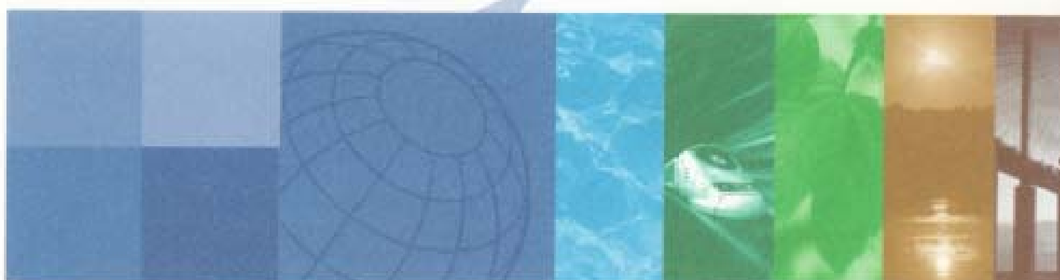
vision42

initiative for an auto-free light rail boulevard on 42nd Street
by the institute for Rational Urban Mobility, Inc. (IRUM)



Cost Estimate Study

March 31, 2005

Halcrow, LLC

In association with

Sam Schwartz Company, LLC
and
Langan Engineering & Environmental Services

LANGAN

Halcrow

vision42
an auto-free light rail boulevard for 42nd Street

Cost Estimate Study

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vision42
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The **vision42** proposal is a citizens' initiative sponsored by the Institute for Rational Urban Mobility, Inc. (IRUM), a New York City-based not-for-profit corporation concerned with advancing cost-effective transport investments that improve the livability of dense urban places.

This study, one of three technical studies that address key concerns about the feasibility of the **vision42** proposal, was made possible through a generous grant from the New York Community Trust/Community Funds, Inc., John Todd McDowell Environmental Fund.

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1 Executive Summary and Recommendations

- Conservatively estimated, a 2.5-mile surface light rail line in a landscaped 42nd Street, with 16 pairs of stops, will cost between approximately $360 and $510 million in 2004 dollars, depending upon the extent of utility relocations and the choice of propulsion system. The cost per mile of the light rail itself is approximately 10 percent of subway construction in New York City.

- The costs of utility diversions requested by the utility companies and agencies for a rail-based system are known to be major and would dominate the capital costs. Unless policies are modified regarding relocation of utilities, this will also produce substantial temporary disruption during the construction phase.

- Operating cost for the light rail line will be nearly identical to operating cost for the displaced bus services using 42nd Street. However, the light rail line will have three times the capacity of the replaced bus service.

- Within a pedestrian street, particularly without any traffic light prioritization, a light rail system on 42nd Street has limited average speed, but much shorter and more consistent journey times than current NY bus services. It is more accessible and convenient for short journeys than the subway, which it complements.

- The Innorail surface contact system, in use in Bordeaux since late 2003, has not yet proven sufficiently reliable for application to New York City and is not recommended.

- Self propelled vehicles are recommended to avoid catenary wire and stray current issues, and will suit the operating profile of this short system.

- It is feasible to consider self-propelled streetcars using hydrogen fuel cell technology already available in the US, and this achieves maximum environmental benefit.

2 Introduction

2.1 Experience of Halcrow, LLC, in Rail Transit Systems Worldwide

Halcrow has undertaken the planning and design of metros and LRTs in over 50 cities worldwide. Our recent experience of LRT and streetcars includes:

- CROSS LONDON TRANSIT - Traffic modeling and preparation of business case
- WEST LONDON TRAM, UK - Scheme development and preliminary design
- CROYDON TRAMLINK, UK - Operational and maintenance advice
- GLASGOW PUBLIC TRANSPORT STUDY, UK - Feasibility study and economic analysis of buses and streetcar options
- TEES VALLEY PUBLIC TRANSPORT, UK - Feasibility study and economic analysis of various light rail options
- NOTTINGHAM EXPRESS TRANSIT, UK – Bank's technical advisor of new streetcar scheme
- MANCHESTER METROLINK PHASE 3, UK - Preliminary design for DBFO consortium
- MANCHESTER METROLINK PHASE 1 AND 2, UK - Project management and technical assistance
- LONDON DOCKLANDS LIGHT RAILWAY, UK - Extension to Woolwich designer in preferred bidder for DBFT consortium
- LONDON DOCKLANDS LIGHT RAILWAY, UK - Extension to City Airport detailed design
- DUBLIN LUAS (STREETCAR), REPUBLIC OF IRELAND - Detailed design of all street running sections in city centre
- ATHENS TRAM, GREECE - audit and technical review
- COPENHAGEN LRT AND METRO, DENMARK - Feasibility of alternative schemes including streetcar and subway
- DUBAI LRT, UAE - Tender design for turnkey contract
- BANGKOK BLUE LINE, THAILAND - Detailed design of depot
- MANILA LRT 2, PHILIPPINES - Preliminary and detailed design, supervision and commissioning
- PUTRA LRT IN KUALA LUMPUR, MALAYSIA - Planning, preliminary and detailed design, supervision and commissioning
- STAR LRT IN KUALA LUMPUR, MALAYSIA - Demand and revenue forecasts and advice on reducing operating costs
- JARKARTA LRT, INDONESIA – Feasibility study
- PYRMONT LRT, SYDNEY, AUSTRALIA - Design and project management
- CROYDON TRAMLINK, UK - Feasibility of extensions
- KINGSTON, SURREY, UK - Feasibility and comparison of bus and streetcars options

2.2 The vision42 Project Scope

This study examines the practicality and costs of providing a highly convenient and accessible surface public transport facility on 42nd Street, which will form an integral part of the plan to pedestrianize and make this famous street one of the most attractive and enjoyable environments in the world.

The transport system has to be environmentally friendly, efficient and aesthetically attractive. It will replace all buses currently on 42nd Street, and complement and connect with the Subway lines, Grand Central Terminal, the Port Authority Bus Terminal and the East River and Hudson River ferries.

Several previous studies have been undertaken for reintroducing surface light rail transit on 42nd Street and there has been controversy over the cost of utility diversions necessary for such a system.

This study has reviewed these previous proposals and updated the costs. In updating the cost estimates we have followed vision42's concept of a rail-based modern, low-floor tram, and have considered specific options that could avoid overhead wire by the use of surface power supply and alternative power sources.

Severe constraints are posed by an extensive system of utilities under 42nd Street, and are a critical issue. The utility problems, together with the unique operating environment on this corridor, have led us to explore methods to minimize utility diversions for a rail based system.

The study summarizes the capital costs estimates for three possible light rail options, and evaluates the operating costs for modern light rail transit in comparison with the operating costs for the bus routes it replaces.

Nottingham, UK

Freiburg Tram, Freiburg, Germany (Kientzler)

3 Operating Parameters

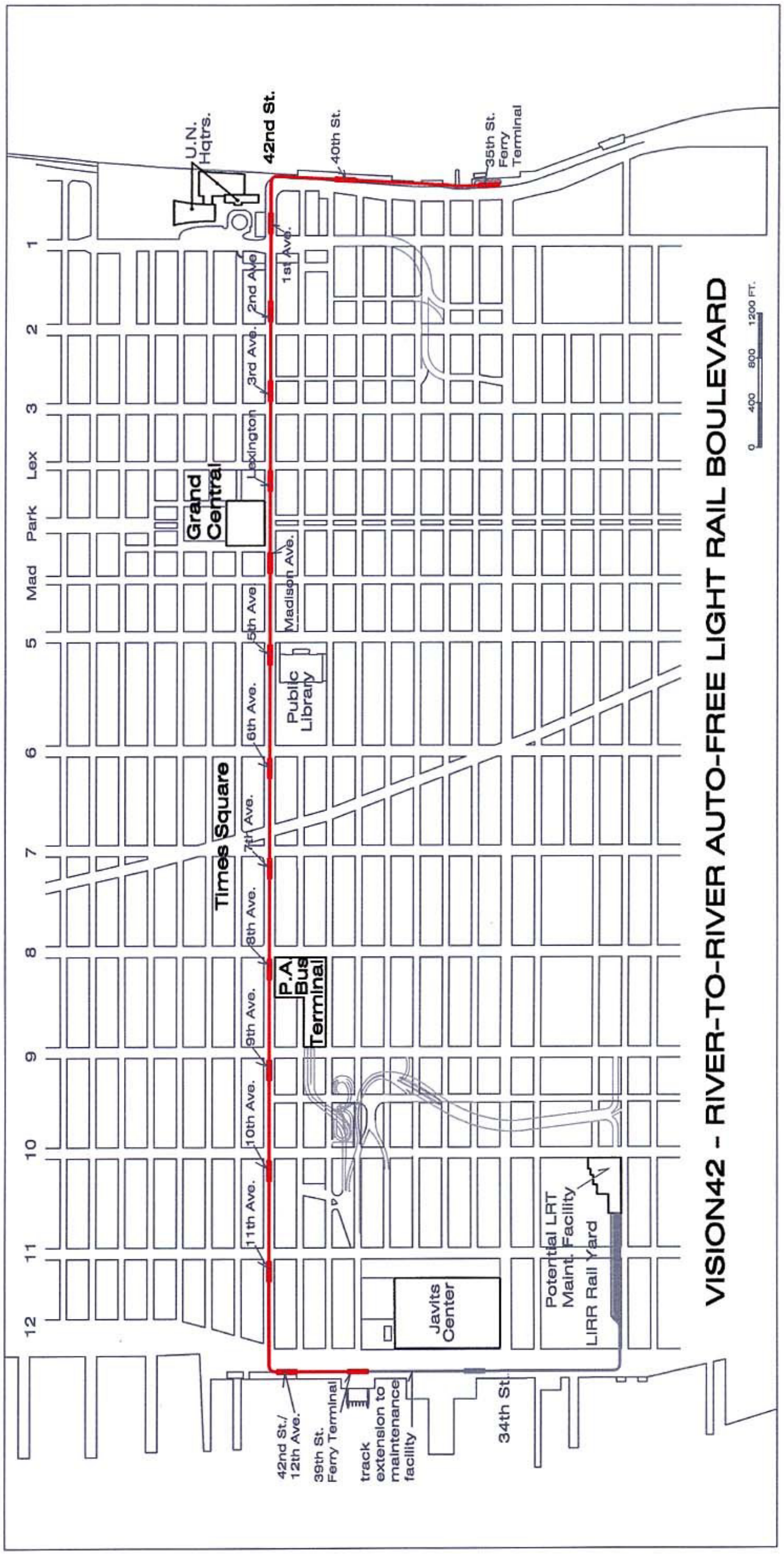
3.1 Route Description

The route is shown on the Plan in Figure 1. The route is comprised of 3 straight sections:

Section	Length	Traffic Interaction	No. of Stops	No. of Traffic Signals
Along bank of Hudson River (39th St Ferry Terminal to the corner of 42nd Street)	0.12 miles (0.19 km)	Dedicated right-of-way	2	0
Along 42nd Street (12th Avenue to 1st Avenue)	1.86 miles (2.99 km)	Pedestrian traffic on path with vehicles crossing path at avenues.	12	13
Along bank of East River (Corner of 42nd Street to 35th Street Ferry Terminal)	0.25 miles (0.40 km)	Dedicated right-of-way	2	0

Luas Tram System, Dublin, Ireland (Photo by Gabriel Conway, March 2004)

Figure 1 – Map of vision42 Light Rail Route



3.2 Run Times

Note: Signals at Broadway and 7th Avenue would be fully synchronized, and are considered as a single signal. Signals will not be required at Vanderbilt or Park Avenues. Signals at the lightly traveled Dyre Avenue leading into the Manhattan Plaza parking garage would be preempted by the light rail.

