NORTH CAMBRIDGE RAILROAD SAFETY STUDY
Cambridge, Massachusetts

June 1994

Prepared for:
The City of Cambridge
Community Development Department

By:
Wallace, Floyd, Associates Inc.
Architects, Landscape Architects, Planners, Urban Designers

In association with:
Gordon, Bua & Read, Inc.
Consulting Engineers

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CAMBRIDGE, MASSACHUSETTS
June 1994

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Special Thanks to Mike Inemer, CHA for the use of the Jefferson Park Meeting Room

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INTRODUCTION

This study was commissioned by the Cambridge Community Development Department in response to a request from the North Cambridge Stabilization Committee (NCSC) to study safety issues around the MBTA Commuter Rail tracks in North Cambridge. A committee was formed with representatives from the NCSC, Walden Square Apartments, Jefferson Park Housing and Fresh Pond Apartments to oversee the progress of the study.

The Project Area runs along both sides of the tracks from Alewife Brook Parkway to Walden Street. At the western end, near Alewife Brook Parkway, the tracks run between Fresh Pond Mall and Danehy Park on the south and Fresh pond Apartments and Jefferson Park residential developments on the north. The rest of the Project Area is mostly residential.

Because of the limited number and inconvenience of the existing railroad crossings in the area, and the strong desire of local residents to go between destinations on opposite sides of the tracks, a number of people walk across and/or along the tracks, creating the potential for serious accidents.

The purpose of this study was to look at the existing conditions which contribute to the safety problems, and assess alternative solutions to those problems. In addition to site inspections, community meetings and surveys, and conversations with local officials to assess existing conditions and community concerns, other locations with similar situations were reviewed for potential solutions. Finally, a series of alternative solutions were developed and evaluated for community and railroad acceptance, effectiveness and cost. Based on those evaluations, recommendations for future actions have been developed.

PART 1: EXISTING CONDITIONS AND COMMUNITY CONCERNS

Information was collected from the following sources:

- The City and the Railroad Safety Task Force meetings
- Site observations
- The Railroad Safety Task Force's survey on issues and concerns
- The first public meeting held on November 9, 1993.

Detailed information from each of these sources follows the summary.

Summary of Use Studies

There are four general kinds of use of the railroad right-of-way (ROW):

- People crossing the tracks because it is the easiest and most direct route to their destinations. In some cases (for the elderly and those who are less mobile) it may be the only route they are physically capable of taking.

- People using the ROW as a linear neighborhood connector because it is the easiest and most direct route to their destinations.

- People (mostly teens and younger children) playing in the ROW Some of this play includes "playing" with the trains (e.g., playing "chicken" or putting things on the tracks).

- People running onto the tracks to retrieve balls.

Crossings occur in three major locations (see **Illustration 1a** for a project area map and **Illustration 1b** for pedestrian activity in the project area):

- At Yerxa Road between Walden Square, Richdale Avenue and the Fitzgerald School. People crossing here include Fitzgerald School children and parents, teen center users, people crossing to use the Rindge Avenue bus and the school bus that stops at Yerxa Road, people going to work and others. At the time of year the site observations were done (November 1993) this crossing received the heaviest and most regular use, and the most use by children.

- Between Jefferson Park and Danehy Park. There are two crossings into Danehy Park although the western one appears to be more frequently used. People crossing here include Jefferson Park residents as well as people coming to the park or shopping plaza by bus (they get off the bus at Jefferson Park and walk down the ROW to avoid mounds of earth at Fresh pond Apartments). Elderly people were observed using this crossing.

Illustration 1a
Project Area

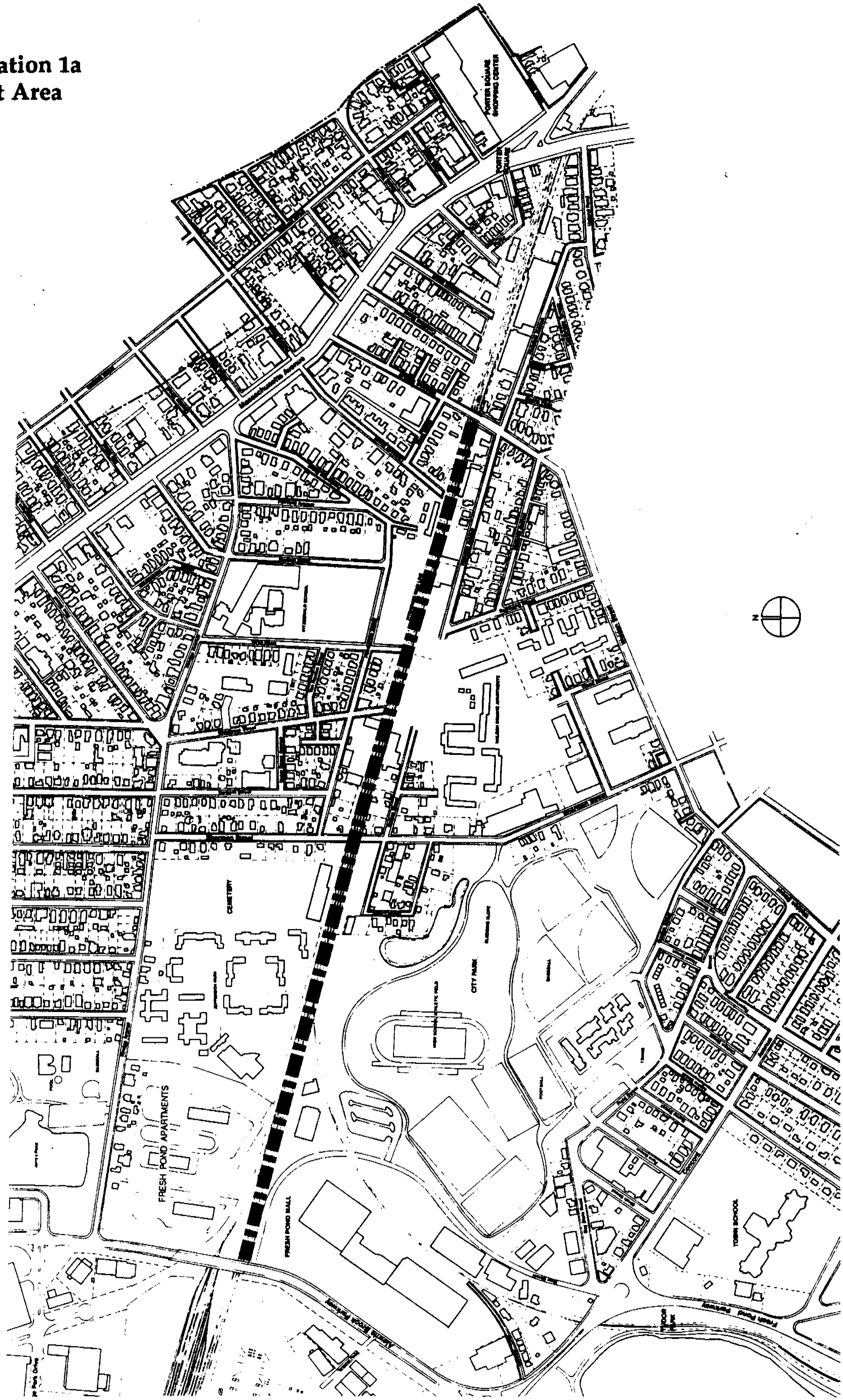
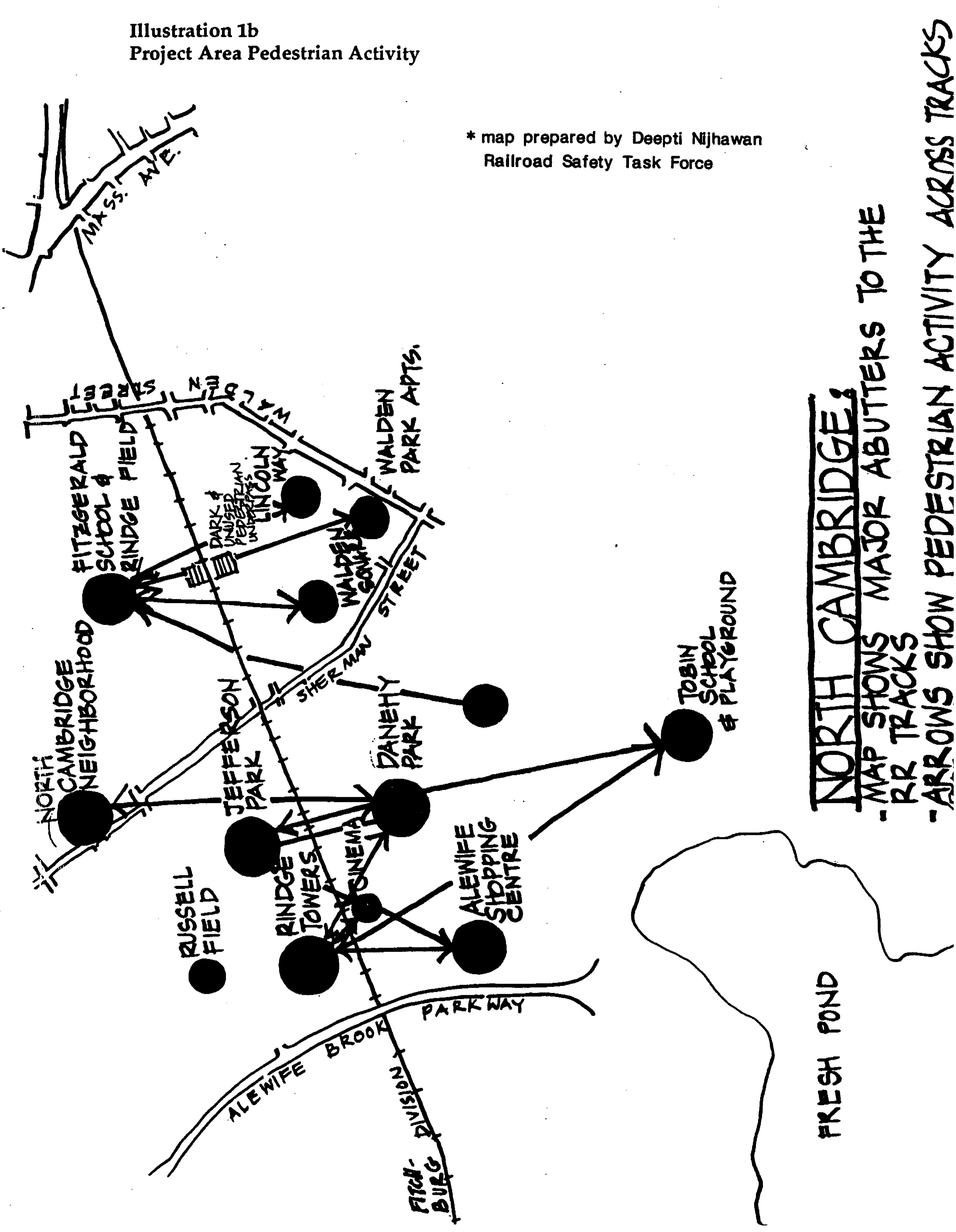


Illustration 1b
Project Area Pedestrian Activity



* map prepared by Deepti Nijhawan
Railroad Safety Task Force

- <u>Between Fresh Pond Apartments and the Fresh Pond Shopping Center.</u> There are two crossings into Fresh Pond Apartments - one by the Alewife Brook Parkway bridge and one by the mound of earth at Building 362. There are also two commonly used crossings into the shopping plaza - one by the cinema and one into the main parking lot. A number of elderly people were observed using the crossing into the main parking lot.

The ROW between Sherman Street and the Alewife Brook Parkway bridge is the most popular as a neighborhood connector. Site observations indicate that the shopping center is the most common destination. Members of the Railroad Safety Task Force have indicated that the ROW between Sherman Street and the Yerxa Road connection is also used. However, this was not observed during the site visits.

Specific locations where residents mentioned that children were playing in the ROW include behind Jefferson Park, by Belles Circle, and at the Sherman Street crossing. People also run onto the ROW to retrieve tennis balls by the Yerxa Road crossing.

<u>Seasonal Use Considerations</u>

As this study was completed within one season (winter), the following seasonal use considerations are based on information gathered from residents, the Railroad Safety Task Force and the City.

- The Alewife Brook Parkway bridge is particularly treacherous in the winter when it is icy and the sidewalks are not cleared. This leaves the residents at Fresh Pond Apartments and Jefferson Park the alternative of walking as far as Sherman Street to cross legally - this route is very indirect, particularly for Fresh Pond Apartments residents, and may be too difficult for the elderly, infirm or very young children.

- The trains are very quiet and the sound absorptive qualities of snow make it very difficult to hear a train before it arrives in the winter.

- Danehy Park attracts many more people in the fair weather. The crossing by Jefferson Park (and perhaps by Fresh pond Apartments) is far more heavily used in the summer (one resident stated 5 times higher). There are field sports programmed by the City in Danehy Park, from April to early November. However, it is general use of the park that attracts ROW crossers rather than any particular game scheduled at particular times. Peak use of Danehy Park is in the summer from approximately 11 am to 1 pm and weekdays at around 6 pm (when people return from work). The Jefferson Park - Danehy Park crossing may be more actively used during these times.

- The use of the ROW as a path or neighborhood connector is heaviest in the summer.

- The Yerxa Road crossing is heavily used during the school season. However, it is also regularly used by the teen center year round (including evenings) and for the Fitzgerald School summer program.

Site Observations

The major crossings were observed in October and November at the following times:

Yerxa Road	weekday from 7:50 am to 9:20 am November 4, 1993
Jefferson Park to Danehy Park	Saturday from 10:40 am to noon November 6, 1993
Fresh pond Apartments to Shopping Plaza	Saturday from 10:40 am to noon October 30. 1993

At Yerxa Road on a weekday morning, there was a total of 85 crossings in a period of 1 hour and 30 minutes; 43 of them were school children. Most people were going to the school but a number were going to work, shop or to just take a walk. Most of them indicated that they would be crossing the tracks again in the afternoon. For the children and adults going to the school, the crossing back was typically between 2:30 pm and 3:00 pm. The basketball and tennis courts by the Fitzgerald School have programmed games in the summer which attract some additional crossing of the tracks. In addition, the teen center and bus stop on Rindge Avenue attract track crossings in the evenings (at the November 9 public meeting one resident stated that there are groups of teens that cross at approximately 9:30 pm when the center closes).

Adults and a number of children observed glanced down the ROW before crossing. When a train approached, a few people would stop and others would follow. In general, children are less cautious than adults.

At the crossing from Jefferson Park to Danehy Park, four young to middle-aged adults and two elderly adults were observed crossing; three of these people crossed back (a total of 9 crossings in a period of 1 hour and 20 minutes) and three walked along the ROW using it as a path. Three people crossed into Danehy Park, while three people walked along the ROW to the shopping plaza (two people came from the Sherman Street direction). It should be noted that residents at the November 9 community meeting stated that the summer use of the crossing into Danehy Park is up to 5 times the winter use. Danehy Park has scheduled games during warm weather seasons on weekends starting at 8 am and after school starting at 3 pm. Peak use of Danehy Park is in the summer on weekends from approximately 11 am to 1 pm and weekdays at around 6 pm when people return from work. The crossing from Jefferson Park to Danehy Park may be more heavily used at these times.

At the crossing between Fresh pond Apartments and the shopping plaza 23 people crossed and one person (an elderly man) crossed back (a total of 24 crossings in a period of 1 hour and 20 minutes). Pedestrians varied in age from children (accompanied by adults) to elderly people. Of the 25 crossings, 6 were by elderly people, 17 were by young to middle-age adults and 2 were by children (accompanied by adults).

(See **Appendix A** for on-site notes of people crossing the tracks.)

Community Survey Results

Survey forms were distributed at Fresh pond Apartments, Jefferson Park and Walden Square by members of the Railroad Safety Task Force, at the November 9 public meeting, and at the Fitzgerald School by the Principal. The survey was conducted as a means of obtaining information on use and neighborhood concerns from people that may have been unable to attend the public meeting. Responses were compiled by a member of the Railroad Safety Task Force, the Cambridge Community Development Dept. and Wallace, Floyd, Associates Inc. Results are as follows:

- Eighty surveys were completed, including 33 from residents at Fresh pond Apartments, 22 from residents at Jefferson Park, 9 from residents at Walden Square and 16 from people who lived in other locations. *(It should be noted that a resident stated at the November 9 public meeting that several people did not want to fill out the survey for fear of later receiving fines for trespassing.)* The majority of the people that responded to the survey were adults between the ages of 21 and 60.

- Most respondents walk across the tracks to shop (the heavy school associated use at Yerxa Road is not apparent in the survey). The cinema and Danehy Park are common destinations from Fresh pond Apartments and Jefferson Park.

- Weekend and weekday use is fairly evenly distributed.

- Twenty eight of the seventy five people who responded to the question on crossing, cross weekly; twenty one cross daily (once or twice a day); ten cross several times a day; and sixteen cross infrequently.

- Heaviest use is during the afternoon to early evening (again, the very heavy school associated use at Yerxa Road is not indicated by the survey).

- The preferred "solutions" varied by place of residence:

  - Most respondents at Fresh pond Apartments listed a pedestrian bridge (although, they may not be aware of the height that they will need to climb to go over the tracks) and having the trains sound their whistle as the preferred alternatives; slowing the trains down was the second preferred alternative and putting the trains underground was noted third.
  - Most respondents at Jefferson Park favored an at-grade crossing; a pedestrian bridge was the second preferred alternative.
  - Of the nine respondents at Walden Square, six favored a pedestrian overpass, two favored having the trains sound their whistle, two favored putting the trains underground and one favored having the trains slow down.
  - Of the remaining 16 respondents from other places of residence, six preferred a pedestrian overpass, five favored putting the trains underground and five favored having the trains sound their whistles.

- The majority of people said they would use a legal crossing if it was located within one block of where they cross. Eleven people said they would not use a pedestrian bridge, sixteen people would not use an underpass (eight of these people appear to use the Yerxa Road crossing where the existing underpass exists) and fifteen people would not use an at-grade crossing (nine of these live near the Yerxa Road crossing and the survey was not clear to all that the crossing would be a safe one as indicated by one of the comments listed below). The majority of respondents said they would use a bus at least some of the time if one were available.

