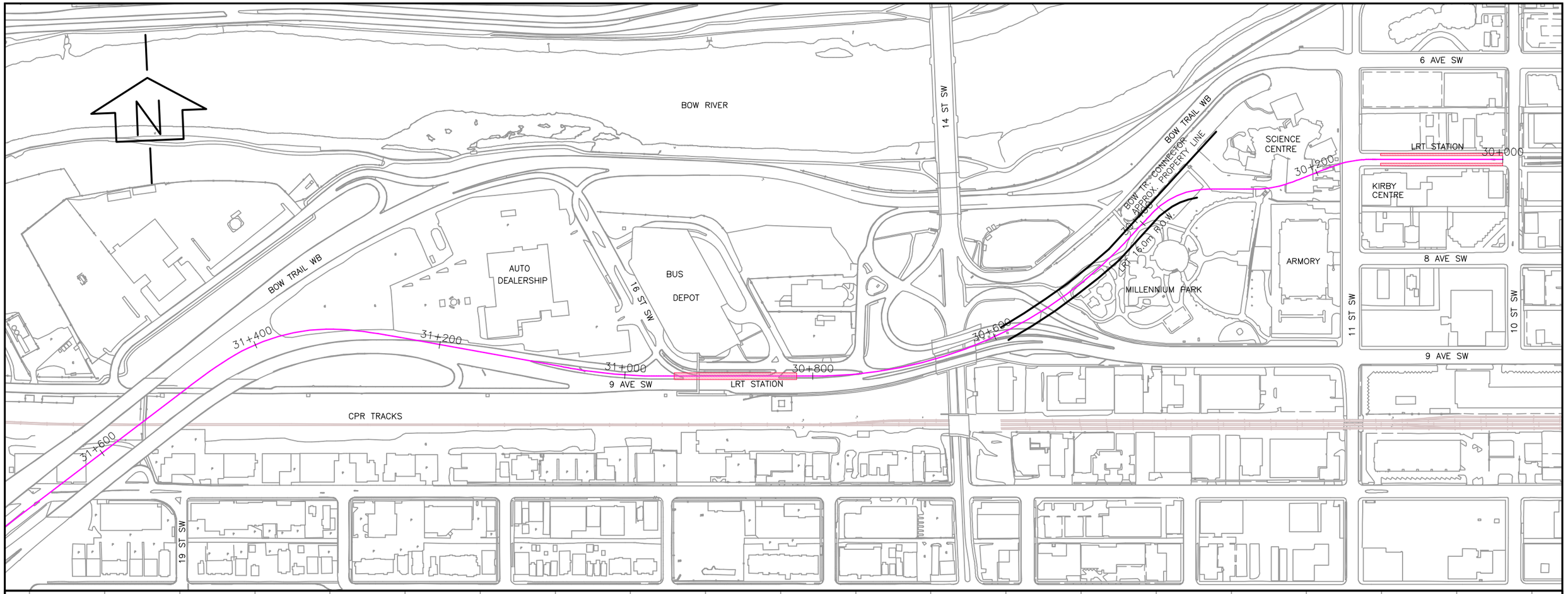
NOTES:
1. 11 AVE STATION IMPACTS SCIENCE CENTRE
2. LRT ALIGNMENT REQUIRES BOW TRAIL CONNECTOR

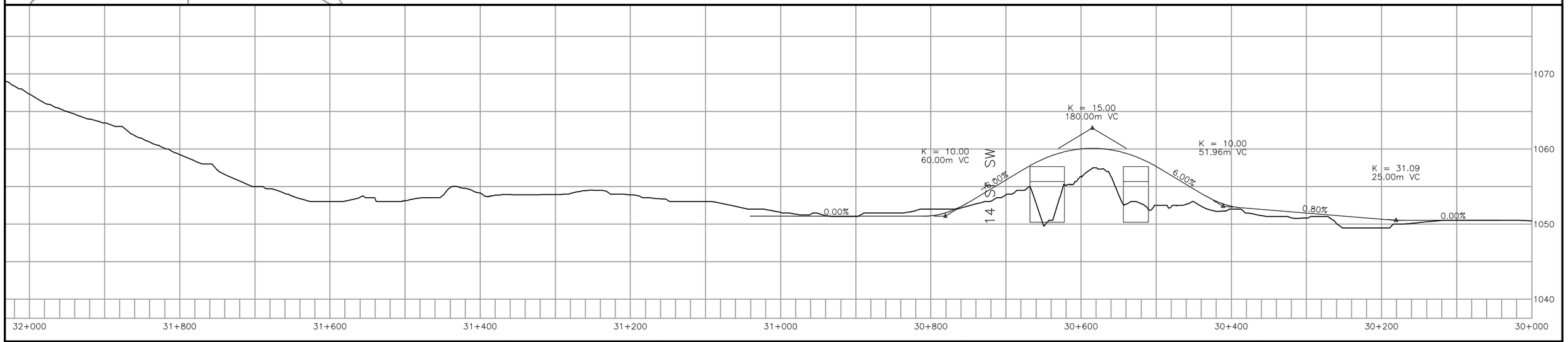
DATE	JUNE '05
SCALE	1 : 4000 H
DWG NO.	11047–OPTION C

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:
WEST LRT
OPTION C
1988 ALIGNMENT





NOTES:

LRT CONTROL LINE

1. LOW SPEED ALIGNMENT THROUGH MILLENNIUM PARK
2. LRT ALIGNMENT REQUIRES BOW TRAIL CONNECTOR

DATE	JUNE '05
SCALE	PLAN – 1 : 4000 PROFILE – 1:4000 H / 1:400 V
DWG NO.	11047–OPTION D

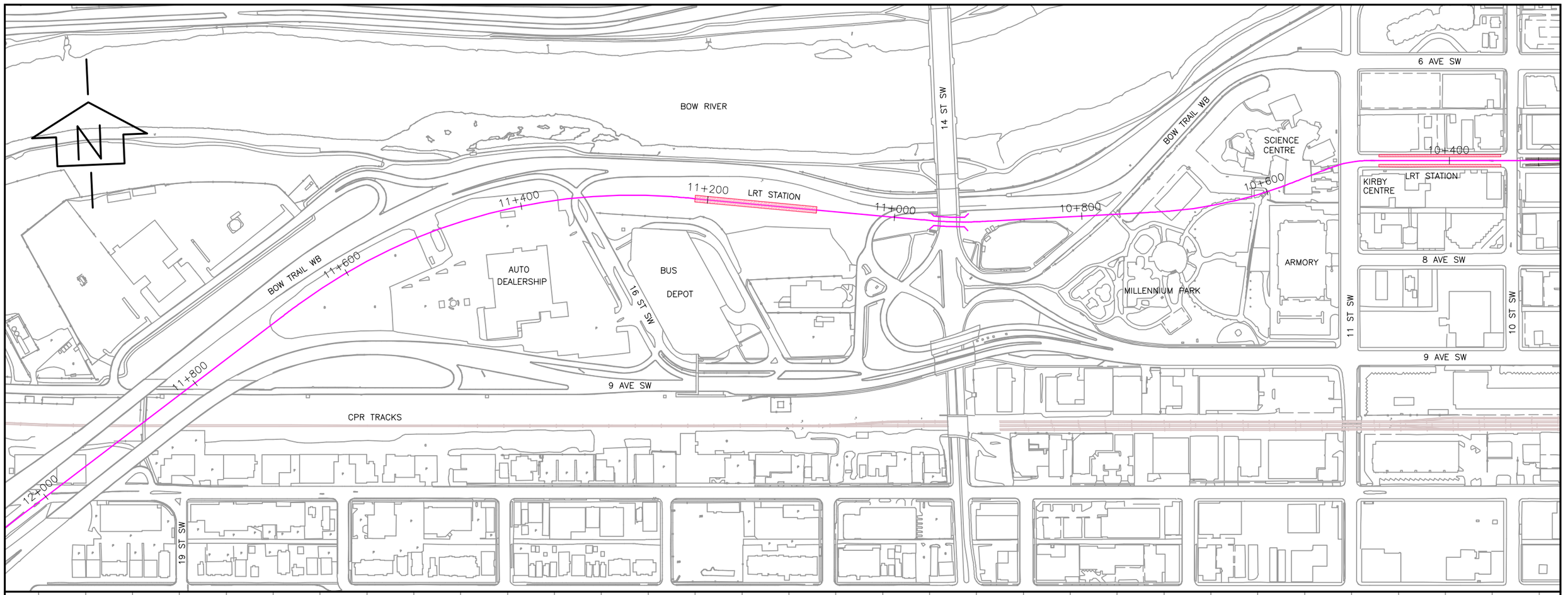
Clifton ND Lea CONSULTING INC.

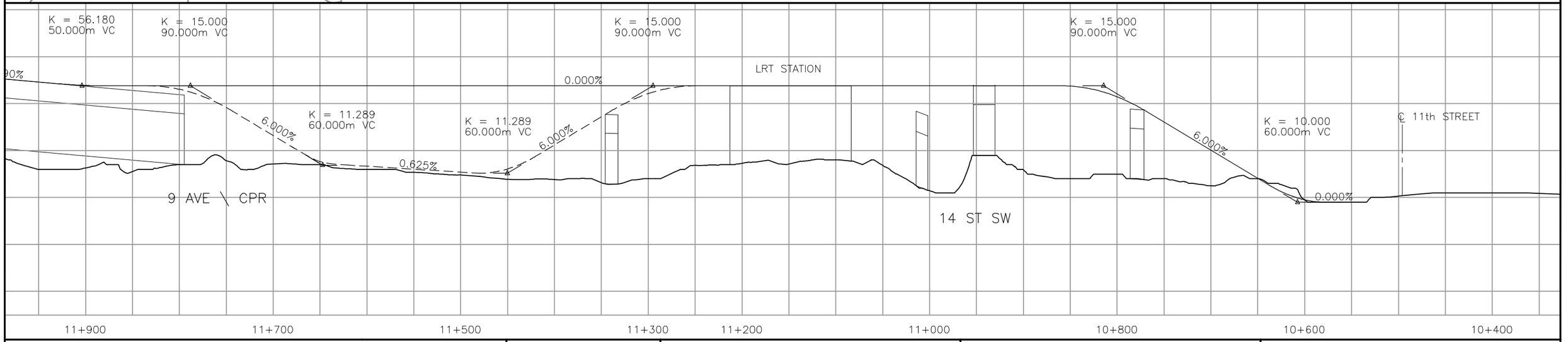
PROJECT:

CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:

WEST LRT
OPTION D
MINIMIZE IMPACT TO PARK





LRT CONTROL LINE

NOTES:
1. LOW SPEED ALIGNMENT THROUGH MILLENNIUM PARK

DATE	JUNE '05
SCALE	PLAN – 1 : 4000 PROFILE – 1:4000 H / 1:400 V
DWG NO.	11047–OPTION E

Clifton ND Lea CONSULTING INC.

PROJECT:
CITY OF CALGARY
DOWNTOWN LRT
FUNCTIONAL PLANNING STUDY

TITLE:
WEST LRT
OPTION E
NO BOW TRAIL CONNECTOR