Segment	Distance (ft)	Distance (m)	Unconstrained Travel Time including 20s stops (s)
39th Street Ferry Terminal – 42nd Street/12th Ave.	630	192	54
42nd Street/12th Ave. – 11th Ave	771	235	61
11th Ave – 10th Ave	801	244	62
10th Ave – 9th Ave	801	244	62
9th Ave – 8th Ave	801	244	62
8th Ave – 7th Ave	801	244	62
7th Ave – 6th Ave	801	244	62
6th Ave – 5th Ave	899	274	66
5th Ave – Madison Ave.	728	222	59
Madison Ave. – Lexington	630	192	54
Lexington – 3rd Ave	741	226	59
3rd Ave – 2nd Ave	630	192	54
2nd Ave – 1st Ave.	686	209	57
1st Ave. – 40th St.	958	292	69
40th St. – 35th St. Ferry Terminal	1142	348	77
Total	**11,820**	**3602**	**921**
			15.3 minutes

These unconstrained run times have been calculated using the following parameters:

- The tram performance specification in Section 3.3 below.
- A 20 second dwell time has been assumed at each stop. This is a realistic average for modern light rail designs with multi-door access and with *proof-of- purchase* fare validation and ticketing methods that avoid lines and delays.

Ideally, it would be desirable to give priority to the light rail at each traffic light at the north/south avenues. The signals at the major north/south one-way avenues that cross 42nd Street are set progressively to maintain traffic flow on these busy arteries. Because of this, little opportunity exists for preemptive signal changes that would interrupt this flow to favor light rail on 42nd Street. However, lights along 42nd Street could be synchronized if light rail vehicles arrive at each intersection at predictable times. Of the twelve light rail stops along 42nd Street, eight are located on the west side of the intersection (on the near side of traffic signals, for east-bound vehicles), and four on the east side.

We have nevertheless assumed that for the new transit system the avenue traffic lights encountered along 42nd Street will remain unsynchronized and streetcars traveling in either direction will not be given any special priority. The probability profile of the total additional delay to the end to end journey times has been calculated in Figure 2, assuming the timing of each traffic light is an independent random event and set on a 90 second cycle with equal priority in all directions.

To avoid further delays it is important that the information about the next traffic light phasing be fed into the light rail communication system. By doing this, operations will normally only hold streetcars in tram-stops and thus avoid a second stop at traffic lights away from tram-stops. Dwell times will vary from a minimum of 20 seconds to a maximum of 65 seconds. The table below gives the two extremes of delays on the travel times caused by traffic signals:

Components of travel time (one direction only)	Minimum traffic light delay	Maximum traffic light delay
Perfect run (with no delay from Traffic Lights)	15.3	15.3
Traffic light delays (once in 30 journeys)	1.5	5.25
Other perturbations (allowing for door delays)	0.7	0.7
Total travel time	**17.5**	**21.25**

The assumed cycle time is the maximum traffic light delay for a return trip plus minimum turnaround at each terminal to allow the driver to change ends.

This gives a cycle time of **44.5 minutes.**

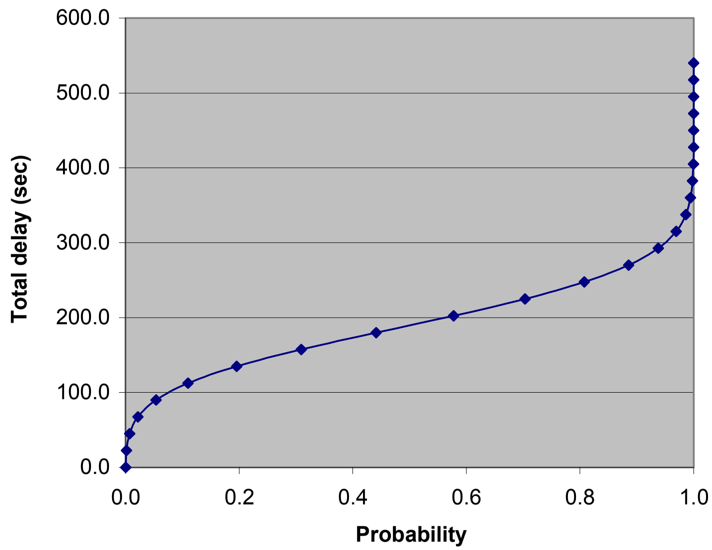
Figure 2 – Delays Due to Traffic Signals on Avenues

Vision 42 - Delays due to traffic signals on Avenues

No of independent signals	12	At each red light:	
Probability of green light	0.5	Probability of delay: 0 to 22.5 sec	0.5
Probability of red light	0.5	Probability of delay: 22.5 to 45 sec	0.5

Number of red lights	0	1	2	3	4	5	6	7	8	9	10	11	12	Delay		Cumul
Probability	0.000	0.003	0.016	0.054	0.121	0.193	0.226	0.193	0.121	0.054	0.016	0.003	0.000	(sec)	Prob	Prob
	1.000													0.0	0.000	0.000
		0.500												22.5	0.001	0.002
		0.500	0.250											45.0	0.005	0.007
			0.500	0.125										67.5	0.015	0.022
			0.250	0.375	0.063									90.0	0.032	0.054
				0.375	0.250	0.031								112.5	0.056	0.110
				0.125	0.375	0.156	0.016							135.0	0.086	0.196
					0.250	0.313	0.094	0.008						157.5	0.113	0.309
					0.063	0.313	0.234	0.055	0.004					180.0	0.132	0.441
						0.156	0.313	0.164	0.031	0.002				202.5	0.136	0.577
						0.031	0.234	0.273	0.109	0.018	0.001			225.0	0.126	0.703
							0.094	0.273	0.219	0.070	0.010	0.000		247.5	0.104	0.808
							0.016	0.164	0.273	0.164	0.044	0.005	0.000	270.0	0.078	0.886
								0.055	0.219	0.246	0.117	0.027	0.003	292.5	0.052	0.938
								0.008	0.109	0.246	0.205	0.081	0.016	315.0	0.031	0.969
									0.031	0.164	0.246	0.161	0.054	337.5	0.017	0.986
									0.004	0.070	0.205	0.226	0.121	360.0	0.008	0.995
										0.018	0.117	0.226	0.193	382.5	0.004	0.998
										0.002	0.044	0.161	0.226	405.0	0.001	0.999
											0.010	0.081	0.193	427.5	0.000	1.000
											0.001	0.027	0.121	450.0	0.000	1.000
												0.005	0.054	472.5	0.000	1.000
												0.000	0.016	495.0	0.000	1.000
													0.003	517.5	0.000	1.000
													0.000	540.0	0.000	1.000

Cumulative probability curve



3.3 Number of LRVs

	Number of LRVs
Number of LRVs for 3.5 to 4 minute service interval (dependent upon unsynchronized traffic signals)	11
Plus one extra held in each terminal	2
Plus one in maintenance	1
Total LRVs Required	**14**

Because of the large variation in run times due to traffic signals, the best option is to always have one vehicle in each terminal, thus

- enabling the service interval to be recovered following delays
- avoids delaying service while waiting for the driver to change ends.
- the passengers always have a vehicle waiting.

Dublin LRT, Dublin Ireland

4 Vehicles

4.1 Main Features

Modern, low-floor light rail vehicles, used in many cities throughout the world, would provide a high-quality surface transit alternative to conventional bus service. Their main features can be summarized as:

- High capacity (more than three times that of local buses)
- Fixed guidance, easier to enforce as a dedicated right-of-way than a bus path
- Rapid boarding (20 sec) with easy access
- Ecologically sound propulsion options (sustainable energy)
- Safe operation in a pedestrianized street, with clearly identified fixed path
- Comfortable interior, smoother ride for standees
- Low noise and vibration levels

4.2 Specifications

4.2.1 Size, Capacity and Configuration

150 ft (45.7m) long by 8 ft (2.4m) wide, multi-articulated, bi-directional vehicle. Maximum capacity 300 with 60 seats and standing at 4 passengers per approximately 10 square feet (1 square meter)

4.2.2 Accessibility

100% low floor with level boarding from 12 to 14 in (300 to 350mm) high platforms. Wheelchair friendly design.

4.2.3 Environmental Requirements

100% zero emissions

4.2.4 Performance

Acceleration 3.3 to 3.9 ft/s^2 (1.0 to 1.2 m/s^2), normal braking deceleration 1.3 m/s^2, emergency braking 2.5m/s^2, maximum available speed 25 mph (40 km/hr). Speed in pedestrian shared areas limited to 15mph (25 km/hr).

4.2.5 Air-Conditioning and Heating

All vehicles must be air-conditioned in summer and heated in winter.

Dublin LRT, Dublin, Ireland

Dublin LRT Interior, Dublin, Ireland

5 Track Bed

5.1 Track Bed for Steel Rails

Although the weight of the vehicles is less than existing highway trucks, steel rails must be located with precision and stability, a solution that has been followed in a number of cities, including Houston and Portland. Modern streetcar systems usually have a reinforced concrete slab as a foundation to ensure the rail is fixed firmly both horizontally and vertically. All access manholes for utilities and any critical utilities will need to be diverted to outside the swept path of the tram. Although this should be decided on a risk based approach, utility companies will safeguard their own commercial interest, and the experience throughout the world with new streetcar routes is that more utility diversions are undertaken than is really necessary.

Conventional streetcars use the running rails for return current and stray currents from the rails can also cause electrochemical corrosion to metallic services such as iron and steel pipes and conduits. This corrosion can be controlled with proper insulation around the rail and bonding the track slab reinforcement. For light rail propulsion systems which do not use the running rail for return current, it is possible and worthwhile to use the ultra light trackbed with strip footings mentioned below to reduce utility diversion costs.