- Most respondents did not know of people that had been hurt or killed on the tracks and most that had heard of the accidents and deaths did not have specific information

Comments from the November 9 Public Meeting

Similar comments regarding use were made at the November 9 public meeting. Major issues discussed included:

- Children playing on tracks
- Safety of underpasses
- Specific solutions such as barriers, buses, alarms, depressing the railroad, and hiring a crossing guard

(See **Appendix B** for a listing of all comments.)

PART 2: RAILROAD ISSUES

Information on the ROW

The Study Area is on the former B&M Fitchburg Division, now the MBTA's Fitchburg Line. There are four tracks between Sherman Street and the Alewife Brook Parkway Bridge. They are:

- Two main-line tracks
- Lead to East Yard and Watertown Branch
- Lead to North Yard and former Lexington Branch

Currently, train operations are as follows:

- Commuter (See **Illustration 2** for a current train schedule).
  -32 daily (16 each way)
  -5 morning and 5 evening peak period trains (peak period is from 6 am to 9 am and from 4 pm to 7 pm)
  -16 Saturday (8 each way)
  -14 Sunday and holidays (7 each way)

- Freight
  -Local 3 times per week (usually M-W-F)
  -Container train once a month (average)

- Speeds
  -60 MPH passenger, 40 MPH freight through Study Area on main line tracks
  -Yard speed (10 MPH) on lead to East Yard and Watertown Branch
  -There is a 55 MPH speed restriction on the main-line tracks between Walden Street and the Alewife Brook Parkway bridge.

- Track Geometry
  -Tangent (straight) in the Study Area
  -Ascending grade (incline) from the west in the Study Area

- Signals
  -West Cambridge: interlocking (the arrangements of signals and signal appliances are interconnected so that movements must succeed each other in proper sequence).
  -Sherman Street: grade crossing

Illustration 2
Train Schedule

MONDAY THROUGH FRIDAY

INBOUND		Train No.	404	408	410	412	454	456	418	420	422	424	466	468	472	434	476	438
READ DOWN	ZONE		A.M.	A.M.	A.M.	A.M.	A.M.	A.M.	A.M.	A.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.
Dep: Fitchburg	9	O	5 45	6 30	6 55	7 15			10 29	11 24	1 05	3 05				7 05		10 30
North Leominster	9		5 52	6 37	7 02	7 22			10 36	11 31	1 14	3 12				7 12		10 37
Shirley	8		5 59	6 44	7 09	7 30			f10 43	f11 38	1 21	3 19				f7 19		f10 44
Ayer	8	O	6 04	6 49	7 14	7 36			f10 48	11 43	1 26	3 24				7 24		10 49
Littleton/Rte 495	7		6 15	7 00	7 25	7 47			10 59	11 54	f1 37	f3 35				f7 35		f11 00
South Acton	6		6 26	7 11	7 36	7 58	8 30	9 25	11 10	12 05	1 48	3 46	4 11	5 15	6 40	7 46	8 40	11 11
West Concord	5	O	6 31	7 16	7 41	8 03	8 35	9 30	11 15	12 10	1 53	3 51	4 16	5 20	6 45	7 51	8 45	11 16
Concord	5	O	6 35	7 20	7 45	8 07	8 39	9 34	11 19	12 14	1 57	3 55	4 20	5 24	6 49	7 55	8 49	11 20
Lincoln	4	O	6 41	7 26	7 52	8 13	8 45	9 40	f11 25	f12 20	2 03	4 01	4 26	5 30	6 55	8 01	8 55	11 26
Hastings	3		6 45	7 30		8 18	8 49	f9 44						f5 34				
Kendal Green	3		6 47	7 32		8 20	8 51	f9 46	f11 31		2 09	4 07	4 32	5 36	f7 01	f8 07	f9 01	f11 32
Brandeis/Roberts	2	O	6 50	7 35		8 24	8 54	9 49	11 34	12 28	2 12	4 10	4 35	5 39	7 04	8 10	9 04	11 35
Waltham	2		6 53	7 38	8 01	8 27	8 57	9 52	11 37	12 32	2 15	4 13	4 38	5 42	7 07	8 13	9 07	11 38
Waverley	1		6 58	7 43		8 32	9 02	f9 57	f11 42				f4 42	f5 47			f9 12	
Belmont	1		7 00	7 45		8 34	9 04	f9 59	f11 44	f12 37	f2 20	f4 18	f4 45	f5 49	f7 12		f9 14	
Porter Square	1B	Ⓣ	7 05	7 50	8 10	8 39	9 09	10 04	11 49	12 42	2 25	4 23	4 50	5 54	7 17	8 22	9 19	11 47
Arr: North Station		Ⓣ O	7 15	8 00	8 20	8 49	9 19	10 14	11 59	12 52	2 35	4 33	5 00	6 04	7 27	8 32	9 29	11 57

OUTBOUND		Train No.	453	455	417	419	421	423	465	467	429	431	471	433	475	437	439	401
READ DOWN	ZONE		A.M.	A.M.	A.M.	A.M.	A.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	A.M.
Dep: North Station		Ⓣ O	7 25	8 20	8 50	9 35	11 20	1 20	3 00	4 00	4 50	5 20	5 30	6 15	7 35	8 45	10 30	12 10
Porter Square	1B	Ⓣ	7 35	8 30	9 00	9 45	11 30	1 30	3 10	4 10	5 00	5 30	5 40	6 25	7 45	8 55	10 40	12 20
Belmont	1		f7 40	f8 35		f9 50		f1 35	f3 15	4 15	5 05		5 45	6 30	f7 50	f9 00	f10 45	f12 25
Waverley	1		f7 42	f8 37		f9 52			f3 17	4 17	5 07		5 47	6 32	f7 52	f9 02	f10 47	f12 27
Waltham	2		7 48	8 43	9 10	9 58	11 40	1 42	3 23	4 23	5 13	5 41	5 53	6 38	7 58	9 08	10 53	12 33
Brandeis/Roberts	2	O	f7 52	8 47		10 02	11 44	1 46	3 27	4 27	5 17		5 57	6 42	8 02	9 12	10 57	12 37
Kendal Green	3		7 55	f8 50		f10 05	f11 47	f1 49	f3 30	4 30	5 20		6 00	6 45	f8 05	f9 15	f11 00	f12 40
Hastings	3					f10 07	f11 49			4 32	f5 22		f6 02	f6 47				
Lincoln	4	O	f8 01	f8 56		f10 11	f11 53	f1 55	f3 36	4 37	5 26	5 51	6 07	6 52	f8 11	f9 21	f11 06	f12 46
Concord	5	O	f8 07	9 02	9 24	10 17	11 59	2 01	3 42	4 43	5 32	5 57	6 13	6 58	8 17	9 27	11 12	12 52
West Concord	5	O	f8 11	9 06		f10 21	12 03	2 05	3 46	4 47	5 36	6 01	6 17	7 02	8 21	9 31	f11 16	f12 56
South Acton	6		8 17	9 12	9 31	10 27	12 09	2 11	3 53	4 54	5 43	6 08	6 24	7 09	8 27	9 37	11 22	1 02
Littleton/Rte 495	7				9 42	10 38	f12 20	f2 22			5 54	6 19		7 20		9 48	f11 33	f1 13
Ayer	8	O			9 53	10 45	12 31	2 33			6 05	6 30		7 31		9 59	11 44	1 24
Shirley	8				9 58	10 50	12 36	2 38			6 10	6 35		7 36		10 04	f11 49	f1 29
North Leominster	9				10 05	11 01	12 43	2 45			6 17	6 42		7 43		10 11	11 56	1 36
Arr: Fitchburg	9	O			10 13	11 09	12 51	2 55			6 27	6 50		7 51		10 19	12 04	1 44

SYMBOLS f: Stops to discharge passengers on notice to conductor and to pick up passengers on platform visible to engineer. O: Ticket outlet is located at or near station
Ⓣ : Subway connection ♿: Wheelchair accessible Shaded portion denotes peak hour service

SATURDAY

INBOUND		Train No.	1402	1406	1408	1460	1410	1466	1412	1470
READ DOWN	ZONE		A.M.	A.M.	A.M.	P.M.	P.M.	P.M.	P.M.	P.M.
Dep: Fitchburg	9	O	6 40	9 20	11 15		2 45		5 35	
North Leominster	9		6 47	9 27	11 22		2 52		5 42	
Shirley	8		f6 54	f9 34	f11 29		f2 59		f5 49	
Ayer	8	O	6 59	9 39	11 34		3 04		5 54	
Littleton/Rte. 495	7		7 10	9 50	11 45		3 15		6 05	
South Acton	6		7 21	10 01	11 56	2 25	3 26	5 35	6 16	8 55
West Concord	5	O	f7 26	f10 06	f12 01	f2 30	f3 31	f5 40	f6 21	f9 00
Concord	5	O	7 30	10 10	12 05	2 34	3 35	5 44	6 25	9 04
Lincoln	4	O	7 36	10 16	12 11	2 40	3 41	5 49	6 31	9 10
Kendal Green	3		f7 42	f10 22	f12 17	f2 46	f3 47	f5 56	f6 37	f9 16
Brandeis/Roberts	2	O	f7 45	f10 25	f12 20	f2 49	f3 50	f5 59	f6 40	f9 19
Waltham	2		7 48	10 28	12 23	2 52	3 53	6 02	6 43	9 22
Waverley	1		f7 53	f10 33	f12 28	f2 57	f3 58	f6 07	f6 48	f9 27
Belmont	1		f7 55	f10 35	f12 30	f2 59	f4 00	f6 09	f6 50	f9 29
Porter Square	1B	Ⓣ	8 00	10 40	12 35	3 04	4 05	6 14	6 55	9 34
Arr: North Station		Ⓣ O	8 11	10 51	12 46	3 15	4 16	6 25	7 06	9 45

OUTBOUND		Train No.	1405	1407	1459	1409	1463	1411	1469	1413
READ DOWN	ZONE		A.M.	A.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.
Dep: North Station		Ⓣ O	8 30	11 20	1 20	3 30	4 30	5 30	7 30	11 00
Porter Square	1B	Ⓣ	8 40	11 30	1 30	3 40	4 40	5 40	7 40	11 10
Belmont	1		f8 45	f11 35	f1 35	f3 45	f4 45	f5 45	f7 45	f11 15
Waverley	1		f8 47	f11 37	f1 37	f3 47	f4 47	f5 47	f7 47	f11 17
Waltham	2		8 52	11 42	1 42	3 52	4 52	5 52	7 52	11 22
Brandeis/Roberts	2	O	f8 56	f11 46	f1 46	f3 56	f4 56	f5 56	f7 56	f11 26
Kendal Green	3		f8 59	f11 49	f1 49	f3 59	f4 59	f5 59	f7 59	f11 29
Lincoln	4	O	9 05	11 55	1 55	4 05	5 05	6 05	8 05	11 35
Concord	5	O	9 11	12 01	2 01	4 11	5 11	6 11	8 11	11 41
West Concord	5	O	f9 15	f12 05	f2 05	f4 15	f5 15	f6 15	f8 15	f11 45
South Acton	6		9 22	12 12	2 12	4 22	5 22	6 22	8 22	11 52
Littleton/Rte. 495	7		9 33	12 23		4 33		6 33		12 03
Ayer	8	O	9 44	12 34		4 44		6 44		12 14
Shirley	8		f9 49	f12 39		f4 49		f6 49		f12 19
North Leominster	9		9 56	12 46		4 56		6 56		12 26
Fitchburg	9	O	10 04	12 54		5 06		7 04		12 34

These trains stop at Silver Hill (Zone 3):
408 - 7 28 am, 412 - 8 15 am
471 - 6 05 pm, 433 - 6 50 pm, 475 - 8 08 pm

INBOUND		Train No.	2402	2454	2404	2406	2458	2408	2462
READ DOWN	ZONE		A.M.	A.M.	A.M.	P.M.	P.M.	P.M.	P.M.
Dep: Fitchburg	9		7 50		11 30	2 15		5 25	
North Leominster	9		f7 57		f11 37	f2 24		f5 32	
Shirley	8		f8 04		f11 44	f2 31		f5 39	
Ayer	8		8 09		11 49	2 36		5 44	
Littleton/Rte. 495	7		f8 20		f12 00	f2 47		f5 55	
South Acton	6		8 31	10 35	12 11	2 58	4 20	6 06	8 35
West Concord	5	O	f8 36	f10 40	f12 16	f3 03	f4 25	f6 11	f8 40
Concord	5	O	8 40	10 44	12 20	3 07	4 29	6 15	8 44
Lincoln	4	O	8 46	10 50	12 26	3 13	4 35	6 21	8 50
Kendal Green	3		f8 52	f10 56	f12 32	f3 19	f4 41	f6 27	f8 56
Brandeis/Roberts	2	O	f8 55	f10 59	f12 35	f3 22	f4 44	f6 30	f8 59
Waltham	2		8 58	11 02	12 38	3 25	4 47	6 33	9 02
Waverley	1		f9 03	f11 07	f12 43	f3 30	f4 52	f6 38	f9 07
Belmont	1		f9 05	f11 09	f12 45	f3 32	f4 54	f6 40	f9 09
Porter Square	1B	Ⓣ	9 10	11 14	12 50	3 37	4 59	6 45	9 14
Arr: North Station		Ⓣ O	9 20	11 25	1 01	3 48	5 10	6 56	9 25

OUTBOUND		Train No.	2453	2403	2457	2405	2461	2407	2409
READ DOWN	ZONE		A.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.
Dep: North Station		Ⓣ O	9 30	12 00	3 00	5 30	7 30	9 35	11 00
Porter Square	1B	Ⓣ	9 40	12 10	3 10	5 40	7 40	9 45	11 10
Belmont	1		f9 45	f12 15	f3 15	f5 45	f7 45	f9 50	f11 15
Waverley	1		f9 47	f12 17	f3 17	f5 47	f7 47	f9 52	f11 17
Waltham	2		9 52	12 22	3 22	5 52	7 52	9 57	11 22
Brandeis/Roberts	2	O	9 56	12 26	3 26	5 56	7 56	10 01	f11 26
Kendal Green	3		f9 59	f12 29	f3 29	f5 59	f7 59	f10 04	f11 29
Lincoln	4	O	10 05	12 35	3 35	6 05	8 05	10 10	11 35
Concord	5	O	10 11	12 41	3 41	6 11	8 11	10 16	11 41
West Concord	5	O	f10 15	f12 45	f3 45	f6 15	f8 15	f10 20	f11 45
South Acton	6		10 22	12 52	3 52	6 22	8 22	10 27	11 52
Littleton/Rte. 495	7			f1 03		f6 33		f10 38	f12 03
Ayer	8			1 14		6 44		10 49	12 14
Shirley	8			f1 19		f6 49		f10 54	f12 19
North Leominster	9			1 26		6 56		11 01	12 26
Fitchburg	9			1 34		7 04		11 09	12 34

HOLIDAYS

REGULAR SERVICE
Martin Luther King Day
Patriots' Day
Bunker Hill Day • Columbus Day
Veterans' Day

SATURDAY SERVICE
Presidents' Day
Independence Day

SUNDAY SERVICE
Memorial Day
Labor Day • Thanksgiving Day

NO SERVICE
Christmas Day • New Year's Day

Accidents within the ROW

Amtrak's chronological record of delays and unusual occurrences and the Cambridge Police Department records indicate two fatalities since 1987:

- 11/19/87 - behind 364 Rindge Avenue
- 3/11/93 - west of Sherman Street grade crossing

In addition, the Cambridge Police Department has record of an accident in Porter Square resulting in "multiple injuries".

Information on previous accidents and fatalities and more detailed information on the fatalities noted above was not available from Amtrak, the MBTA or the City. Articles in the Cambridge Chronicle Certificates of Death included the following information:

- Michael Doiron was struck and killed by a train behind Jefferson Housing in 1973. He was 13 years old.

- Michael Rafferty was struck and killed in July of 1973, near the project area. He was 11 years old.

- Russell Bothelho was struck by a train in 1974. The article (written in 1977) does not state that he was killed. He is described as a "youth".

- Marylynn Ryley was killed between 2 crossing trains in June, 1977 as she crossed the tracks on her way to work at "Deli Delight" in the shopping plaza. She was 35 years old.

- David Burrell, a 27 year old man from Burlington, was killed by a commuter train between Fresh pond Apartments and the Fresh Pond Shopping Center while crossing the tracks with friends on May 1, 1984.

- Charles Zabitis, a 67 year old man who lived at 402 Rindge Ave., was killed by a commuter train on November 19, 1987. He had entered the ROW through a whole in the fence at the Fresh Pond Shopping Center. He was described as having difficulty hearing and seeing.

- Elizabeth Richer, a 45 year old woman who resided at Fresh pond Apartments, was killed by a commuter train at 12:30 PM on March 11, 1993. She was either coming from or going to the Fresh Pond Mall. (A photo in the Chronicle shows that the area was snow covered).

(See **Appendix C** for copies of police reports, death certificates and newspaper articles).

Safety Criteria Used in New England ROW's and Other Parts of the Country

The primary direction in railroad safety is to separate the train traffic from pedestrians (and automobiles). Criteria and methods generally used include:

- Restricting access to the Railroad ROW by constructing barriers and fencing

- Designing at-grade crossings in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) (*Note that a grade-crossing initiative by a former Federal Railroad Administration Administrator called for elimination of redundant grade crossings (approximately 25% of the nation's grade crossings)*, and recommended grade separations and improved warning systems.

- Instituting public education programs such as Operation Lifesaver. (See **ALTERNATIVES ANALYSIS** - Institute Safety Programs and **Appendix F** for information on Operation Lifesaver).

Regulations and Guidelines for Track Crossings

- At-grade crossings require railroad, County and Department of Public Utilities' approval. Design must be in accordance with state and federal design standards, particularly the MUTCD.

- Overhead crossings, which include pedestrian bridges, must meet design standards for the particular type of structure (e.g., AASHTO for a bridge), as well as the requirements of the railroad (including design and construction standards and vertical and horizontal clearances). Project (and design) approval must be obtained from the railroad and PUC.

- Undergrade crossings must meet the requirements of the railroad, which include vertical and horizontal clearances and loading of the trains. Project (and design) approval must be obtained from the railroad.