5.2 Minimizing Utility Relocations

Because the main route on 42nd Street is straight and at low speed, it is possible to use an ultra light track bed consisting of precast concrete strips under each rail, as shown in Figures 3 and 4. Such a system would allow access manholes to be adjusted only slightly to remain centrally between the individual rail strips. Theoretically, this solution would offer a possibility of avoiding some especially expensive diversions of some of the major utilities such as the 8 ft (2.5m) diameter sewer. In New York, it will take a political decision that recognizes that the benefits of the light rail project make it worth working out such an arrangement with the utility companies and agencies.

For routine maintenance, utility companies would be given access during temporary closure of one of the tracks (in off-peak hours). For a 2.5-mile light rail line, it would make sense to have several permanent intermediate crossovers in the heavily used central portion, near Grand Central and Times Square or the Port Authority Bus Terminal. Prefabricated crossover connecting ties, in common use throughout the world, and shown in Figure 5, can be used to allow single-track service in such cases, as well as for emergency repairs, such as a water main break, which might require temporary shutdown of service on one of the tracks for the duration of the repairs. For a major repair that requires shutdown of both tracks, the simplest solution may be to temporarily close off the light rail service in the affected block, and to ask the public, for the duration of the repair, to walk that block and resume their travel by light rail on the other side. In the event of an outage in the central segment of 42nd Street, travelers could use either the Shuttle or the #7 Subway to fill the missing link. A portable crossover, as illustrated in Figure 5, could also be used to shorten the length of single track needed in the event of major repairs or disruptions.

Figure 3 – Section Showing Minimal Relocation of Utilities

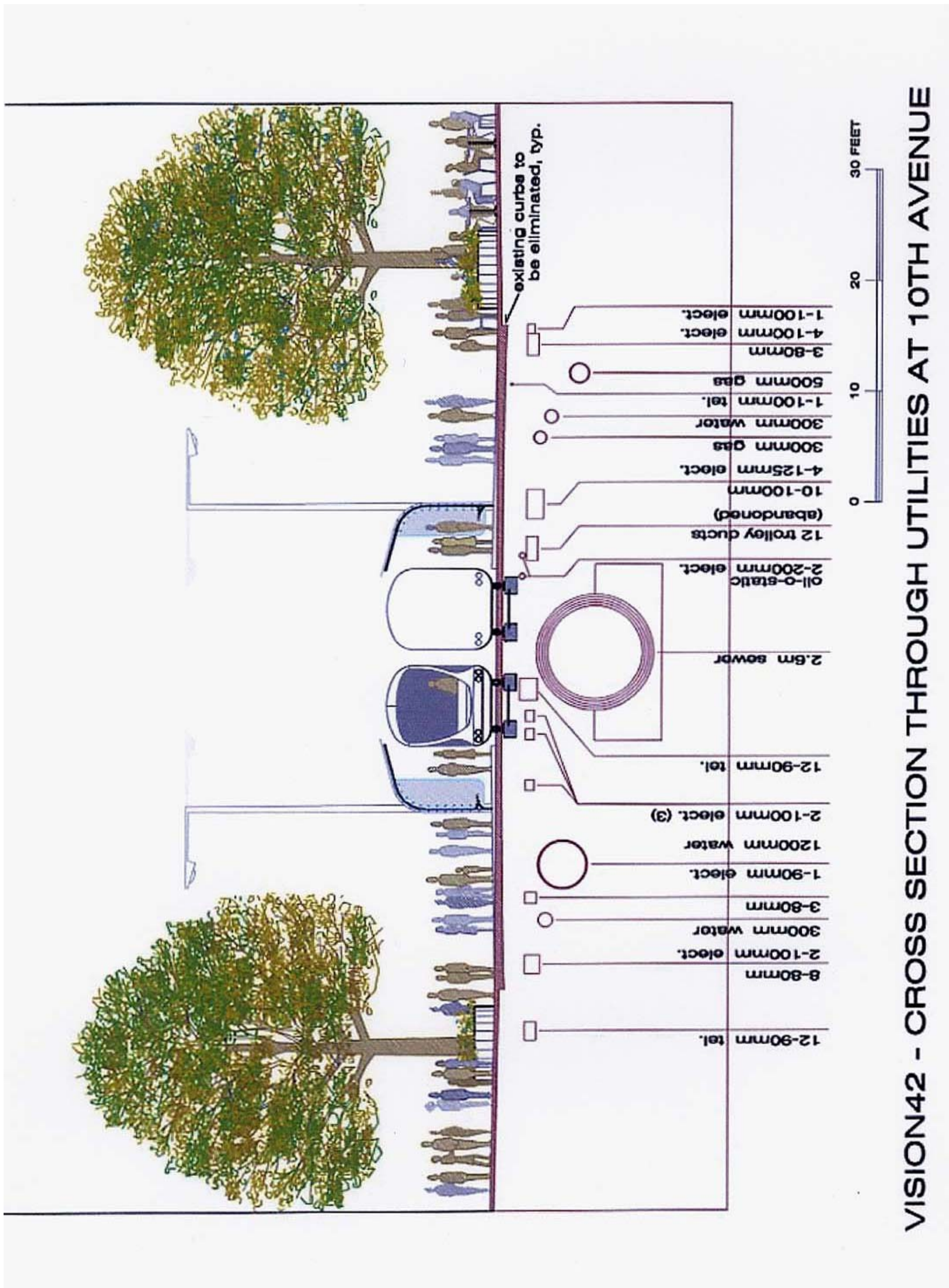


Figure 4 – Section through Special Track Supports to Allow Manholes between Rails

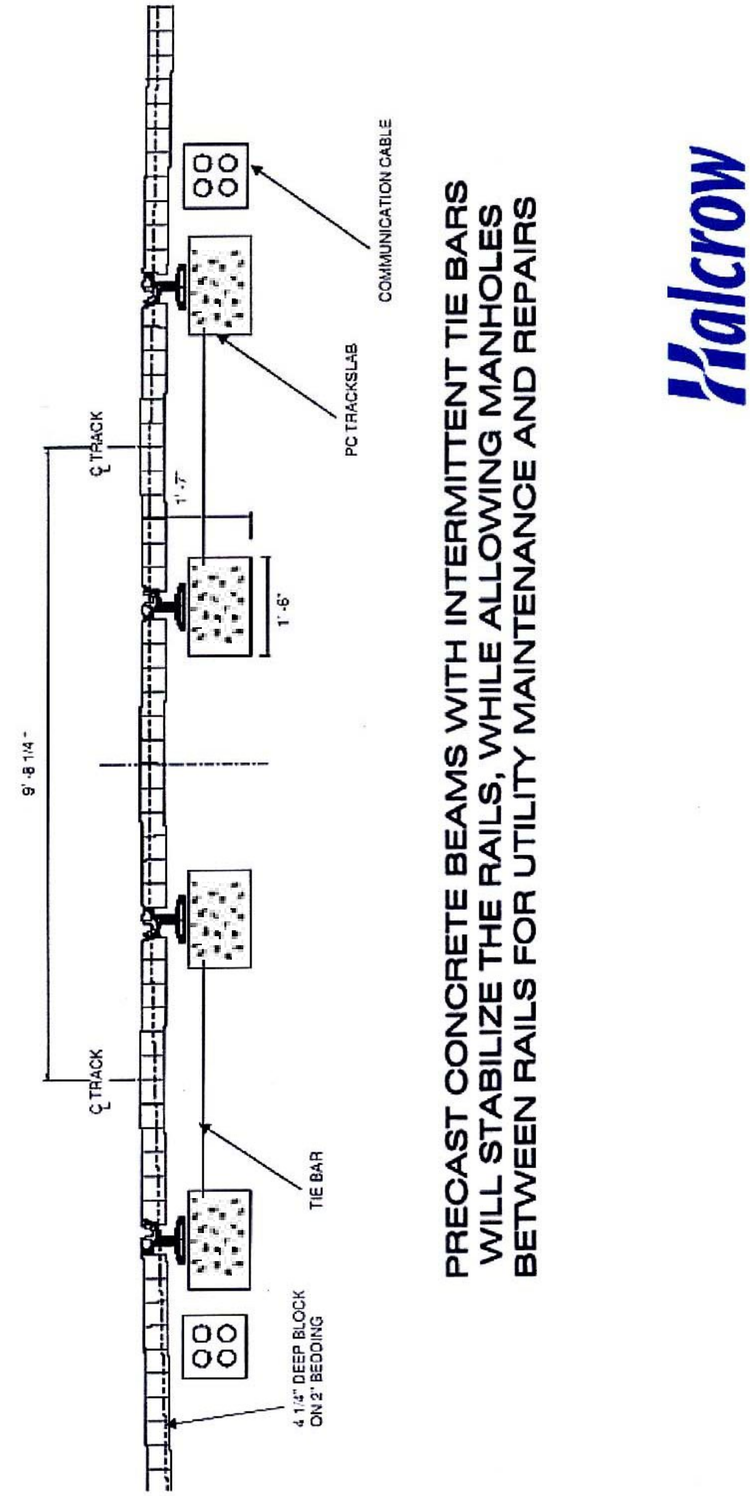


Figure 5 – Temporary Crossover Tracks

5.3 Risks with Extensive Utility Relocations

Extensive utility relocations will inevitably involve:

- Cost and cost risk
- Program and program risk
- Disruption to businesses, the extent determined by the extent of relocations

Detailed investigations have been undertaken in previous studies for light rail on 42nd Street (including trial pits for a study by Raytheon). Although studies help reduce the risk, there is still a high residual risk because of the density of utilities and limited space available, if it is required to fit all utilities clear of the swept path of the streetcar. This risk can only be properly quantified during detailed planning and design of the diversions. (At this stage we have included higher costs per mile for utility relocations than have been incurred for any other light rail project.

6 Outline of Power Supply Options

The following options are briefly discussed:

- Overhead wire (rail return)
- Overhead twin wire (trolley)
- Surface conductor
- Battery
- Fuel Cells
- Flywheels

6.1 Overhead Wire (rail return)

Overhead wire with a 600 or 750V DC supply is the cheapest and simplest method of power supply. Environmentally it will be opposed by some, and it imposes a few practical difficulties such as accommodating parades. Conventional trams use the running rail for return current. Light wire systems have been accepted in the center of many European cities, but wire was always banned from the original streetcar systems in Manhattan, Washington D.C, and London. Nevertheless, in 1994 the NY City Council overwhelmingly approved the light rail proposal of that year, which included overhead wires.

6.2 Overhead Twin Wire (trolley)

Light rail twin wiring avoids stray current and could be used with rubber-tired automated guidance. However, it is environmentally less acceptable than conventional tram wire.

6.3 Surface Conductor

We have specifically reviewed the Innorail surface power rail technology operating in the central downtown portion of the new light rail network in Bordeaux, France. The system is radio controlled and is located centrally between the running rails. Beginning with its operations in October 2003, there were frequent reliability problems on the Innorail sections of system, which lasted for at least 9 months, causing service disruptions. At the time of this writing, the reliability of the system is at 95%, short of the target of 99%. While this technology remains a possibility if its problems are satisfactorily resolved, it has not yet been tested in a less mild climate than that of Bordeaux, and we cannot currently recommend it for 42nd Street.

6.4 Batteries/Flywheels/Capacitators

The short route enables onboard energy storage propulsion systems, such as batteries, flywheels, and capacitors, to be considered as the power source. Recharging can be achieved either at the ends of the line and/or at intermediate points along the route. The devices could also be recharged at stops through regenerative braking. However, the relatively low top speeds will mean that only a limited amount of energy can be recouped in braking.

The main problem with these energy storage systems is posed by the high air-conditioning and heating loads needed for passenger comfort. Normally other power sources are used to run these efficiently. Flywheel energy storage has benefits for the service pattern in vision42. Traditional floor mounted technology is unacceptable because of vision42's low-floor requirement, but 3 experimental or pilot schemes with roof mounted flywheels have recently been built. Capacitors offer an alternative energy storage method but are currently only available from one manufacturer. They are potentially more convenient than flywheels, but are thought to have similar limitations in regenerative capacity for this project with low maximum speeds.

6.5 Fuel Cells

Hydrogen fuel cells are the cleanest onboard energy devices but are currently very expensive. Trial public transit bus services have started in 9 European cities and costs will inevitably be reduced in the next 5 to 10 years. A fuel cell-powered railway locomotive is currently being developed in New Mexico, funded by the U.S. government, with a target date of 2009, whose power output of 1.2 megawatts should be more than adequate for modern light rail vehicles. And the London underground plans to use fuel cells to power its fleet of maintenance vehicles, because of their zero emissions, reliability and efficiency.

6.6 Diesel-Hybrid

Hybrid units with diesel engines for battery charging can be a practical low emission compromise. This is the power supply choice for future NYC buses. Some low cost transit systems are designing modular power units using battery or hybrid diesel battery units, to allow a switch to new, cleaner technology when it becomes affordable. Using diesel-hybrids for self-propelled light rail vehicles on a pedestrianized 42nd Street, even on an interim basis until fuel cells become less costly, may pose significant environmental concerns.

7 Land & Property Acquisitions, Yard & Buildings

7.1 Assumptions

The stabling yards and maintenance facilities for 14 streetcars will require an area of about 60,000 SF. In previous studies, several options were identified for this facility. All of the sites are located towards the West Side between 10th and 12th Avenues and from 30th Street in the south to a former NYC Transit bus depot on the south side of 41st Street. Environmental upgrading and major developments along the Hudson River has restricted options on the river wharfs. The most convenient site is probably a tractor trailer park which is also a possible site for a southern extension of the Jacob Javits Convention Center. However, there are still at least two other sites potentially available. One possibility is to convert a small portion of the Long Island Rail Road maintenance and storage yard into a light rail maintenance facility. Alternately, a number of locations exist where a new light rail yard could be jointly developed as part of a much larger commercial development. Our estimate is a nominal cost that would depend on commercial discussions with land owners.

The only other land costs will be the requirement for substations for the overhead wire options. The preference is for use of existing substations or frequent small substations located in vaults or associated with stops that minimize property costs.

Hiawatha LRT Maintenance Facility, Minneapolis, Minnesota (Photo by Thatcher Imboden, April 2003, http://www.lightrail.com/photos/minneapolis/minneapolis.htm)

8 Vehicle Guidance Systems

8.1 Need for Guidance

Significantly, the vision42 plan calls for a steel wheel on steel rail guidance system. This is the current state-or-the-art for light rail systems throughout the world. We believe that vehicle guidance is the single most important factor that will deliver the experience of a railway or modern tram quality service over that of buses. The benefits include:

- Identification of the route on the ground (an advantage that especially attracts tourists/visitors to use the system)
- An inherent and unique capability for self-enforcement of the dedicated right-of-way, discouraging other forms of traffic from entering the path
- Accessibility at stops due to low-floor vehicles and accurate stopping next to the platform
- Pedestrian safety outside the consistent and marked out swept path

Rails are a potential tripping hazard for pedestrians and a skidding hazard for cyclists, especially when wet. However, given the extensive worldwide experience with light rail in pedestrian streets, this has not been a significant deterrent.

8.2 Relationship to Development

Steel wheel/steel rail transit provides the permanence that developers need in making investment decisions. Projections of vision42's economic potential are predicated on this condition.

8.3 Rubber-Tired Alternatives to Steel Wheel/Steel Rail Guidance

There are a number of experimental "light rail"-like systems that employ rubber tires. These are described in Appendix C. Many transit experts have argued that such systems would reduce costs. The agencies and companies responsible for the utilities in New York City have suggested to us that they would be more comfortable with such systems passing over the utilities. Nonetheless, rubber tired "light rail"-like systems that would meet the service requirements of the 42nd Street corridor remain to be developed and are not recommended.

9 Streetwork, Landscaping & Stops

9.1 Capital Improvements

The streetscape associated with the light rail line project will set the stage for this new, efficient and attractive transportation corridor in midtown Manhattan. The streetscape will provide a lively, wide, high-quality pedestrianized boulevard with a clearly defined, fixed path for the light rail vehicles. Some of the key features of the streetscape include the platform structures at each stop along the route and the pergola structures that share the same architectural vocabulary. The shelters will sit on the paved station platforms that slope up out of the paving to form a seamless, architectural ground-plane unifying the newly created boulevard. The platforms will be made of the same unit pavers as the other walkway areas. Both of these glassy structures will provide shade and seating while the pergolas will provide an opportunity for bringing greenery to the street in areas where utilities, vaults and other below-grade obstructions would prevent the planting of traditional street trees. This vibrant new streetscape will be further enhanced with large shade trees in areas with no utility conflicts, built in planters with flowering shrubs and bulbs and other plantings that will lend seasonal interest and scale to the street.

The proposed light fixtures for the project will be the "Grand Central Partnership" fixture, an accepted and dependable streetscape element already in use along part of the route. These fixtures, along with the benches, trash receptacles and honor box furnishings used within the district will further define and lend a distinct character to the boulevard. The new pedestrian boulevard will be paved with hex asphalt pavers from building face to building face to create the unified ground-plane. The existing street curbing will be removed but a subtle 'fold' in the paving of the new boulevard will allow the existing catch basins to be remain in-use once they have been retrofitted with new ADA compliant grates. The proposed hex pavers are a New York City hallmark that has been used for decades in parks, streetscapes, waterfronts and plazas throughout the city. These pavers wear very well in both vehicular and pedestrian areas and are available in a range of colors and textures that can be used to further define the swept path of the light rail vehicles and to mark other special places along the route.

9.2 Responsibility for Street Cleaning and Security Beyond Business Improvement District (BID) Boundaries

In an effort to identify and dimension the scope and cost of support services related to the operation of a pedestrianized 42nd Street, inquiries were made to the business improvement districts (BIDs) that encompass the tram route. The experience of the BIDs could be used to develop a similar model for vision42. Toward that end, the first step was to identify the parameters of each BID from 42nd Street from First Avenue to 12th Avenue. The boundaries are as follows:

Grand Central Partnership—mid-block between Tudor City Place and Second Ave. to one building lot west of Fifth Ave.

Bryant Park Restoration Corporation—gap between Times Square Alliance and Grand Central Partnership

Times Square Alliance — one building lot west of Sixth Ave. to one building lot west of Eighth Ave. (north side) to the southeast corner of Eighth Ave. (south side).

In addition, some responsibility for maintenance of the street is normally assumed by the management of the **Port Authority Bus Terminal**—for the south side of 42nd Street between Eighth and Ninth Avenues and the north side from one building lot west of Eighth Avenue to Ninth Avenue.

In discussions with the Times Square Alliance, we raised the question whether, if asked to extend their sphere of influence and control to encompass 42nd Street west to 12th Avenue, what services they could provide and what the estimated cost would be. Although there may be slight variations amongst the identified BIDs, the general information provided below applies to the Times Square Alliance, Grand Central Partnership and Bryant Park Association. Each BID performs services to obtain and maintain a uniform level of cleanliness and appearance that affords visitors to the BID a real and perceived sense of managed control. To accomplish this, they provide two key services:

Sanitation: 7-days a week; 6 a.m. to 10 p.m.

Security: 7-days a week; 9:30 a.m. to midnight

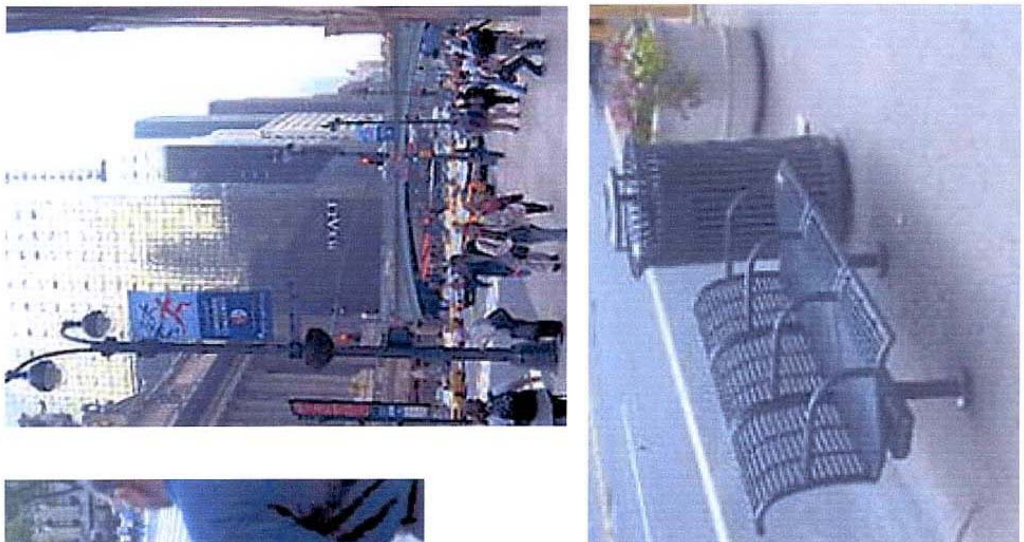
This work is done primarily by in-house forces; there is a concerted effort to minimize the need for outsourcing and the associated turnover of staff.