Similar Conditions in Massachusetts

Information was gathered from the Railroad Safety Task Force, the railroads and legal decisions. (For a summary of legal decisions in Massachusetts see **Appendix D**).

Four specific locations where similar problems have existed in Massachusetts include:

- **Belmont High School**: The railroad ROW (on the Fitchburg line) is frequently crossed for access to the Belmont High School from residential areas on the opposite side of the tracks. The fence is continually cut in this location. In 1982 a fourteen year old student was hit by a commuter train while crossing the tracks on his way to school. The Town of Belmont asked the MBTA to design an underpass at this location (the tracks are elevated on an embankment). The underpass was designed by the B&M (the operator of the commuter services for the MBTA), but was not constructed due to lack of funds.

- **Tufts University**: As part of a building expansion project, Tuft's University hired a consultant to study and provide preliminary designs for a pedestrian bridge which would connect the new science complex with the student parking lot. A walkway system connecting the pedestrian bridge with the lot and science building was also designed . The pedestrian bridge was not built due to a lack of funds. Access to the parking lot and new science building was made available over an existing highway bridge.

- **Joseph Pine School in Lowell**: In the 1980's the school served kindergarten through junior high school students. Children and teens accessed the ROW and crossed the tracks or "played" in the ROW through a fence in disrepair. An eleven year old had his arm severed in 1981 when he tripped and fell into a train while walking parallel to the moving train. A school representative stated that since that time the fence has been repaired, the school now serves kindergarten through fourth grade and the children are bussed. She did not think the tracks were still being crossed. To her knowledge, they have not had any safety programs in the school.

- **City of Westfield - Whitney Playground**: A shortcut over a trestle bridge and freight train tracks which serves as a neighborhood connector and a connection to a park, popular with teenagers, is frequently used by teenagers and adults (according to the description in a legal decision). There is a public bridge over the Westfield River and the tracks approximately 500 feet from the shortcut. In 1981 a sixteen year old and an eighteen year old were struck and killed by a freight train after leaving the city park. There have not been safety improvements made (according to a City of Westfield Law Department representative) because it is not City property.

Solutions Used in Other Locations

The following railroads were contacted and asked how they deal with pedestrian safety:

- Providence and Worcester Railroad
  Richard Fisher - Director of Rules and Regulations

- Conrail (Consolidated Rail Corp, based in Philadelphia, PA)
  Ron Goble - Assistant Director of Safety

- Metro-North Commuter Railroad Company, New York, NY
  Jim Griffin

- Commuter Rail Board (Metra), Chicago, IL
  Don Ward - Manager of Safety

- Conn DOT, Hartford CT
  David Chase - Rail Operations

- Greater Cleveland Regional Transit Authority
  Tom Rabe - Safety Department

In summary, the railroads have responded with safety programs, fencing or planting, signage, and blowing horns at grade crossings. Existing grade crossings are primarily street crossings or at stations. There has been much work done in recent years to up-grade warning systems at grade crossings. Some of the railroads have overpasses and/or underpasses. There was some concern regarding objects thrown at trains from overpasses.

Safety programs were noted by most railroads as the most effective deterrent to railroad related accidents. Operation Life Saver (OLS) was noted by a number of the railroads as an effective safety program. OLS is a nationwide non-profit program which trains representatives to give safety training. The safety programs are most frequently given through the schools and educational tools are age appropriate. In addition to school programs, Metro-North Commuter Railroad Company provided OLS with use of a locomotive for a weekend to stop at towns and give safety talks at stations along the route. They also have open houses and set up safety booths to familiarize the public with grade-crossings.

For more detailed notes on conversations with the above noted railroads, see **Appendix E.**

PART 3: ALTERNATIVES ANALYSIS

The alternatives which follow were identified by:

- the Railroad Safety Task Force
- the City of Cambridge
- the North Cambridge Stabilization Committee
- attendants at the November 9,1993 Public Meeting

The alternatives are listed in order from least expensive to most expensive. Alternatives in the first group investigate potential "short-term" solutions such as means of informing the public about railroad safety issues (the majority of respondents to the community survey were not aware of the accidents or deaths that have occurred) or improving warning systems.

Alternatives in the second group of alternatives have been combined in packages as some "alternatives" are not potential solutions to the problem of safety unless they are combined with other "alternatives". The packages of solutions are "long-term" and address the need to separate trains and people and to provide for the community's need to have a legal, reasonable means of access to facilities such as schools, parks and shopping plazas . The R.O.W. is currently being used for this purpose.

GROUP I ALTERNATIVES

Institute Safety Programs

Cost: Operation Lifesaver presenters course costs $20.00 per person - course is to train representatives (school teachers etc.) to give free presentations to community members

Safety programs have been noted by the various railroads contacted (see Data Collection) as one of the most effective deterrents to railroad accidents. Operation Lifesaver is a nation-wide public education program that trains representatives to give safety training on railroad related issues. The program's four areas of concentration are public education about the hazards of grade crossings (presentations are age appropriate), enforcement of grade crossing laws, public awareness of the programs that install and maintain grade crossings, and regular evaluations of the program. Although the program is geared towards combined vehicular and pedestrian crossings, the program's general safety information can help to raise public consciousness.

Operation Lifesaver tries to work with school systems and could train teachers or representatives from the Fitzgerald School, Fresh Pond Apartments Housing, Jefferson Park Housing, Walden Square Apartments, Gately Shelter and local churches and religious organizations.

Presenter's courses are offered in Boston. Attendants must agree to conduct at least four presentations during the year in which they attend the course.

(See **Appendix F** for additional information on Operation Lifesaver).

Project Safeguard is an educational program at Merrimack High School in Merrimack, New Hampshire, which was set up to bring parents and students together for a "family based education program". It has been very successful as a means for students and parents to discuss a variety of issues (some of them public safety issues). If such programs exist at the Fitzgerald School or the housing developments (none known), railroad safety could be incorporated as one of the topics. If there is interest in developing such a program, the Merrimack program has served as a model for several school systems.

Safety programs are supported by the railroads (as well as cities and community organizations). They have been shown to be effective in reducing accidents, are inexpensive and could easily be initiated in North Cambridge as one short-term safety improvement.

Improving Signage

Cost: $25,000 (ten signs)

The Federal Railroad Administration (FRA) was recently involved in two passive sign programs which involved the installation of more conspicuous signs at grade crossings. The first installation was at rural crossings in Kansas; the second at 3,500 crossings in Ohio. Signage has been effective in reducing accidents in other locations.

Signage along the project area could be another means of raising consciousness about ROW safety issues. The MBTA is currently working with Operation Lifesaver in developing a sign system emphasizing railroad safety which is graphically more conspicious than the existing standard signs. Signs installed along the ROW could inform residents of raiLroad safety issues in addition to the "no trespassing" message. Although signage alone will not stop pedestrian crossings, along with an alternative means of reaching destinations, it can discourage crossing and increase public awareness of railroad safety issues. Signs will probably be most effective immediately following installation.

Signage needs to be conspicuous and vandal resistant. The current fencing is not high enough for mounting signs out of the easy reach of vandals. New fencing would need to be installed; alternatively signs could be pole mounted.

Because the MBTA is not opposed to this alternative, it could be one of the short-term safety improvements.

Increasing Visibility

Cost: Clear shrubbery: $5,000 - $10,000.
New groundcover planting: $20,000 - $30,000

Existing shrubbery along the ROW, outside of the fences, hides the view of pedestrians from train operators. The operator of one of the train trips taken by the Railroad Safety Task Force noted that he was frequently surprised by pedestrians that appear out of the shrubbery. He felt that clearing shrubs at the fence would allow him to see someone in the area of the ROW and give sufficient warning by blowing the whistle.

As the shrubbery is located outside of the ROW, the decision to clear shrubbery would need to be made by the property owners. Adjacent to Fresh pond Apartments (where the train operator made his observation), the berm and plantings on the housing side help to buffer the ROW. High plantings next to the ROW could be cleared and the slopes re-planted with low ground covers.

Because the MBTA is not opposed to this alternative, it could be one of the short-term safety improvements.

Slowing Trains

Cost: The MBTA maintains that there would be some loss of ridership and there would be resignaling costs east and west of the project area.

Community residents expressed strongly that they would like to see the trains move more slowly through the project area. The project area currently has a speed restriction for commuter trains of 55 m.p.h. An initial meeting with the MBTA, and a review of speed restrictions and reasons for restrictions for this line, identified track geometry, stations, at-grade crossings and train operations as the reasons for speed restrictions. Slowing the trains through the project area would require MBTA approval. The MBTA does not restrict speed for unauthorized use of the R.O.W. because of liability issues as previously discussed. In addition, the MBTA maintains that loss of time adversely affects ridership.

Layover times at North Station range from 10 - 30 minutes on this line. Layover times include the time it takes to unload and load passengers, change crews, perform brake tests, and reverse trains. Layover times are "tight" and would not accommodate a reduction in speed. Any overall speed reduction would require the rescheduling of many north side trains and resignaling east and west of the project area.

There are locations along the Fitchburg Line where track geometry is given as the reason for speed restrictions. The MBTA does make improvements to track geometry to reduce travel time. Although it may be possible to make improvements elsewhere along the line to improve travel times, the MBTA would still oppose speed reductions through this area for unauthorized use.

Train speed and stopping distance required:

Minimum stopping distances for 250 foot long commuter trains are as follows: a train traveling at 55 mph can stop in approximately 3,500 feet; the same train traveling at 30 mph can stop in 2,000 feet, and traveling at 10 mph the train can stop in 250 feet. However, minimum stopping distances for trains are given for ideal situations and do not account for reaction time, track conditions or the possibility that a pedestrian might not be seen by a train engineer. Therefore, it is difficult to predict if slower train speeds would result in avoidance of an accident. It is clear that an engineer traveling at 55 mph who sees a pedestrian on the tracks by Fresh pond Apartments or Jefferson Park from 1,500 feet west of Alewife Brook Parkway Bridge (where the tracks curve) cannot stop the train in time to avoid hitting the pedestrian; at 30 mph, the engineer can only stop in time if he sees the pedestrian, brakes immediately and if track conditions are ideal. At 10 mph, the train can be stopped before hitting the pedestrian (again, only if the engineer sees the pedestrian and brakes immediately).

Train speed and pedestrian crossing time required:

If an engineer of a train traveling at 55 mph sees someone on the tracks from 1,000 feet away and sounds a warning, the person will have 12 seconds to get out of the way. A fully mobile and attentive adult can clear the tracks in this amount of time. However, in trying to avoid the oncoming train, the person might move into the path of a train coming in the opposite direction. Furthermore, many factors may reduce the ability of a person to get out of the way in time:

- The age, mobility, health, vision, hearing, etc. of the person
- The person's clothing might obscure him/her from the train operators sight
- Weather conditions may limit visibility
- The time of day: since these trains run east-west, the inbound morning trains and the outbound evening trains run directly into the sun, making it more difficult for the engineer to see a person on the tracks; people in dark clothing are difficult to see at night
- Someone carrying bundles or pushing a carriage or bike crosses more slowly and has a greater chance of being struck
- Someone who trips while crossing may fall into the path of a train

Decreasing the speed to 30 mph would seem to give pedestrians nearly twice as much time to get out of the way. However, it is difficult to predict if slower speeds would lead to pedestrians trying to cross in front of the train when it is closer. There have been some articles written for railroad trade magazines that suggest that slower trains encourage vehicles to try to "beat the train" at vehicular grade crossings. The possibility of a similar response by pedestrians should be considered (there are no known studies on the effects of train speed on pedestrian crossings).

In summary, it is difficult to predict if slower speeds would result in fewer accidents. There may be a perception that it is safer to cross the ROW, which might result in pedestrians crossing in front of closer trains. There is also some concern that at slow speed, young people may try to "hop the trains".

Given the railroads' strong opposition to a decrease in speed, slowing the trains is not a feasible "short-term" solution. Long-term solutions focus on separating people from trains and providing reasonable, safe and legal means for pedestrians to reach their destinations.

<u>Providing Warning Systems - Improving Audio and Visual Warning Devices</u>

Cost: Audio and visual devices which are installed as a result of the Amtrak Authorization and Development Act will be installed system-wide and the costs (dependent on the required improvments) will be absorbed by the railroads.

Noise Barrier Walls (Entire Project Area) $3,300,000.

<u>Audio Devices</u>

Existing Federal regulations, 49 CFE 229.129, require that the lead locomotive be equipped with an audible warning device that produces a minimum sound level of 96 db(A) at 100 feet in the direction of its travel. A maximum is not established. Train whistles and horns are excluded from regulation from the Environmental Protection Agency because they are safety and warning devices.

Whistles and horns are frequently banned by municipalities because they upset the tranquility of neighborhoods. However, they have been shown to considerably affect the safety of railroad crossings. In 1991, the FRA pre-empted local whistle bans along the east coast of Florida (the night-time whistle bans had resulted in an increase in accidents by 200% since the ban in 1984). In 1992, the accident rate returned to pre-ban years. Similar ban preemptions have been taken by Conrail in Indiana and by CSX Transportation in Michigan, both resulting in significant decreases in accidents far exceeding the national decrease resulting from safety improvements at grade crossings.

The design of train whistles has remained relatively unchanged for many years. They have from one to seven horns (the greater the number of horns, the greater the chance of being heard over ambient noise). Low frequency horns allow the sound to be carried over long distances and higher frequency horns are for close range. As some people cannot hear high frequencies and others cannot hear low frequencies, whistles combine both. Combinations of horns give train whistles their distinctive sound. The FRA requires a certain horn volume from required distances. Horn manufacturers contacted currently are not developing horns with more directed sound.

Commuter trains in the project area have recently started consistently sounding their whistles (January 1994). A resident at the November 9, 1993 community meeting, and subsequently another resident at a meeting of the North Cambridge Stabilization Committee, complained of whistles late in the evening. The commuter trains operate in the project area from 7 am to 12:30 am. Whistles are disruptive to some residents along the ROW, but are important as a warning device (at least until use of the ROW by pedestrians is alleviated by other means). Restricting the times that whistles are regularly blown (except when there is someone on the tracks) may help alleviate some disturbance (perhaps trains should stop sounding whistles at 10 or 11 pm).

Noise barriers are another means of shielding residents from train whistles. Barriers are walls constructed of concrete, wood or plastics. However, to be effective, they need to be higher than the source of the noise, which in this case is 16' - 18' (whistles are located on top of the locomotive). Planting, although effective as a visual barrier, is not an effective noise barrier.

Visual Devices

The Amtrak Authorization and Development Act, which passed into law in the Fall of 1992, included an amendment to the Federal Railroad Safety Act of 1970 requiring a review of rules with respect to increasing locomotive conspicuity. Regulations are to be issued by mid-1995 (current status is "pending regulatory approval"). Options to be considered are:

- revisions to locomotive headlight standards including standards for placement and intensity
- requiring use of reflective materials to enhance locomotive conspicuity
- requiring use of additional alerting lights (including ditch, crossing, strobe, and oscillating lights)
- requiring use of auxiliary lights to enhance locomotive conspicuity when viewed from the side
- the effect of enhanced conspicuity measures on the vision, health, and safety of crew members

- separate standards for self-propelled, push-pull and multi-unit passenger operations without a dedicated head-end locomotive

The above listed improvements in locomotive conspicuity will be tools for the railroads to use. Trains could also be made more easily visible by creating a greater contrast with their surroundings. Changing the color of locomotive and head passenger cars to have a greater contrast with surroundings may not be feasible as all B&M trains would need to be painted. However, changes to the trains' background should be considered. For example, the color of ROW fences can be chosen to better contrast with trains. Substantial, regularly placed vertical elements such as telephone poles could help pedestrians notice the train's movement and speed. Elements would need to be placed outside of the ROW which would make them the responsibility of the City.

<u>Warning Systems - for Pedestrians</u>

Cost: MBTA installed systems - $150,000 - $250,000
maintenance - $10,000 per year

The MBTA and Commuter Railroads contacted (see **Part 1**) currently do not install warning systems for pedestrians only, do not build at-grade crossings for pedestrians only (road crossings frequently have sidewalks), and do not permit pedestrians into the R.O.W. The MBTA is currently looking at warning systems for pedestrians at stations on the Old Colony Line. However, these systems are not intended to allow pedestrians to cross in areas of high speed operations. They are intended only to warn passengers of arriving and departing trains. They will be located at recognized station crossing areas at passenger platforms.

Warning systems are installed only at recognized, legal grade crossings (for commuter lines, roads) and station platforms. They consist of crossing gates, bells and flashing lights. Some crossings have gates for both vehicles and pedestrians. Newer systems are designed to give a constant warning time for any train speed. This reduces the amount of time that the gates are down for slow moving trains and has been shown to decrease the number of people who become impatient and cross around the gates.

Although there is funding available for grade crossing safety improvements, the crossings must be legal, recognized crossings. The MBTA will not install warning systems for the heavily used crossings between Fresh pond Apartments and Fresh Pond Shopping Plaza, Jefferson Park and Danehy Park, or Richdale Avenue and the Fitzgerald School. Warning systems for illegal pedestrian crossings may pose liability issues for the MBTA as they could be interpreted as sanctioning the use of the R.O.W. Similarly, if the City were to install a warning system outside of the R.O.W. it too would increase its liability. There is an existing warning system which is heard approximately 20 seconds before an eastbound train passes the crossing at Jefferson Park and

Fresh Pond Apartments and 50 seconds before an eastbound train passes the crossing at the Fitzgerald School. The warning system is heard 45 seconds before a westbound train passes the crossing at the Fitzgerald School and 105 seconds before a westbound train passes the crossing at Jefferson Park and Fresh Pond Apartments. *The warning system is for the Sherman Street crossing and is more easaily heard at the Fitzgerald School crossing than the crossings at Fresh Pond Apartments and Jefferson Park.* Assuming the warning is heard, thirty-five seconds is enough time for a mobile adult to cross the tracks. However, a young child who stumbles with a bike, or is not paying attention and does not hear the warning, may not clear the tracks in time or may put himself into the path of a train coming from the opposite direction.

GROUP II ALTERNATIVES

Providing Barriers and Increasing Public and Other Transportation Options

Total Cost: Side fences, 1 shuttle, 1 school bus - 1.2 million first year, School bus and shuttle are $150,000 - $180,000 annually.