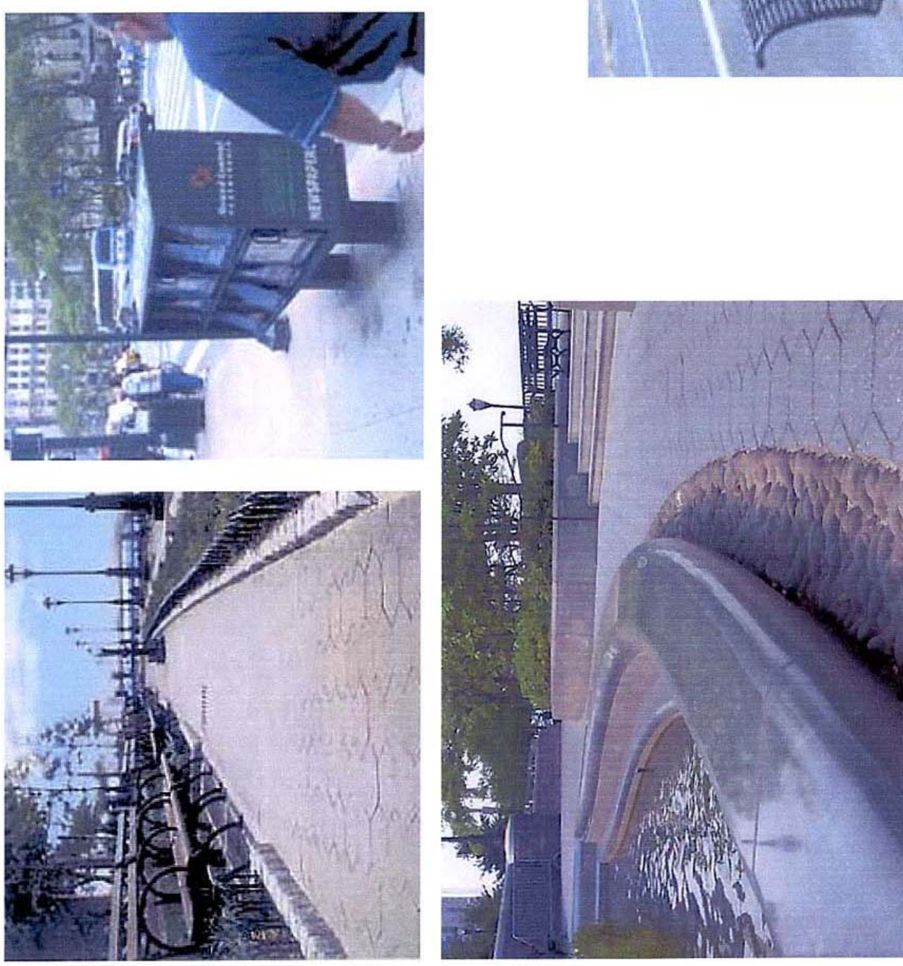
In answer to whether the Times Square Alliance would be willing to extend their western boundary to encompass maintenance and security of vision42, we were told that this would be a possibility after consulting with residents and businesses. However, further, more detailed, research would need to be done to determine what, if any, legislative or charter revisions would be required to commence this change.

9.3 Operating and Maintenance Costs

The Times Square Alliance provided a preliminary estimate of $370,000 for annualized operating expenses for sanitation and security services, for extending their western boundary to 12th Avenue. If the option of using the BIDs to perform these types of services is pursued, then a more detailed costing would be necessary, both to confirm the preliminary estimate and to develop a more fully representative expenditure with all other parties included.

Figure 6 - Streetscape Features





FOR A HIGH QUALITY WALKING ENVIRONMENT, STREET FURNISHINGS AND LIGHTING SHOULD MATCH THE QUALITY OF THOSE OF THE GRAND CENTRAL PARTNERSHIP. HEX PAVERS CAN PROVIDE INTEREST AND VISUALLY UNITE THE GROUND PLANE.

Figure 7 - Pergolas for Shade, where underground utilities preclude tree planting

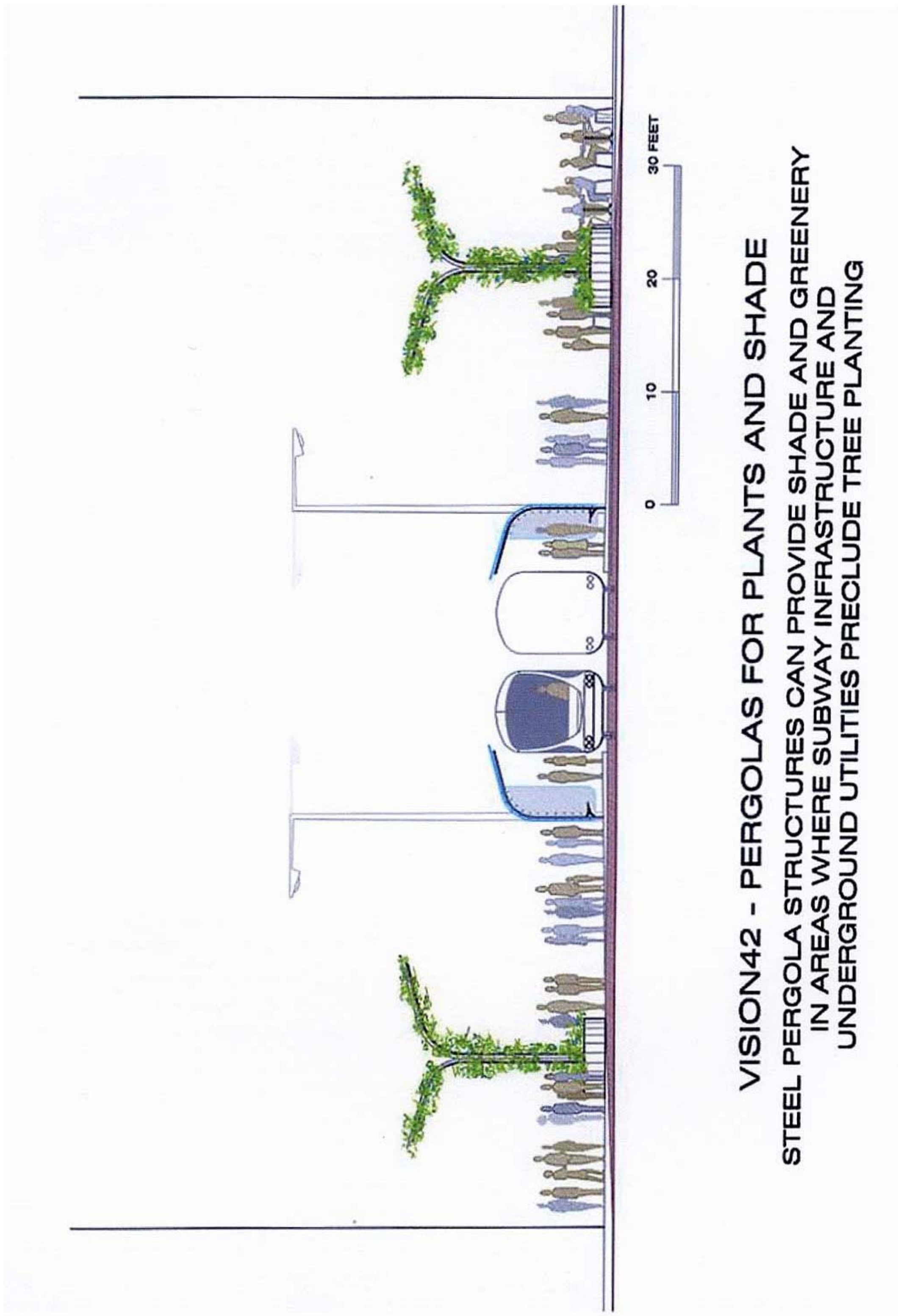
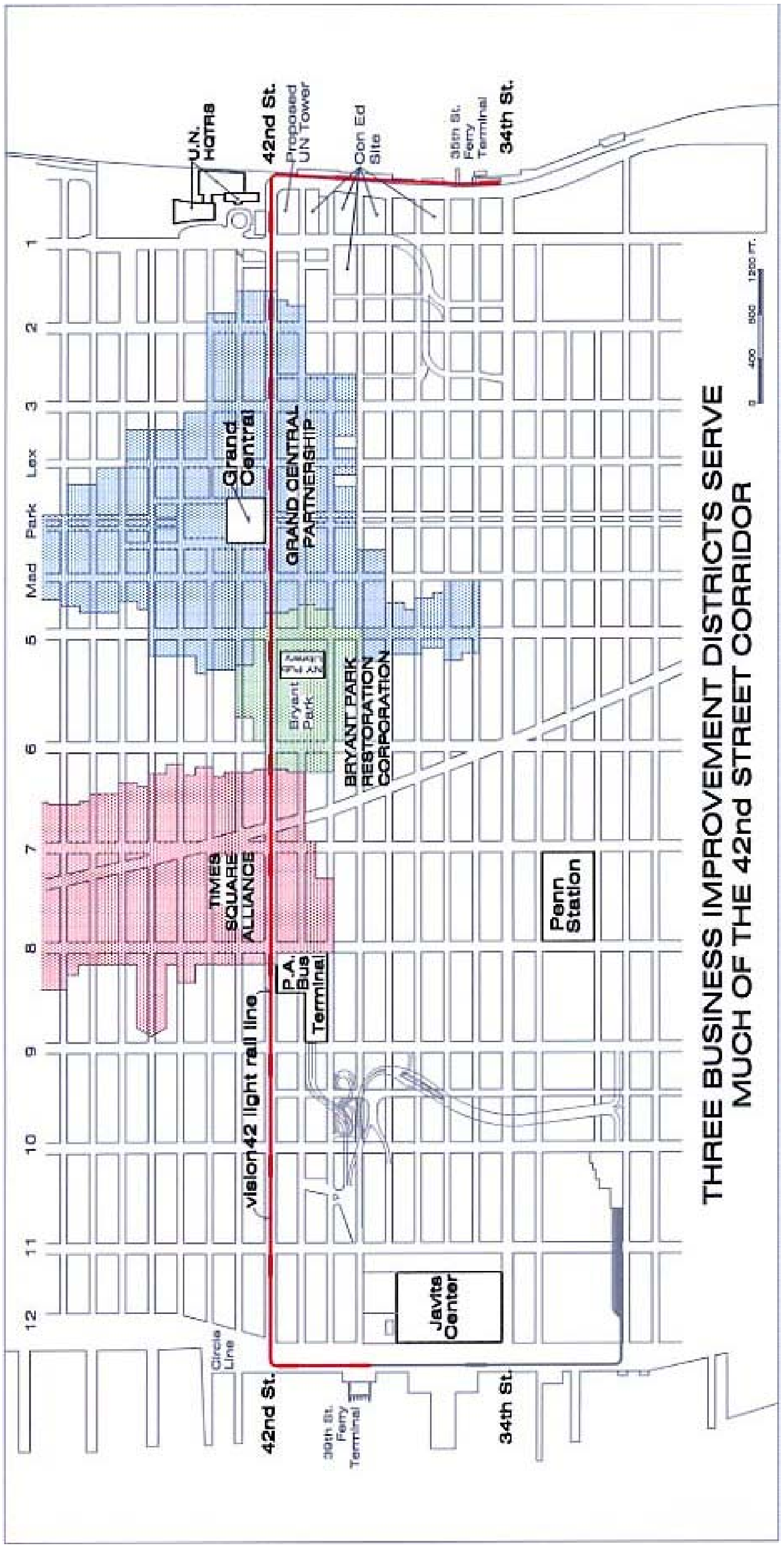


Figure 8 – Business Improvement District Areas



10 Estimate of Capital Costs

10.1 Estimate of Costs

Costs have been estimated for three steel wheel/steel rail options: Conventional catenary system power supply, self-propelled vehicles using fuel cell technology or nickel cadmium batteries, and the latter but with the ultra light strip track system and avoiding the diversion of the sewer mains and some other utility works.

Table 10.1 - Capital Cost Estimate for Alternative LRT Options

Element	Catenary System	Self-propelled system	Self-propelled system with min utility work
Utility Relocation *	$319,042,000	$319,042,000	$188,675,000
Streetwork, Landscaping & Stops *	$58,700,000	$58,700,000	$58,700,000
Trackwork	$19,550,000	$19,550,000	$19,550,000
Electrification – feeder substations	$3,675,000	$3,000,000	$3,000,000
Electrification - overhead wire or power rail	$4,900,000	$0	$0
Control and communications	$3,350,000	$3,350,000	$3,350,000
Yard and Buildings	$11,500,000	$11,500,000	$11,500,000
Land & Property acquisition	$5,000,000	$5,000,000	$5,000,000
Subtotal	$425,717,000	$420,142,000	$289,775,000
Vehicles (14 number)	$56,000,000	$72,800,000	$72,800,000
Contingencies	$48,172,000	$49,294,000	$36,258,,000
Engineering & Construction management	$21,286,000	$21,007,000	$14,489,000
Net Present Value of Savings in Capital Cost from Eliminating Bus Routes (Over 30 Year LRT Lifespan)	($52,875,000)	($52,875,000)	($52,875,000)
Total Project	**$498,300,000**	**$510,368,000**	**$360,447,000**

All costs are at 2004 price levels. * See Appendix A – Details of Costs for Relocation of Utilities, and Appendix B – Details of Costs for Streetwork, Landscaping and Stops.

11 Maintenance and Operating Costs

11.1 Estimate of Annual Costs

Resource	Unit	Quantity	Unit Rate	Total Cost
Vehicle Operations				
Operations Manager	Person Years	1	$121,500	$121,500
Admin Support	Person Years	1	$40,500	$40,500
Crew Dispatcher	Person Years	3	$81,000	$243,000
Drivers	Person Years	40	$70,200	$2,808,000
Chief Dispatcher	Person Years	1	$101,250	$101,250
Dispatchers	Person Years	5	$81,000	$405,000
Revenue Collectors	Person Years	4	$40,500	$162,000
Security	Person Years	3	$47,250	$141,750
Electric Power	Vehicle kms	530800	$0.32	$171,513
Casualty / Liability	Vehicle kms	530800	$0.12	$65,967
				$4,260,480
Vehicle Maintenance				
Maintenance Manager	Person Years	1	$121,500	$121,500
Admin Support	Person Years	1	$40,500	$40,500
Foreman – Vehicles	Person Years	3	$87,750	$263,250
Mechanics	Person Years	4	$74,250	$297,000
Electricians	Person Years	3	$74,250	$222,750
Cleaners	Person Years	2	$47,250	$94,500
Spares and consumables	Per Vehicle	13	$9,300	$120,900
				$1,160,400
Non-Vehicle Maintenance				
Foreman - Way & Structures	Person Years	1	$87,750	$87,750
Electrical Maintainers	Person Years	2	$74,250	$148,500
Track Maintainers	Person Years	2	$67,500	$135,000
Storekeeper	Person Years	3	$67,500	$202,500
Track Materials	Track kms	8	$18,642	$150,000
				$723,750
General Admin				
General Manager	Person Years	1	$141,750	$141,750
Office administrator	Person Years	1	$54,000	$54,000
IT Support	Person Years	1	$60,750	$60,750
Office Equipment including IT	Item	1	$30,000	$30,000
Office Utilities	Monthly Allowance	12	$2,000	$24,000
Office Consumables	Monthly Allowance	12	$2,000	$24,000
Contingency	Item	1	$50,000	$50,000
				$384,500
				$6,529,130

All costs are at 2004 price levels

11.2 Costing Assumptions

- There are no major differences in operating expenses for the 3 options.
- Labor rates are based on 2004 rates.
- Maximum Speed of 15MPH (24km/hr) due to integration with pedestrian traffic.
- A 3.5 to 4 minute service interval (dependent upon unsynchronized traffic signals) has been assumed during the peak periods.
- 20 second stopping time has been allowed at each station.

11.3 Comparison of Light Rail and Bus System Operating and Maintenance Costs

The annual operating costs of the high quality LRT service will be only slightly less than the bus services it replaces. However, because the light rail system has more than three times the capacity, its operating costs per place-mile are less than one-third those of buses. See Appendix D for details of replaced bus service costs.

	LRT	Replaced Bus Services
Vehicle Operations	$4,260,000	$5,627,000
Vehicle Maintenance	$1,160,000	$869,000
Non-Vehicle Maintenance	$724,000	$50,000
General Administration	$385,000	$50,000
Total	**$6,529,000**	**$6,596,000**
Cost/Place Mile	**$0.09**	**$0.33**

12 Impacts on Existing Surface Transit Systems

Operation of light rail along 42nd Street in a right-of-way unavailable to other vehicles will affect six existing transit services. These can be grouped into four categories, based on impact. These are:

- Fully duplicated and displaced 42nd Street local bus service (M42).
- Local bus service partially duplicated and displaced along 42nd Street (M104).
- Staten Island express bus services operated by MTA NYC Transit.
- New York Waterway-operated distributor buses connecting with their Hudson River terminal.

Each of these is considered in detail in Appendix D.

Appendix A

Details of Costs for Relocation of Utilities

METERS OF UTILITIES TO BE RELOCATED — Option A - Middle of 42nd Street

Location	Station Start	Station End	Sewer Main	Sewer	Water	Electric	Gas	Telecom	Oil	Vaults	**Total**
12th Ave Intersection	40+108	40+160	60	0	6	12	0	24	0	0	**102**
W. 42nd Street	40+160	40+260	20	110	0	18	0	6	0	0	**154**
W. 42nd Street	40+260	40+380	0	120	0	6	0	0	0	0	**126**
11th Ave Intersection	40+380	40+440	0	84	6	38	30	12	12	0	**182**
W. 42nd Street	40+440	40+540	0	100	100	208	0	0	0	4	**408**
W. 42nd Street	40+540	40+660	38	82	22	240	0	0	0	2	**382**
10th Ave Intersection	40+660	40+700	60	24	18	34	12	12	0	0	**160**
W. 42nd Street	40+700	40+800	100	0	0	66	6	18	100	0	**290**
W. 42nd Street	40+800	40+940	140	0	0	316	0	0	140	4	**596**
9th Ave Intersection	40+940	40+980	45	29	20	90	12	30	0	2	**226**
W. 42nd Street	40+980	41+080	0	100	0	112	12	100	100	1	**424**
W. 42nd Street	41+080	41+200	0	120	18	144	6	0	120	2	**408**
8th Ave Intersection	41+200	41+260	0	0	108	330	12	24	0	3	**474**
W. 42nd Street	41+260	41+360	0	100	100	300	0	0	100	1	**600**
W. 42nd Street	41+360	41+460	0	110	110	146	110	0	0	3	**476**
7th Ave & Broadway	41+460	41+580	0	0	125	678	0	48	120	1	**971**
W. 42nd Street	41+580	41+640	0	6	80	250	0	150	100	2	**586**
W. 42nd Street	41+640	41+760	0	0	120	510	120	10	120	2	**880**
6th Ave Intersection	41+760	41+800	0	0	40	254	12	30	0	0	**336**
W. 42nd Street	41+800	41+920	0	25	0	700	12	0	0	4	**737**
W. 42nd Street	41+920	42+080	0	12	0	706	160	0	160	4	**1038**
5th Ave Intersection	42+080	42+100	0	6	38	112	26	12	0	1	**194**
E.42nd Street	42+100	42+200	0	80	70	560	112	20	0	3	**842**
E.42nd Street	42+200	42+230	0	18	30	175	30	0	20	2	**273**
Madison Ave Intersection	42+230	42+280	0	6	40	330	25	36	0	3	**437**
E.42nd Street	42+280	42+480	10	30	50	1024	200	48	200	8	**1562**
E.42nd Street	42+480	42+540	0	0	60	252	60	0	0	2	**372**
Lexington Ave Intersection	42+540	42+580	8	0	6	168	0	30	0	1	**212**
E.42nd Street	42+580	42+700	0	0	120	540	0	12	0	5	**672**
3rd Ave Intersection	42+700	42+740	10	6	18	120	12	12	0	0	**178**
E.42nd Street	42+740	42+900	160	0	160	320	100	25	160	2	**925**
2nd Ave Intersection	42+900	42+960	60	0	45	180	6	24	0	0	**315**
E.42nd Street	42+960	43+140	186	6	156	600	30	30	12	4	**1020**
1st Ave Intersection	43+140	43+200	60	6	80	250	50	100	0	3	**546**
Total			**957**	**1180**	**1746**	**9789**	**1155**	**813**	**1464**	**69**	**17104**

Notes:
1) Utility and vault relocation based on 6 meter effected area. (3 meters on either side of street center.)
2) All values in meters. (Convert to feet multiply by 3.28)
3) Sewer main represents 2.6 meter diameter pipe. Sewer represents .8 meter diameter.
4) At intersections, minimum of 6 meters of utilities running north/south will have to be deepened to allow for LRT foundations.