Installing Barriers (Fences, Walls, Plantings)

Fencing

Cost: Installed costs are approximately $80-$110 per linear foot for 8' high fences or $105 - $125 for a 10' high fence.

Total for project: 1 center fence (5,500 LF) at $95/linear foot - $522,500 (the cost of a center fence will increase if track relocation is necessary); 2 side fences - $1,045,000.

There are vandal resistant, durable fences which form effective barriers and are designed to prevent cutting, climbing or other means of passing. The fences are steel and are designed with vertical posts only (except for a top and bottom rail), with no place for footholds; or as steel grids, without openings large enough for footholds. Barriers would need to extend from several feet west of the Alewife Brook Parkway Bridge to Sherman Street, and from Sherman Street to Walden Street. A fence located between the tracks would prevent crossing but would not stop pedestrians from walking alongside trains in the ROW. Fences located on the outside of tracks would require gates at feeder lines (which pose maintenance and operations problems for the railroads). The location of fences would need to be carefully considered in the design process.

For examples of fences see **Appendix G**.

Walls

Cost: Installed cost for a free standing eight foot high concrete wall is approximately $150 per linear foot.

Total for project: 1 center wall (5,500 LF) - $825,000; 2 side walls - $1,650,000.

Barriers may work as part of a solution if there are other reasonable means for residents to reach their destinations. Concrete walls can be considered in place of steel fences and generally follow the same alignment as fences.

Plantings

Although plantings form an effective barrier in some locations, pedestrian "desire lines" are so strong here that residents may remove or cut down plantings that stop them from reaching their destinations. Additionally, plantings hide the view of residents about to cross the tracks from train engineers, creating more danger by not allowing the operator to see pedestrians in time to sound the whistle.

Increased Public Transportation

Cost: no initial cost; bus fare costs for residents (currently .60 in each direction)

When the Alewife Brook Parkway Bridge is completed in the Fall of 1994, a new ramp from the parking lot at Fresh Pond Apartments and a new sidewalk (part of the design) will better serve some of the residents of Fresh pond Apartments. In addition, the construction of the new bridge will allow buses to once again use the bridge, making an extension of the #83 bus route possible from a physical design standpoint.

The MBTA #78 bus used to stop at the Fresh Pond Shopping Plaza but buses currently use Concord Ave. and Blanchard Road because of the weight restrictions on the Alewife Brook Parkway Bridge. When the new bridge is completed, it will be safe for the #83 bus to be extended to the Fresh Pond Plaza (and perhaps Danehy Park and Walden Square). The City of Cambridge would need to discuss this issue with the MBTA (an initial meeting with the MBTA indicates that they are very open to this idea). The bus runs every 15 minutes from 7 am to 9 am and from 2 pm to 6:30 pm, and every 30 minutes from 9 am to 2 pm and from 6:30 pm until 12:40 am (which is probably frequent enough to meet the needs of residents going to Fresh Pond Shopping Plaza).

At a Railroad Safety Task Force meeting, some concern was voiced regarding residents' inability to afford the cost of daily bus rides. There are no known MBTA subsidy programs and this was not brought up at the meeting with the MBTA. It should be discussed with businesses at the Fresh Pond Plaza as well as with the MBTA.

Operating School Buses

Cost: School buses - one additional at $30,000 per year

The City of Cambridge currently buses kindergarten through third grade to the Fitzgerald School. Two buses are operated: one for Rindge Avenue and one for Walden Square, at a cost to the City of $60,000 per year. There are currently 65 children from Walden Square, Richdale Avenue and Lincoln Way that attend the Fitzgerald School. One additional bus would be needed to bus all school children from Walden Square and Richdale Avenue to the Fitzgerald School. Although busing children would certainly cut down on the volume of children crossing the tracks (particularly in the morning), it would not alleviate the problem of people crossing to catch a bus on Rindge, to go to or return from work, or to use the teen center or recreational facilities. Other than the morning school use, the school's summer program and the teen center's evening program, the crossings here are at scattered times throughout the day and evening.

Busing, although a way of improving safety by reducing the volume of crossings that occur, is not a complete solution in itself, and as a long-term solution will be very costly to the City. The School Committee and Superintendent make final decisions with regards to busing.

Operating Shuttle Buses

Cost: $120,000 - $150,000 per year (assuming 7 day, 12 hours per day service)

The City of Cambridge has participated in planning (but not in funding) shuttle services for a number of new developments. One such service is a shuttle funded by New England Development for the Galleria in East Cambridge. The service consists of a bus (two at peak hour) every fifteen minutes that connecting MBTA stations at Lechmere and Kendall Square to the Galleria. The service is free to riders, has been a great success, and transported 650,000 passengers last year.

If a shuttle service is part of the solution, buses would need to run a minimum of every twenty minutes for this to be a reasonable mode of transportation. A service which includes stops at Porter Square and Alewife MBTA stations, as well as the common community destinations identified in this report, may interest shopping plaza businesses. Their potential willingness to participate in funding is unknown at this time.

Providing Linear Paths, R.O.W. Crossings, Barriers and Increasing Other Means of Transportation

Total Cost: Side fences, 1 shuttle, 4,000 LF of path, two crossings - 3.5 million first year.
Shuttle is $120,000 - $150,000 annually.

Installing Barriers

See previous discussion of barriers.

Increasing Other Means of Transportation

As less mobile people will find bridges and underpasses more difficult to use, another means of transportation will need to be provided. See previous discussion of increasing public transportation or providing shuttles.

Developing Linear Paths Running Parallel to the ROW

Cost: For 4,000 LF (one side, entire project area with planting but no additional fencing) - $350,000 - $500,000

As stated in the data collection section of this report, the ROW is used as a neighborhood connector by people walking parallel to the ROW as well as crossing it. Linear paths which parallel the ROW, combined with crossings, could serve this same function. Paths could function as combination pedestrian ways and bike paths. There is currently funding ($1.5 million) for a bike path from the Minuteman Bike Path to the Charles River. A feasibility study for the location of the path is underway. A path in this location may serve both projects. The section of path included in this study may be included as part of a transportation route connecting to Porter Square, and Alewife, which could take advantage of future funding opportunities.

West of Sherman Street, there appears to be enough space within the ROW for the trains and for a pedestrian path (approximately 9' wide). Additional path width or plantings would probably need to be on adjacent property. There does not appear to be enough space for paths on both the Shopping Plaza/Danehy Park side and the Jefferson Park/Fresh Pond Apartments side (without track relocations). An initial review by the MBTA indicates that there is probably not space for a path east of Sherman Street within the ROW (without track modifications). Further coordination between the MBTA and the City will be useful in making final determinations.

(See **Appendix H** for sections illustrating a path west of Sherman Street).

The possibility of a path connection to Porter should be considered in the reconstruction of the Walden Street bridge.

To build a path within the ROW, the City might need to obtain an easement or lease the land from the MBTA. Designs would need to be approved by the MBTA. An initial meeting with the MBTA indicated that they are open to this alternative. If a path is part of a preferred solution, a meeting with the MBTA to better understand constraints and opportunities for paths is recommended. A schematic plan would need to be developed for more serious consideration.

Providing At-grade Crossing

Cost: Vehicular/pedestrian crossings and warning sytems - $250,000

Currently, there is a Federal Railroad Administration initiative to reduce the number of "redundant" grade crossings by 25% nationally. Safety at grade crossings has always been an issue for the railroads and they have responded with improved warning systems at existing crossings and a general policy to decrease the number of grade crossings.

At the initial meeting with the MBTA, they expressed opposition to this possible solution. Our research of other commuter rail lines indicates that at-grade pedestrian crossings (except at stations) have not been a solution to similar problems in other locations. The pedestrian crossings over the Conrail Grand Junction Connector line at MIT and Fort Washington in Cambridgeport cross a line where a maximum of two trains per day travel at under ten miles per hour. In addition, the City has an agreement with Conrail through which they have assumed liability for the Fort Washimgton Crossing. Because of the MBTA's firm opposition to this solution and the fact that even recognized at-grade crossings (particularly in this area where there are children who presently ignore the warning systems at Sherman Street) pose public safety problems, a pedestrian at-grade crossing may not be a viable solution.

A pedestrian crossing combined with a vehicular crossing (also opposed by the MBTA) was considered at Yerxa Road where there is a road which is dead-ended at the railroad. (See **Appendix H** - Yerxa Scheme 1). If connecting Yerxa Road and Richdale Avenue is consistent with the City's plans for this area, an at-grade crossing could be considered here (although it may not be approved by Public Utilities because of MBTA opposition). Introducing a road and vehicular traffic is also likely to be opposed by some community residents. Again, because of the number of young children in the area who may ignore warning systems, the crossing may not alleviate the safety problem in this location.

In general, solutions which physically separate people and trains are the safest solutions.

Providing Pedestrian Bridges

Costs: A pedestrian bridge will cost approximately $700,000 - $1,200,000 depending on design and materials and whether elevators or escalators are included. Exterior elevators cost approximately $70,000 - $100,000 each (two would be required for each bridge). Glass backed elevators designed for areas where there are security issues should be considered. Exterior elevators require approximately $400/month in repairs (generally done by the elevator supplier). In addition, there would be general maintenance cleaning costs (ideally, this would be done daily).

Exterior escalators cost approximately $250,000. They require approximately $1,000 per month in repair costs as well as general cleaning and maintenance. Exterior escalators are installed by the MBTA at train stations.

Pedestrian bridges were the most popular answer to possible solutions for this problem noted by Fresh Pond Apartments residents on the neighborhood survey. As was indicated in the Data Collection section of this study, residents may not realize the required height of such a structure; this may have impacted their answers. There are a number of elderly or less mobile people crossing the tracks who may find navigating a pedestrian bridge very difficult. Possible solutions to this problem are: 1) build a bridge with an elevator (there are maintenance and possibly security issues associated with this); or 2) offer an alternative means for people to reach their destinations (the MBTA #83 bus or shuttles are two possibilities).

There are several different ways of designing pedestrian bridges (with or without elevators) which should be examined if this is the direction taken. Bridges must be designed with an accessible ramp (approximately 350' long on each side) or an elevator for persons with disabilities. Stairs may be incorporated into the design as well so that people who can use stairs have a more direct route. Covered bridges, so that pedestrians are partially sheltered and snow removal is less of a problem, should be considered. Most pedestrian bridges will require some modifications to the sites where they touch down. For the purpose of this study, bridge schemes have been shown with switch-back accessible ramps and stairs.

(See **Appendix I** for examples of other styles of constructed pedestrian bridges). These have been included to show a variety of design styles (a number of these bridges do not conform to current accessibility standards).

Bridges would be most effective if paired with a linear path paralleling the ROW so that a larger group of people could use them to reach their destinations. The following pedestrian bridge location schemes are illustrated in Appendix G. The alternative locations are listed in geographic order from west to east.

Between Alewife Brook Parkway and Sherman Street there are two popular crossing points; one between Fresh pond Apartments and the shopping plaza and one between Jefferson Park and Danehy Park. Fresh Pond Apartments/Jefferson Park Scheme 1 shows a double bridge location option; Schemes 2, 3, and 4 show single location options to bring pedestrians to these destinations.

The following chart outlines the pros and cons of each location option between Alewife Brook Parkway and Sherman Street.

	Pros	Cons
SCHEME 1 - Bridges are located where pedestrians are currently crossing the tracks.		
	Because bridge locations are where current crossings exist, these are the most direct routes to both Danehy and the shopping plaza.	Some residents may be opposed to a bridge connecting to the housing developments because of security concerns. However, this is less of a concern if there are bridges at Fresh Pond Apartments and Jefferson so that bridges are part of a system. This is the most costly scheme as it involves the construction of two bridges rather than one.

SCHEME 2 - A single bridge is located close to where residents currently cross into the shopping plaza.

The bridge (if combined with a path) is a direct route to the plaza for Jefferson Park and Fresh Pond Apartments

This scheme does not address the Jefferson/Danehy crossing (route through the plaza is too indirect - the connection would need to be made by alternative means of transportation).

Scheme 2 is half the cost of Scheme 1.

SCHEME 3 - A single bridge is centrally located in between where residents currently cross into the shopping plaza or Danehy.

The bridge location is a compromise between the two crossing points.

This scheme may not address either the Jefferson/Danehy or the Fresh Pond Apartments/ shopping plaza connection well enough (for some, the route to the plaza is as indirect as the Alewife bridge).

The bridge lands at the side of the movie theatre which is hidden from view and may pose security issues.

Scheme 3 is half the cost of Scheme 1.

SCHEME 4 - A single bridge is located close to where residents currently cross from Jefferson Park into Danehy Park.

The bridge location is a direct Jefferson/Danehy route.	The scheme may pose security issues for some Jefferson Park residents.
Scheme 4 is half the cost of Scheme 1.	The scheme does not address the Fresh Pond Apartments/ shopping plaza connection.

If a bridge option is chosen, Scheme 1 best addresses the access needs of residents. However, if a single bridge scheme is preferred because of community, cost or design issues, schemes 2 or 3 should be considered.

A pedestrian bridge also is a possible means of crossing between Richdale Avenue and Yerxa Road (see Yerxa Pedestrian Bridge Scheme 1). There is room on both sides of the ROW for a bridge and connecting ramps (or elevator). Discussion of other solutions for this crossing follow.

Providing Pedestrian Underpasses

Cost: $700,000 - $1,000,000

Underpasses were considered for the Yerxa Road crossing only. In general, underpasses hide people and therefore encourage undesirable uses. This is particularly true where approach ramps are steep (they do not allow adequate natural light into the underpass) and where the underpass is not wide enough or does not have enough clearance (visibility is poor and pedestrians feel as though they are walking into a hole). Designing a safe (and accessible) underpass requires approximately 200 feet of approach (if the ROW is at the same elevation as the surrounding land). Ideally, the approach would be perpendicular to the ROW and would be gradually widened to its entrances to allow for the greatest visibility into the underpass and to allow for easy surveillance.

At the crossings west of Sherman Street (Fresh Pond Apartments and Jefferson Park), the elevation of the land adjacent to the ROW is equal to or higher than the ROW, increasing the length of the approach. From a physical design standpoint, as well as a security standpoint, an underpass is not a feasible solution in this location (in addition, according to the neighborhood survey, residents would not use an underpass). However, at the Yerxa Road crossing, because the grade of the ROW is higher than adjacent property, the length of the approach is decreased and there appears to be enough space for a safe and accessible design. Underpasses in the approximate location of the existing underpass where considered.

- Scheme 2a (and Yerxa Road Sections D and F) shows the continuation of Yerxa Road under the ROW, connecting through to Richdale Avenue. By making the underpass a road, it is wide enough for visibility into the underpass, an occasional car provides some security, and surveillance is much easier. The underpass would get some natural sunlight but would need to be well lit in the evenings. A new drainage system would need to be installed.

- Scheme 2b (and Yerxa Road Sections E and F) shows a pedestrian underpass at this location. The approach and underpass would be the same length but less wide. However, making the underpass wide enough so that a police vehicle could pass through should be considered.

Any construction under the tracks would require MBTA approval and would need to be undertaken without interrupting train operations.

Improving the existing underpass would require new approaches for access and considerable work to correct drainage problems. Given the expense of these improvements, it is far more cost effective to provide a better designed underpass if this is the direction taken.

<u>Depressing the Trains</u>

Total Cost: **The cost of depressing the tracks for this section of track is approximately $70 million - $90 million for planning, design and construction of the tunnel. As one track needs to remain operable through the construction period, construction would need to be phased (tracks would be depressed one at a time).**

The estimated costs of other cut and cover tunnels include: Courthouse Station - 2,000 LF (less than half the length of this tunnel) at $60 million and Haymarket Station at $72 million.

As expressed at the first community meeting, putting the trains underground would be a perfect solution from the community's standpoint, and when completed, would serve the MBTA's desire to physically separate pedestrians and trains. There are issues with freight trains that require gentler slopes and need to access adjacent properties, and some issues regarding where the trains enter and exit the tunnel (a minimum of 1,000 feet of boat section). Two means of depressing the trains are: 1) to put the train in a tunnel (the tunnel would need to be vented and air pollution and vent locations would be issues), or 2) to depress the train so that flush (or slightly raised) platforms can be built over the tracks in places where people cross.

In order to have the train in a tunnel between Alewife Brook Parkway and the Fitzgerald School, the train would need to begin its decline 1,000 feet west of the Alewife Brook Parkway (impacting access to the freight line) and 1,000 feet east of the recreational facilities at the Fitzgerald School. The feeder line which runs between Danehy and the shopping plaza would need to be in a tunnel at the entrance to Danehy and its boat section would extend another 1,000 feet.

Problems associated with depressing the trains include cost, drainage issues resulting from the high water table, a lengthy and involved planning and design process, and possible impacts to freight services. Two projects which involved putting a railroad underground are the extension of the Redline in North Cambridge and the Old Colony Railroad. The Old Colony includes a one mile long tunnel (the approximate length of a tunnel in this project area) through Hingham. The cost of the tunnel is estimated to be $170-200 million (the project is not funded to date). Planning and design for this project, if a tunnel is the direction taken, would require approximately five to seven years.

PART 4: RECOMMENDATIONS

Short-term Solutions

Short-term solutions have been defined as solutions which can be in-place within one year. Some possible solutions, such as safety programs, signage, fencing repairs, trains sounding whistles, and clearing shrubbery for better visibility can be implemented in a shorter time span and should be pursued immediately. In general, short-term solutions are those which are less expensive (to enable the City or MBTA to cover costs without seeking additional funding) and which the City and MBTA are likely to support. Any solution which involves access to or crossing of the ROW will need to be approved by the MBTA.

Installing barriers such as vandal resistant fencing or walls has not been included as a short-term solution because reasonable alternative routes for pedestrians must be in-place prior to their construction. In addition, they are very costly.

Alternatives to consider as short-term solutions include:

- Slowing trains - Although it is difficult to predict if slowing the trains will result in fewer accidents in the project area, it is widely requested by the surrounding neighborhood. Slowing the trains is not supported by the MBTA for reasons previously discussed, and the time frame within which this can be implemented (if it can be implemented) may be greater than one year. If the City decides to pursue this as an option the process is as follows:

  The City of Cambridge must file a petition with the Department of Public Utilities (DPU) requesting a hearing. The petition must reference a part of Chapter 160 of the Massachusetts General Laws (Ch. 160 M.G.L.) applicable to the situation. If the petition is accepted, a hearing will be held and the DPU can choose to restrict the speed. If no applicable section of Ch. 160 M.G.L. is found, the DPU has no jurisdiction and no hearing will be held.

  In the project area, the speed limit of 55 MPH was set by the MBTA based on limited sight distance at the Sherman Street at-grade crossing. Exceeding this speed is a violation of MBTA and Amtrak operating rules.

  The Federal Railroad Administration (FRA) sets speed limits based on track maintenance conditions only. For example, FRA Class 3 allows 60 MPH passenger operations. Exceeding this speed would violate FRA rules. However, if the track was maintained to Class 6 Standards, up to 110 MPH speeds would be allowable by the FRA.

- Safety programs - Operation Lifesaver has had positive effects in other communities and should be offered at the Fitzgerald School and throughout the school system, Fresh Pond Apartments, Jefferson Park, Walden Square, Gately Shelter and local churches and religious organizations. Costs are minimal. The North Cambridge News would be a good way of publicizing both the program (for those who may want to attend) and results (to raise public consciousness).

In addition, existing community programs run by the City (such as the Mayor's program), local schools, religious organizations , Gately Shelter and the North Cambridge Task Force (such as "National Night Out Against Crime") may provide a forum for the discussion of railroad safety issues. Projects which involve children (as well as adults) in the process will be the most effective. Operation Lifesaver has information on age appropriate programs.

- Signage - The MBTA is currently working with Operation Lifesaver on new signage systems emphasizing railroad safety. The schedule for completing the design of the signs is unknown. However, as improvements are urgently needed in this area, there is incentive to complete the planning, design and installation of new signs as quickly as possible. Further coordination is needed between the City and the MBTA.

- Alewife Brook Parkway Bridge - The bridge and pedestrian ramp and sidewalks will be complete in spring 1995. This will offer a safer route to some residents at Fresh Pond Apartments at no cost to the City. The MDC is responsible for maintaining the ramps and sidewalks, and should be called when snow shoveling or maintenance is needed.

- #83 bus - The #83 bus route should be extended when the bridge is complete (Spring 1995). Bus routes are reviewed quarterly and the City needs to discuss the route with the MBTA.

- Visibility - Visibility for train engineers should be improved by clearing overgrown shrubbery wherever possible adjacent to the ROW.

- Shuttle Service - The MBTA has suggested operating a no-fare shuttle which would run every 15 minutes during peak hours (7 am to 9 am and 4 pm to 6 pm) and every 30 minutes from 9 am to 4 pm. Shuttle service would be provided on Saturdays from 8 am to 7 pm and Sundays from 9 am to 7 pm. The shuttle would be operable within six months and would be funded by the MBTA. A shuttle will offer a safer alternative to residents as a short-term solution and as part of a long-term solution.

- Audio Warning - Engineers can sound their whistles in the project area. Trains are currently sounding their whistles which has brought some criticism from residents disturbed by the noise. Whistle sounding is an important component of safety and should continue at least until long-term safety improvements are in place. However, reasonable time restrictions should be considered to limit annoyance to residents.

- Fencing Repairs - Damaged fencing by the tennis courts at Yerxa Road should be repaired so that pedestrians do not need to chase balls into the ROW.

Long-term Solutions

Long-term solutions considered were based on providing reasonable means for pedestrians to reach their destinations and separating people from trains. From the community's point of view, depressing the trains is an ideal solution as it would allow residents to cross where they wish and walk along the ROW. This solution may pose some issues for the railroads (such as steep grades and access problems for freight) and for the community (such as the location of retaining walls where the trains enter and exit the tunnel and vent locations) and its cost would make funding very difficult. As there are other means of addressing safety issues which are much less costly and more likely to be funded, depressing the trains is not the recommended alternative.

The recommended alternative is a package of necessary improvements which will be successful only in their entirety. It is important to recognize that each recommendation is part of the system and all must be in place for the system to work.

The recommended alternative is intended to give the City direction in providing the solution. Its components have not been designed. All appropriate community groups and agencies including the City of Cambridge Police Department, the Fire Department, the Public Works Department, Cambridge Housing Authority, abuttors and other interested parties and the MBTA should be included in the design process to assure its success. Security and maintenance are extremely important and need to be considered in all design decisions.

The recommended alternative consists of the following:

Providing grade separated crossings in the locations where pedestrians are currently crossing:

-Yerxa Road
-Fresh Pond Apartments and the shopping center
-Jefferson Housing and Danehy Park

At the Yerxa Road location, an underpass or pedestrian bridge should be considered. At this time, an underpass is preferable as the clearance requirements would result in a much shorter walk for pedestrians and would be easier to use. The underpass should be designed to be fully visible from Richdale Ave. and Pemberton St. Mirrors have been used in other locations as a means of allowing pedestrians to see their path from street to street. The underpass should be wide enough to allow police surveillance vehicles to pass through (approximately 12 feet) as well as to provide greater visibility. The design should prevent ordinary vehicles from passing through as this could create a dangerous place for pedestrians. If the police are using motorcycles, bollards should be placed at the entrance ramps a maximum of six feet on center to prevent cars from passing through. If the police are using cars, removeable bollards or swing gates should be considered. The underpass should be lighted with vandal-resistant fixtures, a police phonebox should be provided and the use of surveillance video cameras should be considered (these are currently being used by the City of Lynn). The underpass should be designed to be open, visible, light, accessible and dry. Because of the high water table in this area, drainage is an issue and a pump may need to be installed. It is critical that the underpass be maintained and kept clean (lighting needs to be operable, the underpass needs to be cleaned and painted regularly, and drainage structures must be kept clean).

The community survey indicates that a number of residents are opposed to an underpass in this location. This opposition is likely to be a response to the design and condition of the existing underpass. If the community strongly opposes an underpass in this location, a pedestrian bridge should be considered.

The property on the south side of the tracks is privately owned. Property would need to be aquired for any of the solutions in this area.

The community access needs would be best addressed by two pedestrian bridges west of Sherman Street, one between Jefferson Housing and Danehy Park and one between Fresh Pond Apartments and the Fresh Pond Shopping Center, connected by a linear path paralleling the ROW. One-bridge schemes between the two popular crossing spots may not be direct enough to eliminate ROW crossings (particularly athletic young people who may find scaling ten foot barriers a challenge).

Bridges should be designed with ramps and stairs, and so as not to preclude the addition of elevators at a future date (elevators were not included at this time as they pose unmanagable maintenance issues). Bridges and ramp/stair structures should be highly visible so that users do not feel isolated and unseen. Lighting is critical, and as stated with underpasses, structures need to be kept clean and safe. Snow plowing is a maintenance concern. Roofs or heated pavements should be considered to avoid some plowing issues. If bridges are open, "missile barriers" will need to be installed to keep objects from being thrown on to trains below.

Bridge approaches (ramp/stair structures) will be large as the railroad standard for bridge clearances is 22.5 feet. Approach designs need to accommodate required modifications to existing parking lots and park land. All bridge approaches and bridges should be easily accessible to police for regular surveillance as well as emergencies. Existing grade differences, such as the berms at Rindge, should be considered as a means of decreasing the lengths of accessible ramps.

Underpasses are not feasible in these locations as the elevations of abutting properties are high, requiring long access ramps and little opportunity to make the underpasses highly visible (which is critical to their success).

Provide linear path connections wherever possible, paralleling the ROW and connecting ROW crossings.

An initial meeting with the MBTA suggests that a 9' wide linear path is possible west of Sherman Street on the north side of the tracks. A path in this location would allow for greater use of the pedestrian bridges and would accommodate those pedestrians who are currently using the ROW as a neighborhood connector. In addition, a linear path to crossings can be part of a system of pedestrianway/bikeways fulfilling the City's intention to increase these modes of transportation and increasing the possibilities for funding for this project (discussion of funding follows). If possible, the path should continue east of Sherman Street and eventually connect to the new Walden Square Bridge. The City will need to meet with the MBTA to see if there is any way of accommodating this path. As the ROW is frequently used as a neighborhood connector, this use should be accommodated in a safe and legal way to the greatest degree possible.

The path should be separated by a fence from the train tracks (see **Barriers**) and security issues such as whether or not to provide lighting should be discussed with the community.

Increasing other means of transportation

The alternatives recommended above provide a reasonable means for fully mobile pedestrians to reach their destinations. However, for less mobile people, alternatives to climbing pedestrian bridges will need to be provided. Extending the #83 bus route (recommended as part of a short-term solution) is a reasonable part of the solution. Continuing to run a free shuttle would accommodate less mobile people who cannot afford bus fares. A shuttle which also connects to Porter Square and Alewife Station may increase patrons of the shopping center, and businesses may be willing to support a permanent system. An on-call ride service is recommended as another possible means of transportation.

Constructing Barriers

Once the alternative means of transportation are in place, the ROW should be fenced on both sides with a minimum 8' high, vandal resistant steel fence. Durable steel fences are an effective barrier and do not encourage grafitti. (See **Appendix G** of this report for examples of fencing). Fencing should extend the entire length of the linear path and to a minimum of 100' west of Alewife Brook Parkway (to discourage pedestrians from walking around the fence and crossing the ROW), and to Walden

Street. As the Alewife masterplan is developed, fencing west of Alewife should be extended to the next legal crossing.

APPENDIX G

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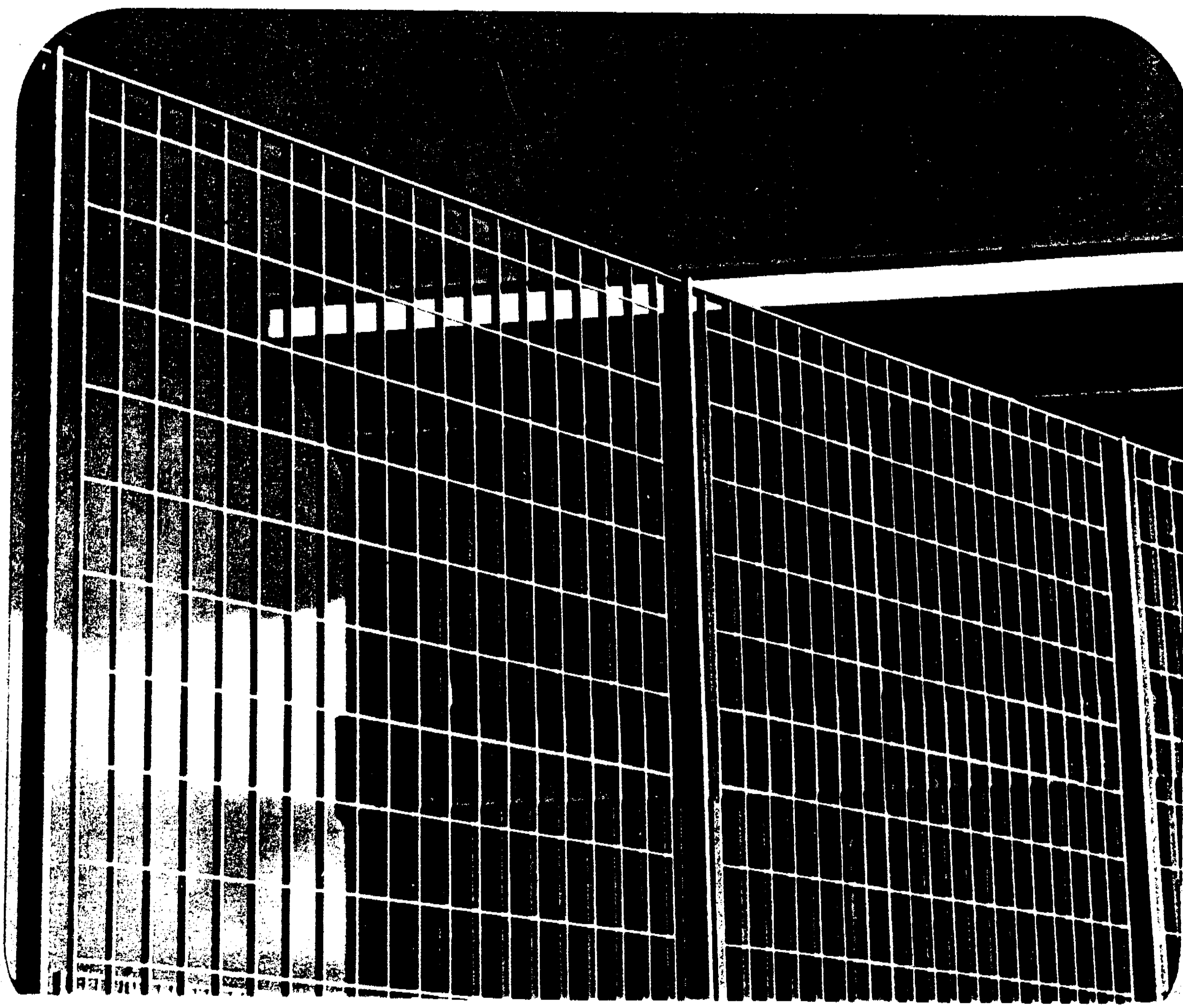

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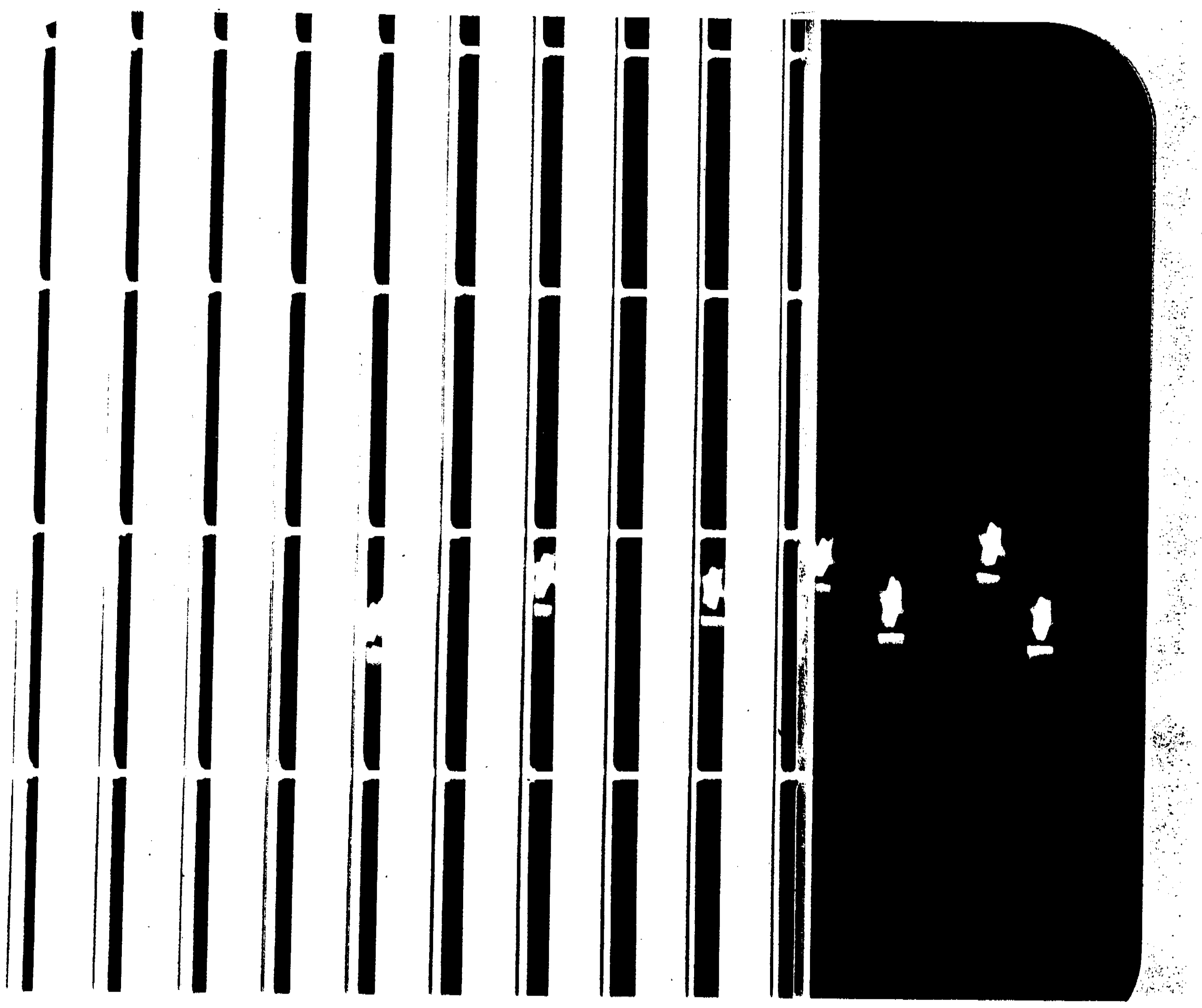