ESTIMATED AMOUNT OF UTILITIES TO BE RELOCATED

Location	Street Station Start	Street Station End	Sewer Main
West Side Extension	39+193	40+108	-
12th Ave Intersection	40+108	40+160	60
W. 42nd Street	40+160	40+260	20
W. 42nd Street	40+260	40+380	0
11th Ave Intersection	40+380	40+440	0
W. 42nd Street	40+440	40+540	0
W. 42nd Street	40+540	40+660	38
10th Ave Intersection	40+660	40+700	60
W. 42nd Street	40+700	40+800	100
W. 42nd Street	40+800	40+940	140
9th Ave Intersection	40+940	40+980	45
W. 42nd Street	40+980	41+080	0
W. 42nd Street	41+080	41+200	0
8th Ave Intersection	41+200	41+260	0
W. 42nd Street	41+260	41+360	0
W. 42nd Street	41+360	41+460	0
7th Ave & Broadway	41+460	41+580	0
W. 42nd Street	41+580	41+640	0
W. 42nd Street	41+640	41+760	0
6th Ave Intersection	41+760	41+800	0
W. 42nd Street	41+800	41+920	0
W. 42nd Street	41+920	42+080	0
5th Ave Intersection	42+080	42+100	0
E.42nd Street	42+100	42+200	0
E.42nd Street	42+200	42+230	0
Madison Ave Intersection	42+230	42+280	0
E.42nd Street	42+280	42+480	10
E.42nd Street	42+480	42+540	0
Lexington Ave Intersection	42+540	42+580	8
E.42nd Street	42+580	42+700	0
3rd Ave Intersection	42+700	42+740	10
E.42nd Street	42+740	42+900	160
2nd Ave Intersection	42+900	42+960	60
E.42nd Street	42+960	43+140	186
1st Ave Intersection	43+140	43+200	60
East Side Extension	43+200	43+795	-
Total		**4602 m (15,094 ft)**	**957 m (3,138 ft)**

Notes:

1) Utility and vault relocation based on 6 meter effected area. (3 meters on either side of street center.)
2) All values in meters. (Convert to feet multiply by 3.28)
3) Sewer main represents 2.6 meter diameter pipe. Sewer represents .8 meter diameter.
4) At intersections, minimum of 6 meters of utilities running north/south will have to be deepened to allow for LRT foundations.

ESTIMATED COST BREAKDOWN PER LINEAR FOOT OF STREET
A) NO SEWER MAIN
11,955 ft x $17,500/ft = $209,212,500
B) SEWER MAIN
3,138 ft x $35,000/ft = $109,830,000
ESTIMATED TOTAL COST
$319,042,000

Note:

1) General linear foot cost escalated 35% based on conversation with NYCDEP and NYCDDC.

2) For areas of sewer mains, linear foot cost doubled on recommendation of NYCDEP.

3) Linear foot cost based on escalated prices from May 1997 NYCDOT report.

4) NYCDEP and NYCDDC indicated price escalations are very approximate.

Appendix B

Details of Costs for Streetwork, Landscaping and Stops

Langan
Engineering and Environmental Services

Project # 5625201
July 2004

FEASIBILITY COST SUMMARY
Vision 42
City of New York, New York

NOTE: Estimate is based on 42nd Steet Light Rail Transit Line Surveys and Feasibility Testing dated May, 1995 prepared by Seelye Stevenson Value & Knecht.
Capital Project HW 1130

COST SUMMARY:	TOTAL COST: "A" LEVEL FINISHES	TOTAL COST: "B" LEVEL FINISHES
1. SITE PREPARATION/ DEMOLITION	$1,788,200	$1,788,200
2. UTILITY DEMOLITION/ RELOCATION	$0	$0
3. SITE IMPROVEMENTS	$2,731,920	$2,731,920
4. FINISH ITEMS	$41,698,000	$32,758,400
5. DRAINAGE	$0	$0
6. UTILITY	$0	$0
7. SITE LIGHTING	$2,222,870	$815,800
8. LANDSCAPE PLANTING	$451,500	$241,000
SUBTOTAL -		**$38,335,320**
20% CONTINGENCY		**$7,667,064**
TOTAL ESTIMATED COST-		**$46,002,384**
		SAY $46.1 million
SUBTOTAL-	**$48,892,490**	
20% CONTINGENCY	**$9,778,498**	
TOTAL ESTIMATED COST-	**$58,670,988**	
	SAY $58.7 million	

Notes:

1. See final page of 'Cost Estimate' for inclusions and exclusions.
2. Costs identified in Cost Summary are based on the Cost Estimate but have been rounded up to the nearest thousand dollars.

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Langan
Engineering and Environmental Services

Project # 5625201
July 2004

FEASIBILITY COST STUDY
Vision 42
City of New York, New York

NOTE: Estimate is based on 42nd Steet Light Rail Transit Line Surveys and Feasibility Testing dated May, 1995 prepared by Seelye Stevenson Value & Knecht.
Capital Project HW 1130

DESCRIPTION OF ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
1. SITE PREPARATION/ DEMOLITION				
A. Asphalt Pavement Surface Removal (8" Thick)	68,500	SY	$ 10.00	$685,000
B. Underlying Paving Material (8" Thick)	68,500	SY	$ 10.00	$685,000
C. Curb Demolition 6" Wide x 21" Deep	6,500	LF	$ -	$0
D. Standard Concrete Sidewalk Demo. (6"Thick)	38,000	SY	$ -	$0
E. Removal of Street Light Fixture	143	EA	$ 300.00	$42,900
F. Existing Street Tree Removal (8" Caliper)	159	EA	$ 700.00	$111,300
G. Inlet Protection	0	EA	$ 200.00	$0
H. Construction Fencing	3,000	LF	$ 8.00	$24,000
I. Traffic Controls/ Security/ Safety	0	LS	$ -	$0
J. Miscellaneous Demolition/ Disposal	12	Block	$ 20,000.00	$240,000
			SUBTOTAL	**$1,788,200**
2.UTILITY DEMOLITION AND RELOCATION				
			SUBTOTAL	**$0**
3. SITE IMPROVEMENTS				
A. Information / Newspaper Kiosks (Prefabricated)	6	EA	$ 100,000.00	$600,000
B. Steel Faced Concrete Standard Curb (6"x9"x20")	1,770	LF	$ 50.00	$88,500
C. Flush Steel Faced Concrete Standard Curb (6"x9"x20")	890	LF	$ 78.00	$69,420
D. Benches (6 Per. Block)	72	EA	$ 3,500.00	$252,000
E. Trash Receptacles (6 Per. Block)	48	EA	$ 1,500.00	$72,000
F. Wayfinding Signage and Graphics	1	LS	$ 200,000.00	$200,000
G. Decorative Steel Bollards (36"Height) (4' O.C.)	580	EA	$ 2,500.00	$1,450,000
			SUBTOTAL	**$2,731,920**
4. FINISH ITEMS				
A. Finish Items, Level A 'High Build'				
1. Hex Asphalt Pavers (6" Thick Concrete Base)				
a. Light Rail Stops/ Footprint	164,000	SF	$ 22.00	$3,608,000
b. Roadway Intersections	135,000	SF	$ 22.00	$2,970,000
c. Sidewalk/ Plaza	656,000	SF	$ 20.00	$13,120,000
2. Steel Prefabricated Pergolas w/ planters and bench	110	EA	$ 200,000.00	$22,000,000
			SUBTOTAL	**$41,698,000**
B. Finish Items, Level B 'Low Build'				
1. Poured In Place Concrete				
a. Sidewalk/ Plaza	524,800	SF	$ 8.00	$4,198,400
2. Cobblestone Paving (6" Concrete Base)				
a. Light Rail Stops/ Footprint	131,200	SF	$ 50.00	$6,560,000
3. Steel Prefabricated Pergolas w/ planters and bench	110	EA	$ 200,000.00	$22,000,000
			SUBTOTAL	**$32,758,400**

DESCRIPTION OF ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
5. DRAINAGE				
A. Area Drains	0	EA	$ 2,500.00	$0
B. Convert CB Grate	0	EA	$ 1,500.00	$0
C. Roof Leaders	0	EA	$ 200.00	$0
D. Replace Outfall Grates	0	LS	$ 10,000.00	$0
E. Reset Outfall Manhole Covers	0	EA	$ 1,000.00	$0
F. Existing Outfall Improvements (allowance)	0	LS	$ 25,000.00	$0
			SUBTOTAL	**$0**
6. UTILITY				
A. Fire Hydrant w/ Valve	0	EA	$ 3,000.00	$0
B. 6" Waterline w/in Sleeve and Insulate	0	LF	$ 100.00	$0
C. 2" Waterline w/in Sleeve	0	LF	$ 75.00	$0
D. 6" Valve	0	EA	$ 500.00	$0
E. 8" Sanitary w/in 12" Sleeve	0	EA	$ 100.00	$0
F. 8" Sanitary in Road	0	LF	$ 100.00	$0
G. Sanitary Manhole	0	EA	$ 3,000.00	$0
H. Tie into Existing Manhole	0	EA	$ 500.00	$0
I. Flexible Connections	0	EA	$ 2,500.00	$0
J. Gas w/in Sleeve	0	LF	$ 50.00	$0
K. Cable w/in Sleeve	0	LF	$ 25.00	$0
L. T-Phone w/in Sleeve	0	LF	$ 25.00	$0
M. Electric w/in Sleeve	0	LF	$ 25.00	$0
N. Electric (hung from pier)	0	LF	$ 35.00	$0
O. 2" Water Valves	0	EA	$ 500.00	$0
P. Backflow Preventor	0	EA	$ 1,000.00	$0
			SUBTOTAL	**$0**

7. SITE LIGHTING				
A. Level A 'High Build'				
1. Pole Foundations, 24" Dia. (Pre-cast)	198	EA	$ 1,500.00	$297,000
2. Twin Hess Pollux Light Fixture (250 Watt Metal Halide) Mounted on 30' High Pole	95	EA	$ 9,560.00	$908,200
3. Single Hess Pollux Light Fixture (250 Watt Metal Halide) Mounted on 30' High Pole	103	EA	$ 8,010.00	$825,030
4. Underground Feeder Cable (includes exc. and backfill)	13,760	LF	$ 14.00	$192,640
5. Specialty Lighting (20 Per Area)	140	EA	$ 9,000.00	$1,260,000
6. Demolition of Existing Footings	143	EA	$ 300.00	$42,900
			SUBTOTAL	**$2,222,870**
B. Level B 'Low Build'				
1. Retrofit Existing Footings	143	EA	$ 300.00	$42,900
2. Twin Sterner Light Fixture (Grand Central) (250 Watt Metal Halide) Mounted on 25' High Pole	56	EA	$ 7,700.00	$431,200
3. Single Sterner Light Fixture (Grand Central) (250 Watt Metal Halide) Mounted on 25' High Pole	85	EA	$ 4,020.00	$341,700
			SUBTOTAL	**$815,800**