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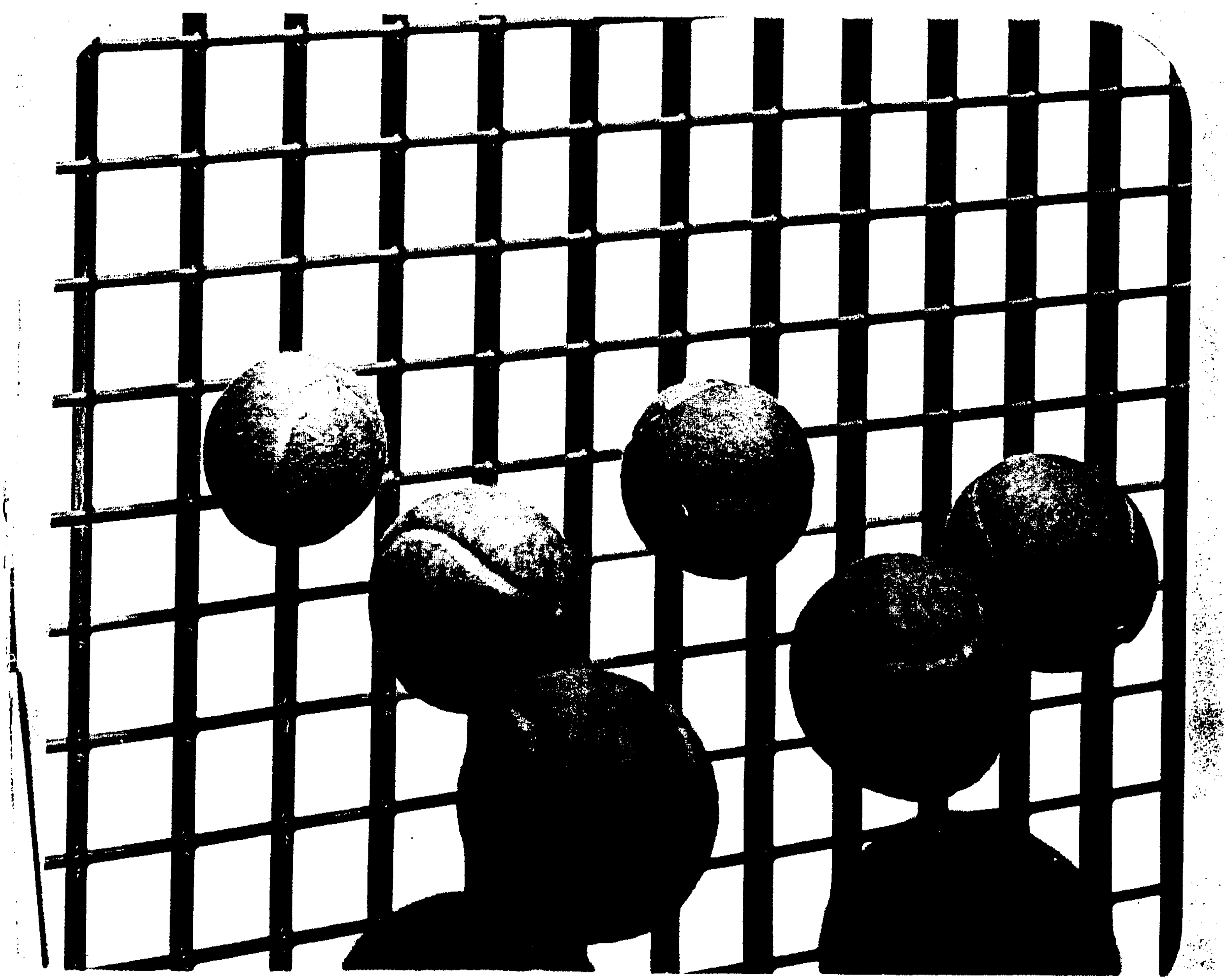
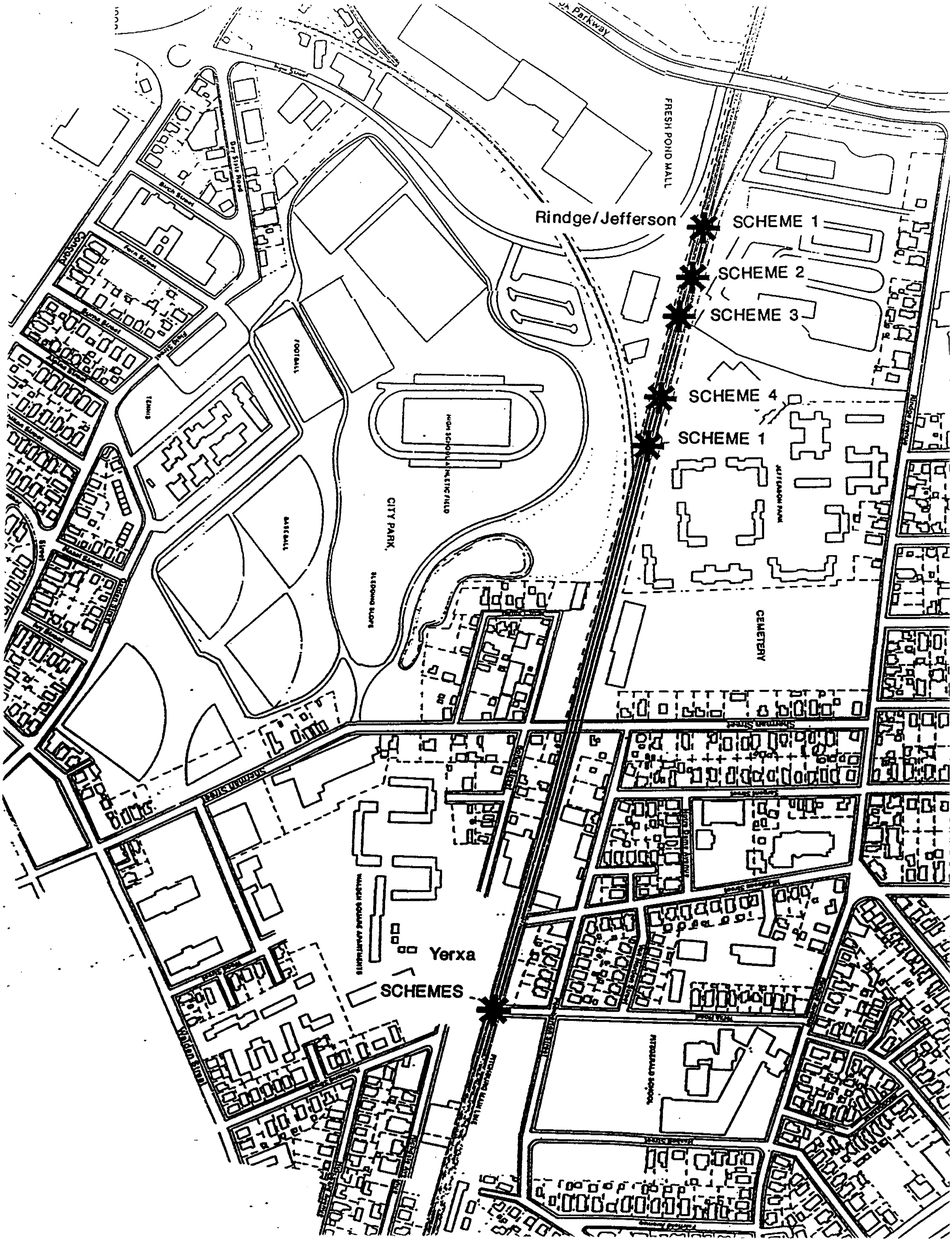
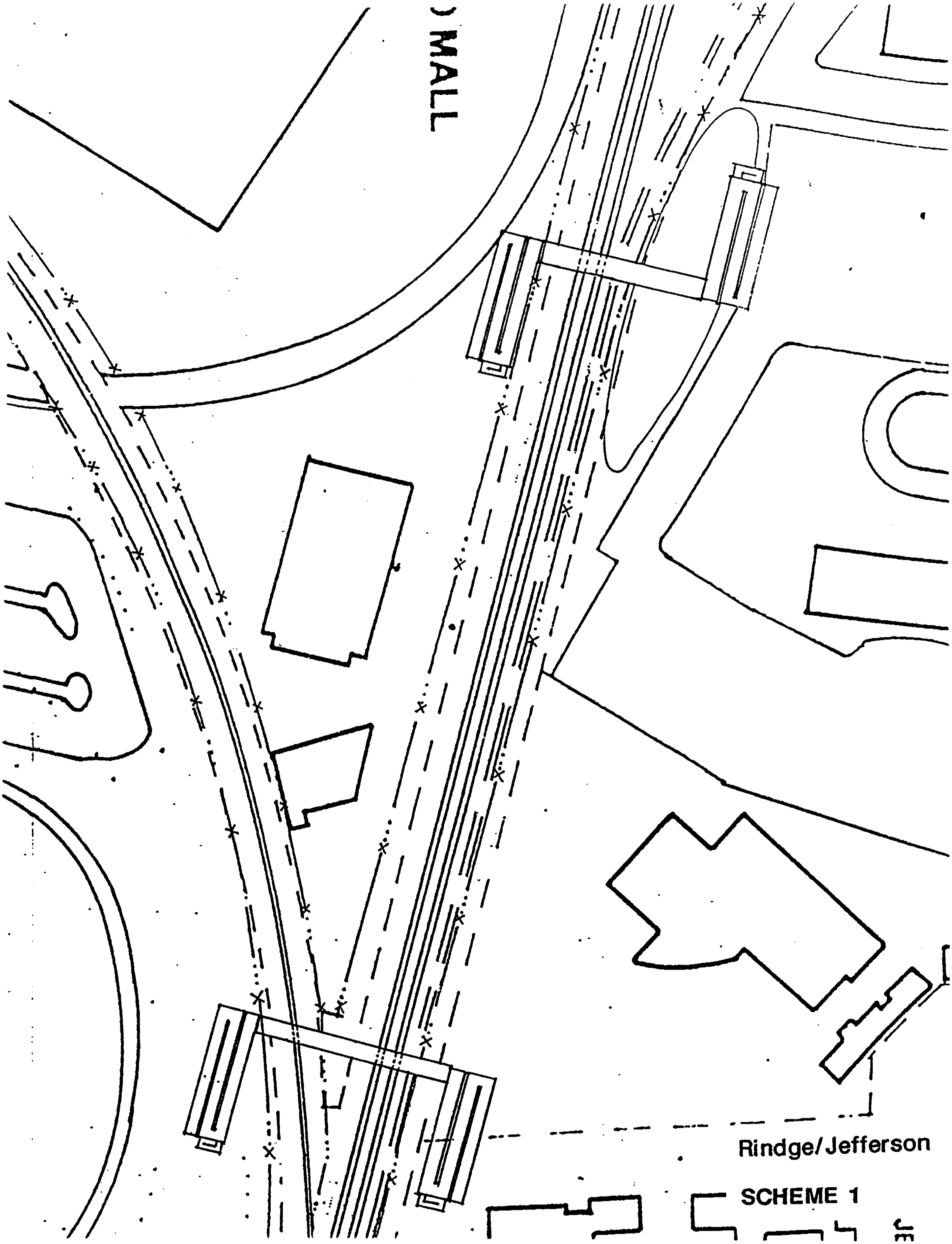


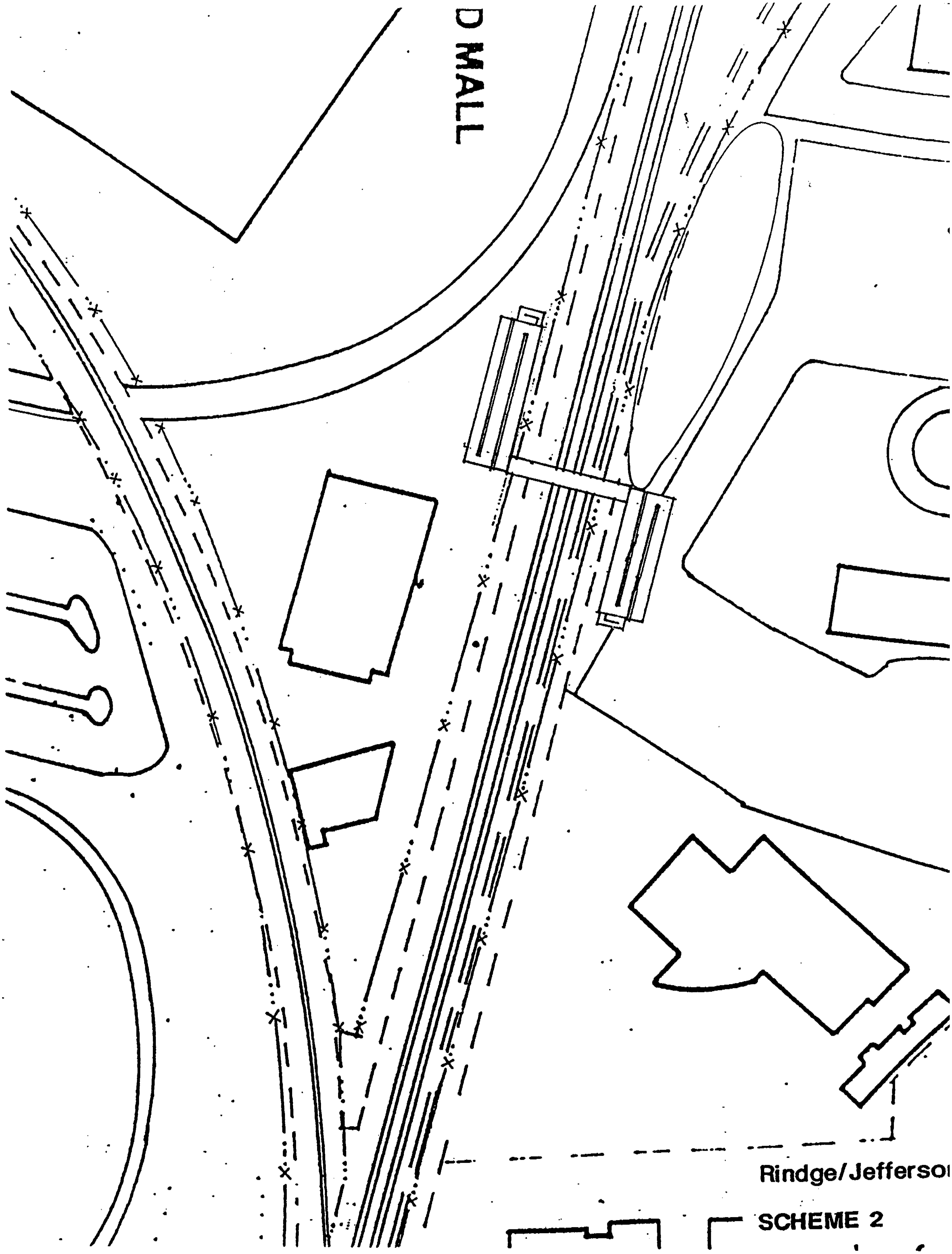
APPENDIX H


Rindge/Jefferson
SCHEME 1
SCHEME 2
SCHEME 3
SCHEME 4
SCHEME 1
Yerxa
SCHEMES
FRESH POND MALL
CITY PARK
CEMETERY
FOOTBALL
BASEBALL
TENNIS



Rindge/Jefferson

SCHEME 1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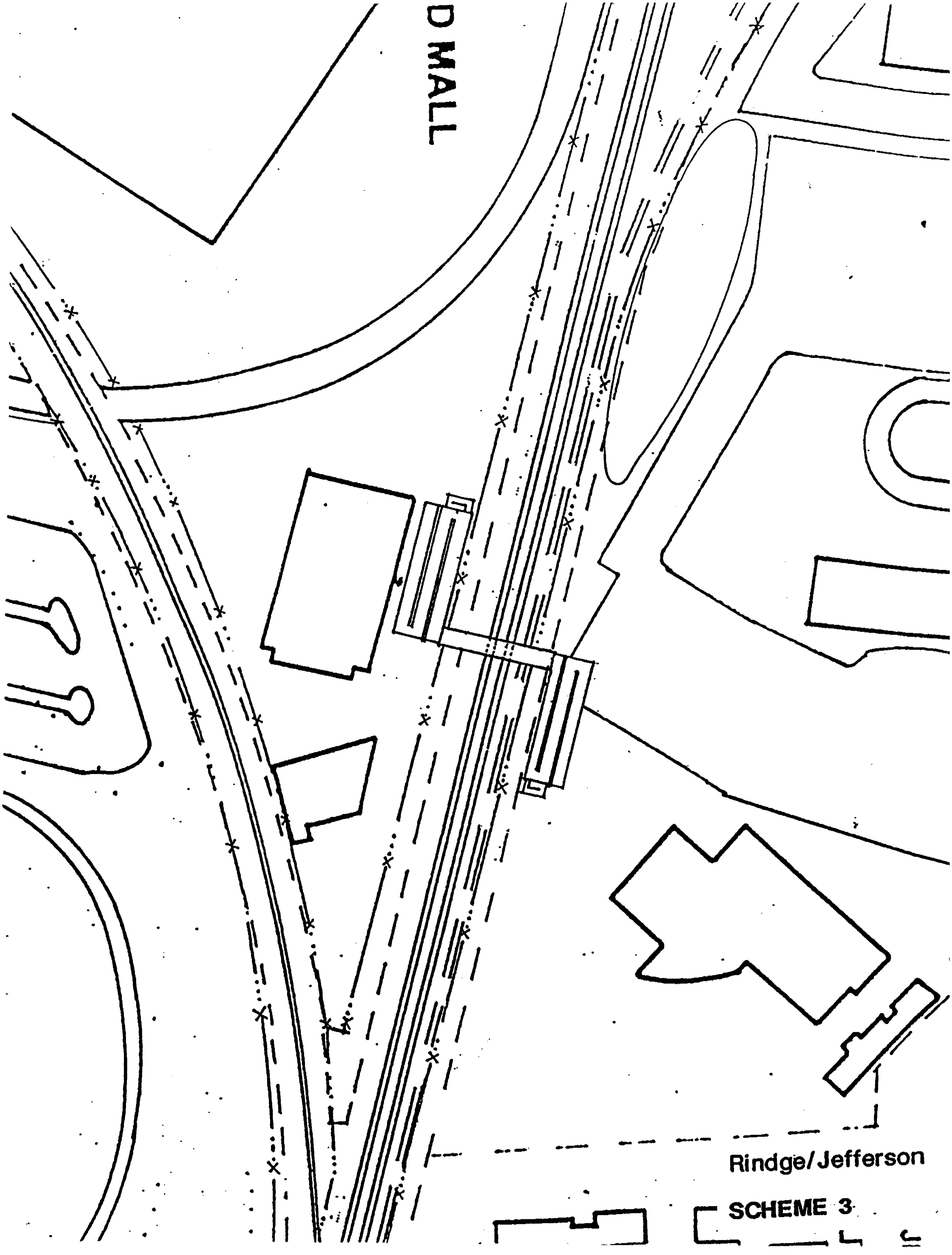
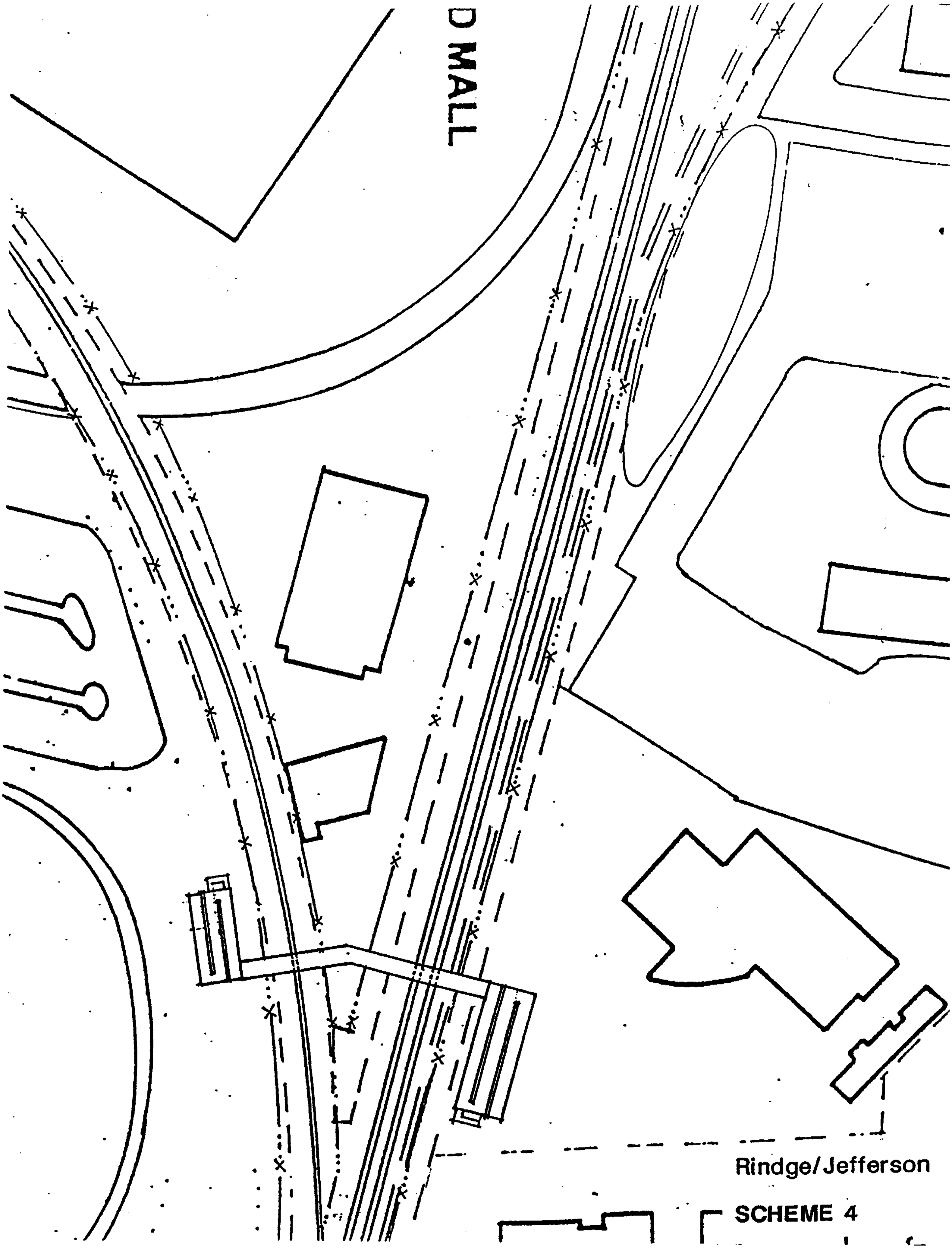
Rindge/Jefferso
SCHEME 2