DESCRIPTION OF ITEM	QUANTITY	UNITS	UNIT COST		TOTAL COST
8. LANDSCAPE PLANTING					
A. Level A 'High Build'					
1. Trees, furnished and planted, 3.5"-4" Caliper	243	EA	$	1,500.00	$364,500
2. Misc. Plant Material, Purchased & Planted	0	EA	$	40.00	
3. Drainage For Planters	0	LF	?		
4. Soil For Tree Pits	174	Truck	$	500.00	$87,000
				SUBTOTAL	**$451,500**
B. Level B 'Low Build'					
1. Trees, furnished and planted, 3.5"-4" Caliper (35' O.C.)	132	EA	$	1,500.00	$198,000
2. Soil For Tree Pits	86	Truck	$	500.00	$43,000
				SUBTOTAL	**$241,000**
				TOTAL - (A Finishes Included)	**$48,892,490**
				20% CONTINGENCY	**$9,778,498**
				ESTIMATED COST	**$58,670,988**
				SAY	**58.7 million**
				TOTAL - (B Finishes Included)	**$38,335,320**
				20% CONTINGENCY	**$7,667,064**
				ESTIMATED COST	**$46,002,384**
				SAY	**46.1 million**

Notes:

1. Costs are preliminary and are for budgetary purposes only. Unit costs are based on several sources and are approximate.
2. Festival Sheds and Kiosks figures are based on open-air structures with no walls (interior or exterior) or amenities.
3. Cost does not include traffic control, temporary improvements, permits, or fees that may be required.
4. Underlying removal of pavement material does not include removal/ demolition of concrete pavement, cobblestone, or any other paving materials or obstructions.
5. Subway stairs/ stations adjustments, removal, and installation are not included in cost estimate.
6. Kiosk construction/ installation not included in cost estimate.
7. No Structural Slabs @ vaults or subway strair, concourses, etc.

Appendix C

Rubber-Tired Surface Transit Systems

Automated vehicle guidance technology is now well proven and totally reliable, allowing accuracy of better than +/- 5mm. Vehicle guidance systems can be classified as:

a) Physical guidance

- Central guidance rail: In a pedestrian environment, this would have to be below grade. There is an example in Nancy, France, where a central rail guides what is essentially a trolley bus.

b) Automated computer control vehicle guidance technology, utilizing computers and sensors based on several different methods including:

- Optical
- Buried wire
- Radar
- Magnetic

Some systems rely entirely on following sensors. These have only been used in taxi-sized vehicles, such as the Dutch FROG system. These are pre-programmed and only use the sensors to confirm minor variations such as variations in tire pressure.

Automatic guidance – its advantage and disadvantage relative to physical guidance:

- Most systems require very little installation in the roadway (e.g. a small magnet every 4m (12 ft). This readily allows creation of temporary diversions to facilitate access to utilities.
- The main disadvantage with automated guidance can be the difficulty of demonstrating the safety case to the transit authorities issuing licenses.

Appendix D

Details of Impacts on Existing Surface Transit Systems

The methodology for costing services operated by MTA NYC Transit is derived as follows:

- Bus Operator labor uses the top rate effective June, 2004, which is $23.575. This rate will, however, increase by 3% in December, 2004.

- Labor hours, service levels, running times, vehicle requirements, and vehicle miles are derived from route schedules dated April 12, 2004, and in effect in June, 2004.

- Maintenance costs are derived from actual 2003 mileage of Manhattan buses and actual gross 2003 maintenance expenditures on those same buses.

- Fuel costs are an estimate based on 2 miles-per-gallon reflecting the inefficiency of low-speed, frequent-idling Manhattan operations and the generally more favorable and tax-free contract price enjoyed by NYC Transit. These factors translate into a $0.67 composite rate. While this is probably the least precise and most volatile of the cost measures, it is also the smallest.

- Overhead, capital, employee benefit, and management costs are not included. These costs are potentially significant but would not be realized on day-one of light rail operation and may never be fully realized. A further detailed and longer term analysis is necessary.

New York Waterway's bus services are operated privately and independent of New York City Transit's. New York Waterway has been very cooperative in providing information on their routings and service levels along 42nd Street. However, as a private enterprise, their records are not open for inspection, and they have elected not to provide financial data. Because they are not bound by the labor requirements of NYC Transit and operate a less sophisticated fleet, we have applied lower costs to their operation, specifically $20 per vehicle (not pay) hour. Maintenance costs were assigned at approximately 89% of NYC Transit's level. And fuel costs were allocated at $0.80 per mile to reflect more efficient equipment and operating speed, but less advantageous pricing and the inclusion of taxes.

Replaced bus services:

D.1 M42, 42nd Street Crosstown Route

The M42 bus follows a routing virtually identical to the 42nd Street Light Rail line. The bus carries approximately 5 million passengers per year. A maximum of 27 vehicles (excluding spares) is required to provide service. The route operates 283,511 miles per year. Its continued operation would be precluded by the light rail line, and it is anticipated that no alteration of it would be necessary; the light rail line will accommodate all M42 riders. Because of this, the entire cost of its operation will be deemed to be saved, without loss of ridership. These savings have been estimated, based on Spring 2004 schedules, as follows:

* Bus Operator labor (@ $24.2823/hour + 35% for benefits)	$3,055,128
* Fuel	$189,952
* Maintenance	$497,425
* Operations Manager (1@ $90,000 + 25% for benefits)	$121,500
TOTAL	**$3,864,005**
* Capitalized cost of 31 buses, including spares (@ $450,000 ea.)	$13,950,000

These savings reflect only direct costs. Among the other costs not included here are:

- Overhead costs for management, supervision, and support services.
- Overhead costs associated with employee benefits.
- Capitalized costs of garage and maintenance facilities.

D.2 M104, Broadway-42nd Street Route.

This 6.5-mile-long bus route runs along Broadway from Harlem to 42nd Street, and then along 42nd Street as far east as the FDR Drive. M104 is the 13th-heaviest bus route in New York, carrying approximately 10.5 million riders per year. It operates 844,612 miles annually, and requires 34 buses (excluding spares) to provide scheduled service during peak periods. The 11/4-mile segment of M104 that runs along 42nd Street will no longer be available to buses once the light rail line is in operation. It is proposed that the M104 be extended south along Seventh Avenue for one block to West 41st Street, then west along West 41st Street to Eighth Avenue, from whence it will commence its northbound trip. 41st Street is currently both a route and terminal for M27 buses, so it should be appropriate and acceptable for use by the truncated M104. Each of these is considered in greater detail in Appendix B. This new terminal will actually offer more attractive and convenient service to users of the Port Authority Bus Terminal.

Under this plan, current through-riders on the M104 will have to transfer to the light rail line. This will be done conveniently through a combination of a bus stop north (nearside) of 42nd Street with a light rail stop west of Seventh Avenue, so that transferees may have less than a 100' walk between vehicles. (Note: the relocation of the bus stop to the nearside of 42nd Street is only possible because conflicting right turn movements have been obviated by the closing of 42nd Street to other vehicular traffic). The convenience of frequent service on both routes – generally every 5-minutes or less at most times – makes this option feasible. In addition, westbound customers, in particular, will have their transfer time offset by the speedier travel time of the light rail. For much of the day, westbound M104 buses are scheduled at an average speed of 4 mph, approximately half that anticipated for the light rail. Based on this, customers will save 5 minutes or more of travel time via light rail along 42nd Street vs. their historic bus trip time.

Cost reductions realized by truncating Route M104 were calculated off Spring 2004 schedules. Labor savings were based on a 22.5% reduction in running time, while fuel and maintenance costs were based on a 19% reduction in mileage. These annual savings are summarized below:

* Bus Operator labor (@ $24.2823/hour + 35% for benefits)	$1,156,482
* Fuel (@ $0.67/mile)	$107,519
* Maintenance	$281,558
TOTAL	**$1,545,559**
* Capitalized cost of 8 buses, including spares (@ $450,000 each.)	$3,600,000

The indirect costs detailed for M42 (above) are also excluded here. This change in M104 will also yield a fleet reduction of 8 buses, including spares.

D.3 Staten Island Express Bus Services

Along 42nd Street, between Lexington and Tenth Avenues, New York City Transit operates three express bus routes from Staten Island. These routes use the Lincoln Tunnel rather than the Verrazano Bridge route followed by all other NYC Transit Staten Island buses. The three routes, X22, X30, and X31 operate during weekday rush hours only. X30 runs eastbound along 42nd Street in the morning and westbound in the afternoon. X22 and X31 run only westbound along 42nd Street, and only in the afternoon. The total number of one-way trips all of these buses make along 42nd Street is 59 per weekday under current (June 2004) schedules. These routes will need to be relocated. There are various approaches to doing this, including use of nearby parallel streets, reversing midtown routings so buses go north, then west, then approach the tunnel from the north, or using the light rail and local buses to access more radically rerouted expresses. The last may be least palatable, as it goes against the underlying one-seat-ride principle of premium-fare express services. The first may require some traffic or priority treatments. The choice and detailed solution should be left to NYC Transit. For purposes of this study, though, the two significant conclusions are that:

- there are feasible solutions, and
- none of the solutions generate significant costs or savings that might impact this analysis.

D.4 New York Waterway Distributor/Collector Buses

The last significant transit use to be accounted for on 42nd Street is the bus service connecting with the ferries to New Jersey west of Twelfth Avenue. These are available to ferry riders without payment of a separate fare, and are an essential element of what has made the New York Waterway ferries successful. During peak periods, buses use 42nd Street as a stand-alone route; during other hours, buses use 42nd Street as part of a loop that includes 34th Street. Buses operate seven days a week over a 1.8 mile route. During the course of a year, 32,264 trips are made, carrying over 750,000 customers. Subject to an interline agreement with the light rail operator, the New York Waterway service could be fully replaced and its passengers accommodated on the light rail line. The resultant cost savings to New York Waterway is estimated to be:

* Labor (@ $20 per vehicle hour)	$430,400
* Estimated maintenance (@ $1.55/mile)	$90,000
* Estimated fuel (@ $0.80/mile)	$46,460
TOTAL	**$566,680**

New York Waterway is under no obligation to redirect these savings. However, requiring ferry riders to fully absorb the cost of light rail would be a de facto fare increase with likely negative effects on ferry ridership. Were New York Waterway to turn this money back to subsidize its riders using light rail, it would cover only 74 cents of the cost of each trip. There are clearly cost savings and implications involving New York Waterway, but they will have to be left to negotiations between the parties. For purposes of this study, we have dimensioned this operation. It is further estimated that this service uses the equivalent of 8 buses, including a spare.