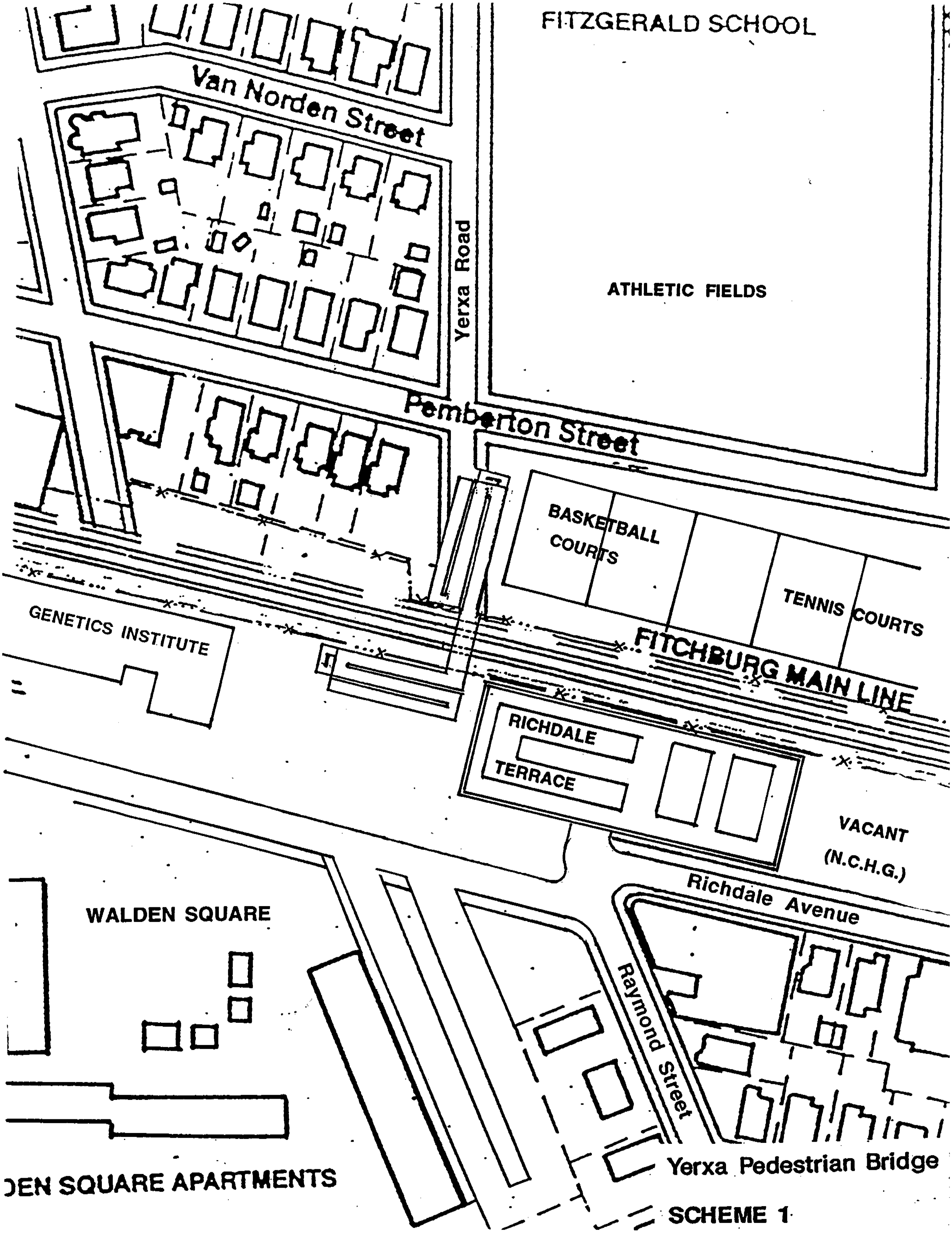
Rindge/Jefferson

SCHEME 3



Rindge/Jefferson

SCHEME 4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Yerxa Road
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Pemberton Street
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Richdale Avenue
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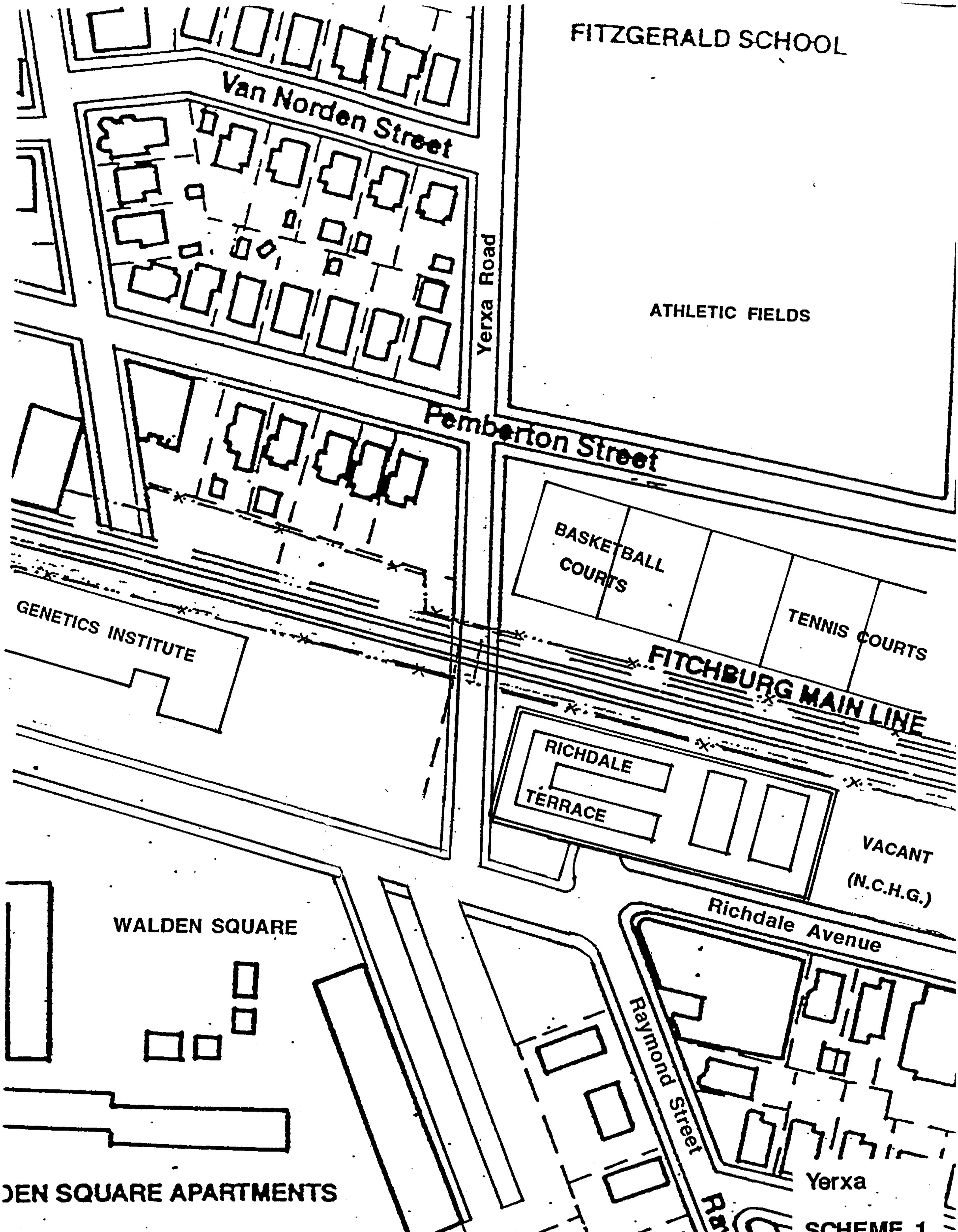
Raymond Street
Yerxa Pedestrian Bridge
DEN SQUARE APARTMENTS
SCHEME 1



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Van Norden Street
ATHLETIC FIELDS
Yerxa Road
Pemberton Street
BASKETBALL COURTS
TENNIS COURTS
GENETICS INSTITUTE
FITCHBURG MAIN LINE
RICHDALE
TERRACE
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Richdale Avenue
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Raymond Street
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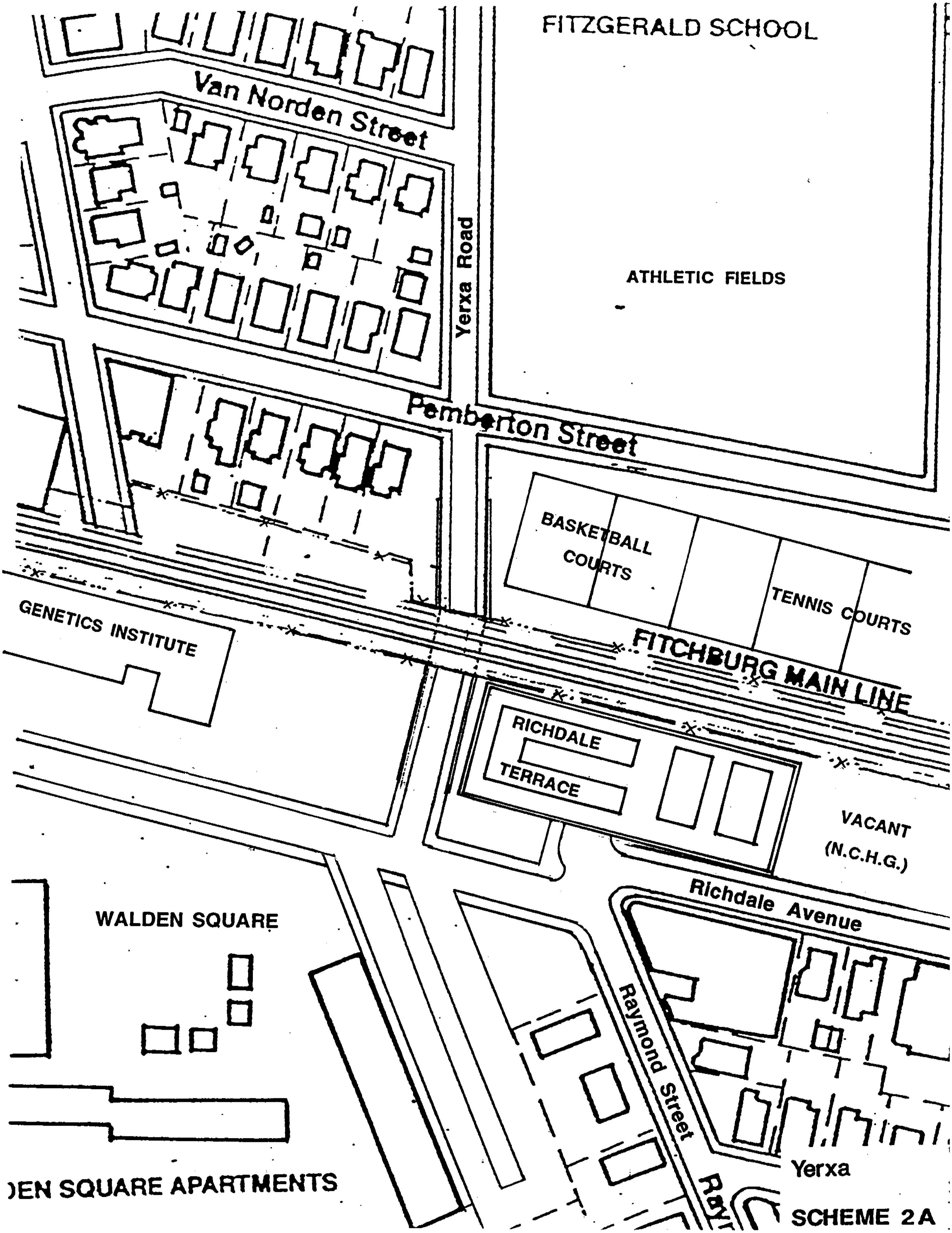
SCHEME 1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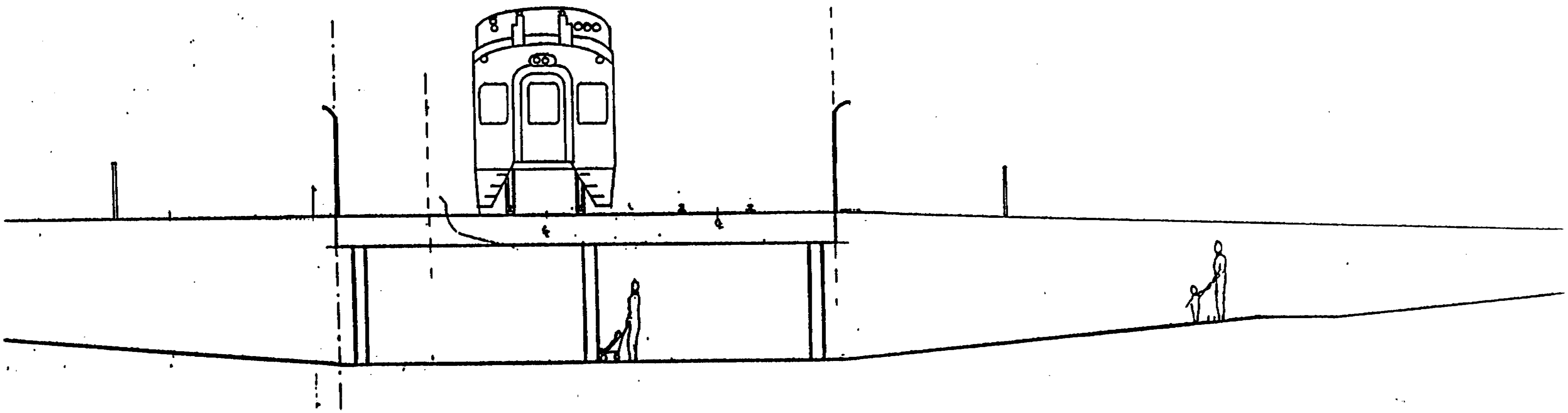
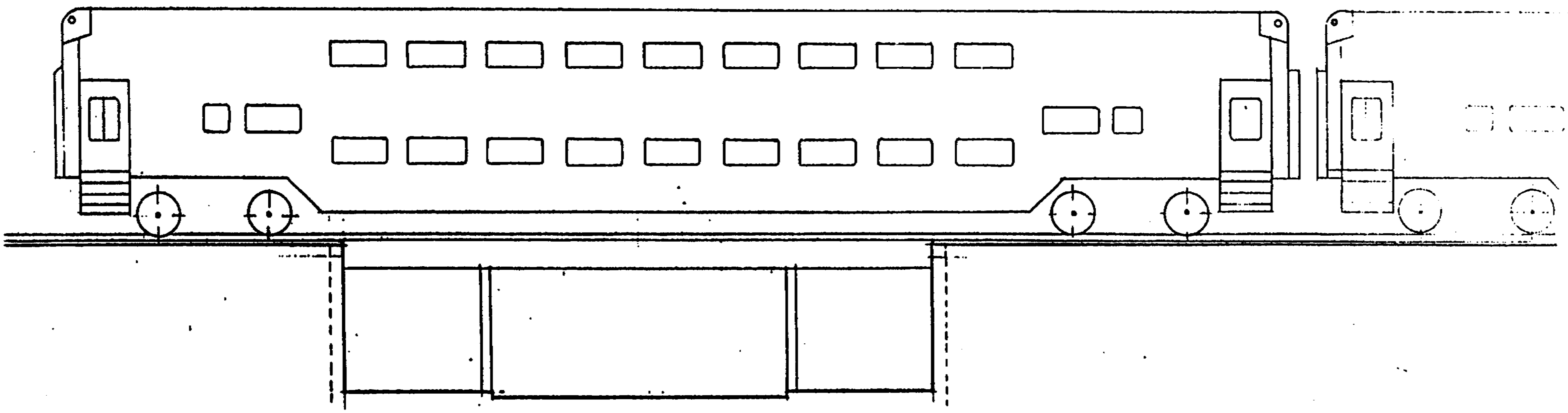
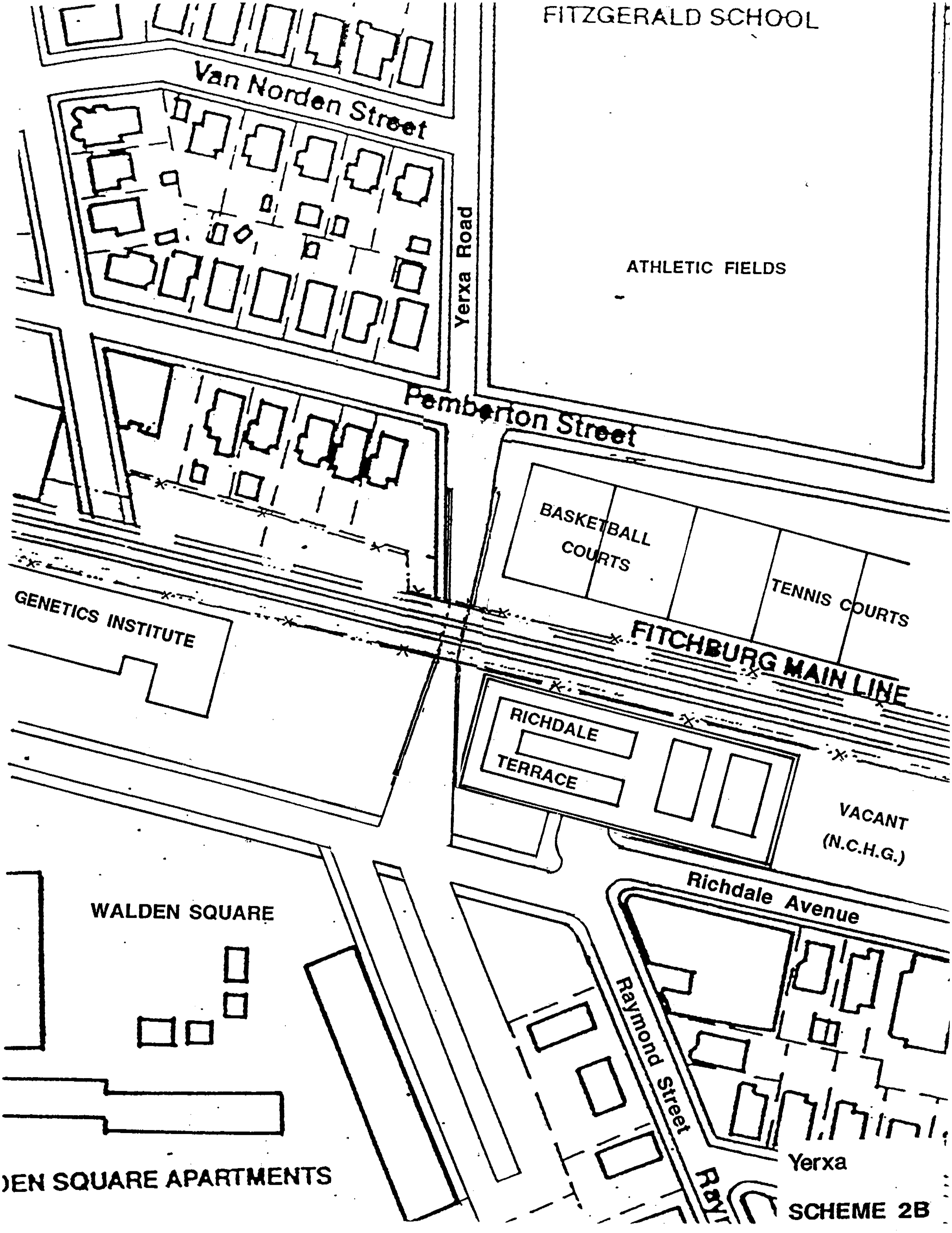
SCHEME 2A



D YERXA. ROAD (FITZGERALD SCHOOL)
PEDESTRIAN UNDERPASS
X-SECTION LOOKING WEST



F YERXA ROAD (FITZGERALD SCHOOL)
PEDESTRIAN UNDERPASS
LONGITUDINAL SECTION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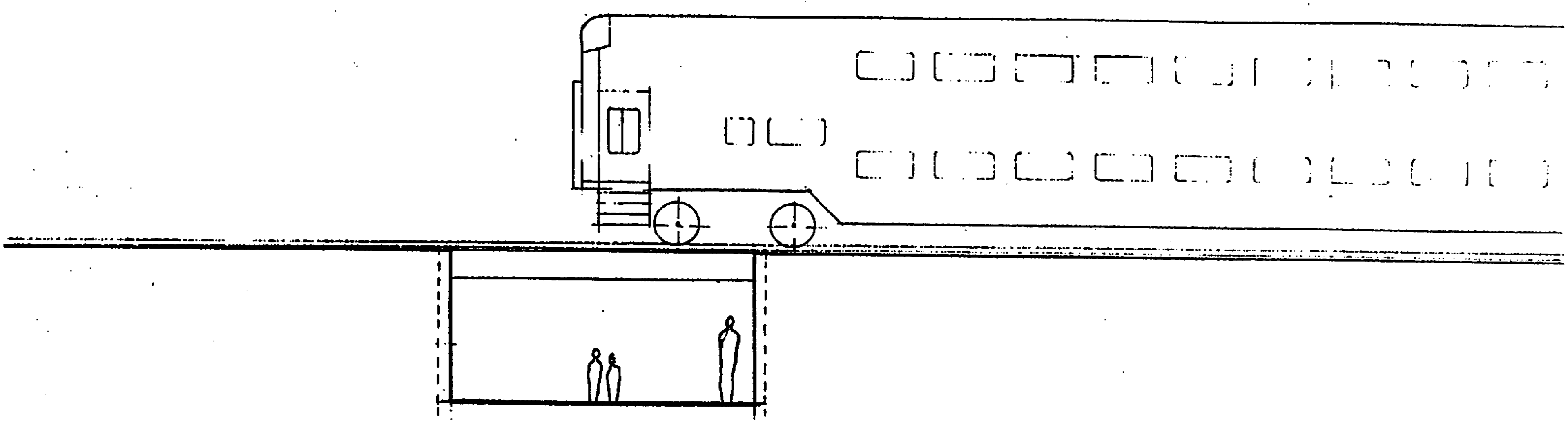
SCHEME 2B



E YERXA ROAD (FITZGERALD SCHOOL)
PEDESTRIAN UNDERPASS
LONGITUDINAL SECTION

APPENDIX I

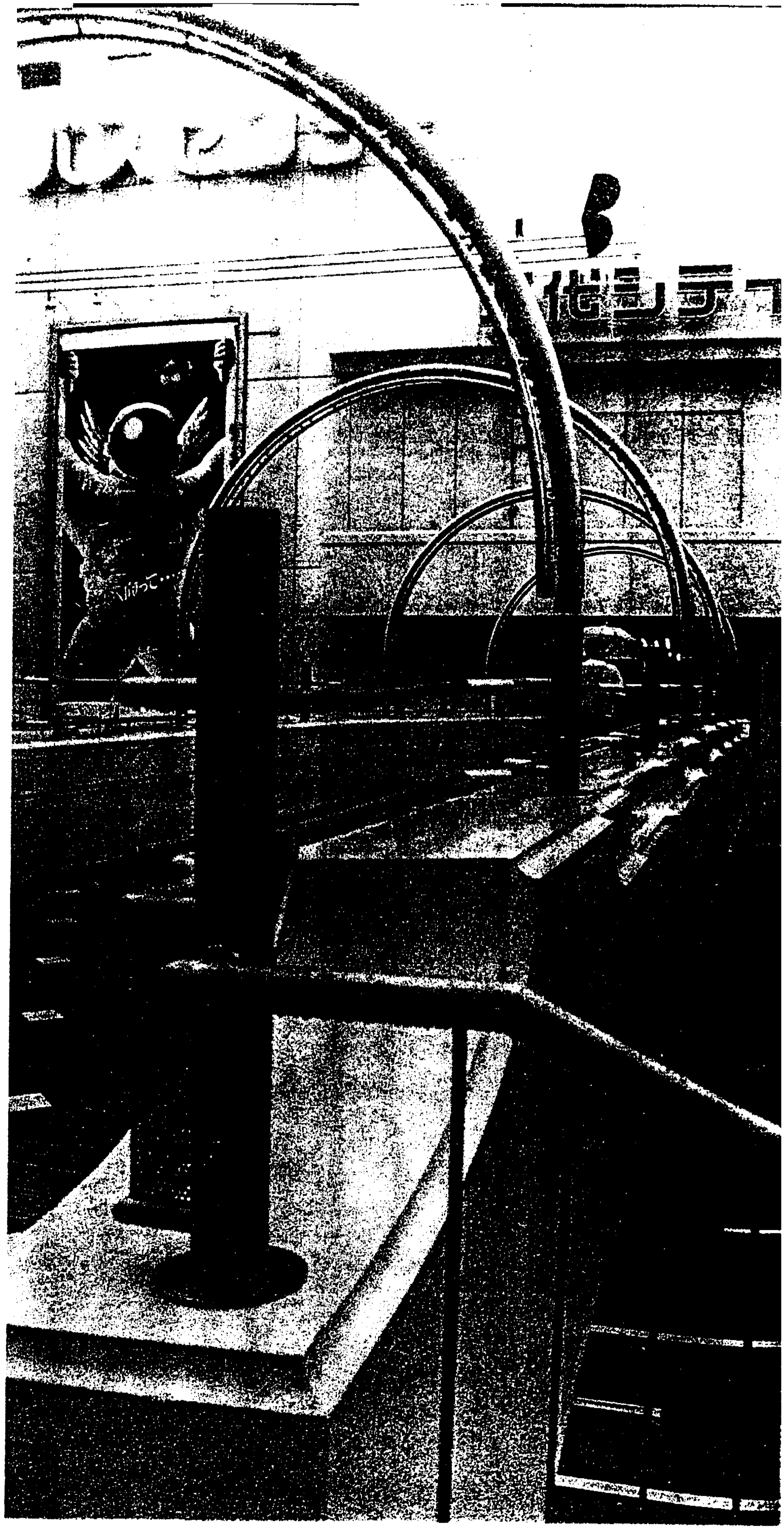
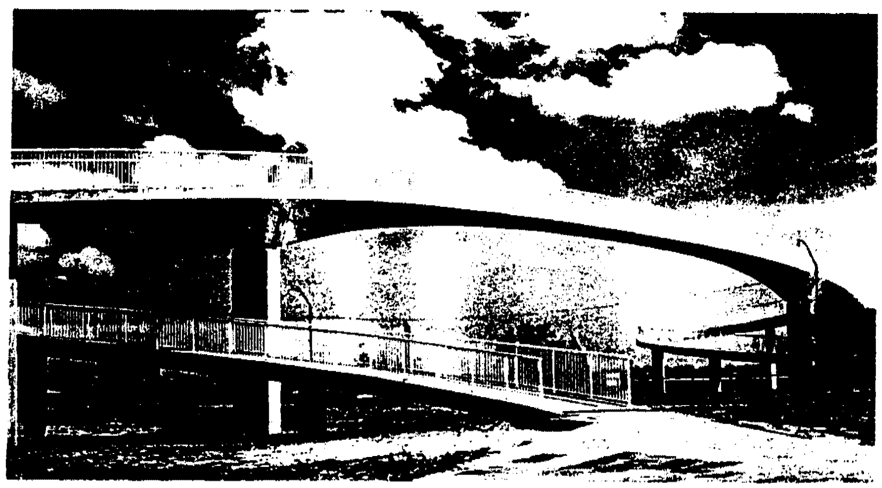


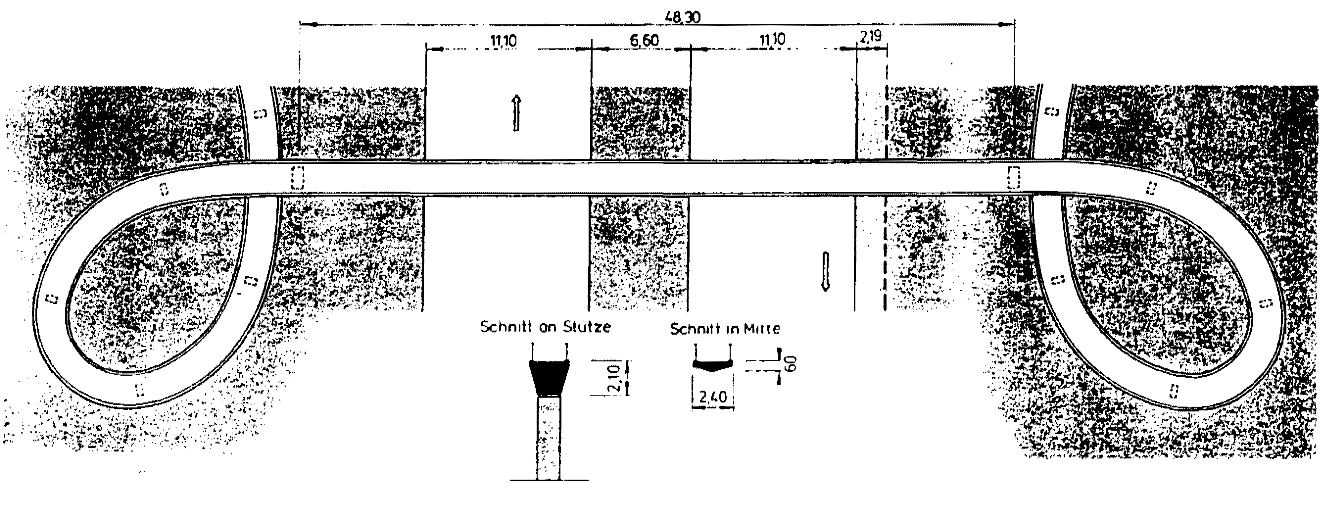
FIGURE 10
Pedestrian bridge connecting buildings in Bandai City, Niigata, Japan.

ıtigkeit begeistert ist. Alle Linien verlaufen in lang ,ezogenen Kurven mit stetigen Übergängen – nir- ıs ein Bruch des eleganten Fließens. Das Geländer eitet das überschlanke Tragwerk fast schwerelos, je- ıchte Stab ist kräftiger als die Zwischenstäbe, was ein ıg Unruhe in das transparente Geländerband bringt. sehr es bei solchen Wendelrampen auf den Quer- ıitt ankommt, zeigt ein Vergleich mit der Wendelrampe Stockmannsmühle für den Weg über die Bundes- ;e 326 in Wuppertal (Bild 8.45). Anstelle des Trapez- schnitts ist hier ein T-Querschnitt mit vertikalen Steg- ıen gewählt worden, der das Tragwerk schwer er- ;inen läßt. In der Führung der Krümmungen sind Un- gkeiten, die zusätzlich störend wirken.

ıen schlanken Überführungen über den Schloßpark- · in Karlsruhe konnten die Rampen geradlinig in die rstraße geführt werden (Bild 8.46). Von den Stützen



8.44



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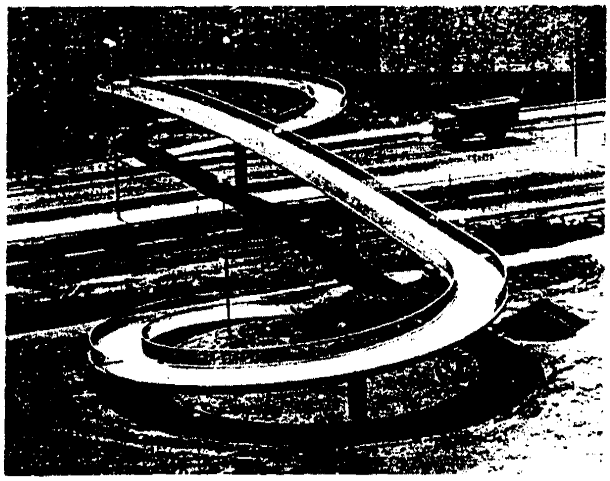
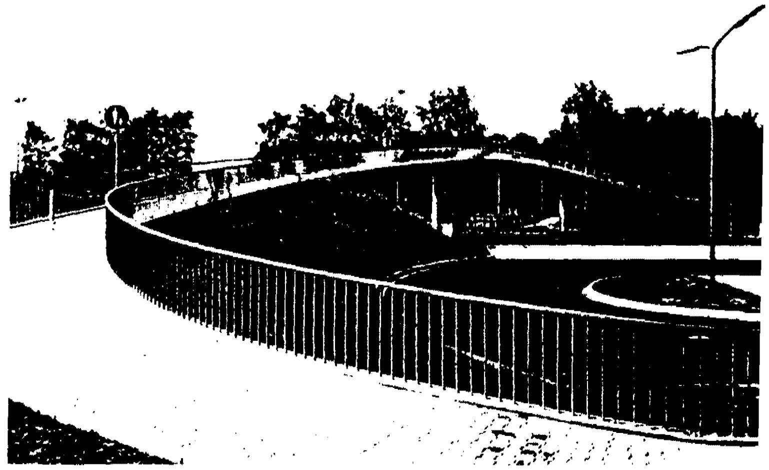


8.41

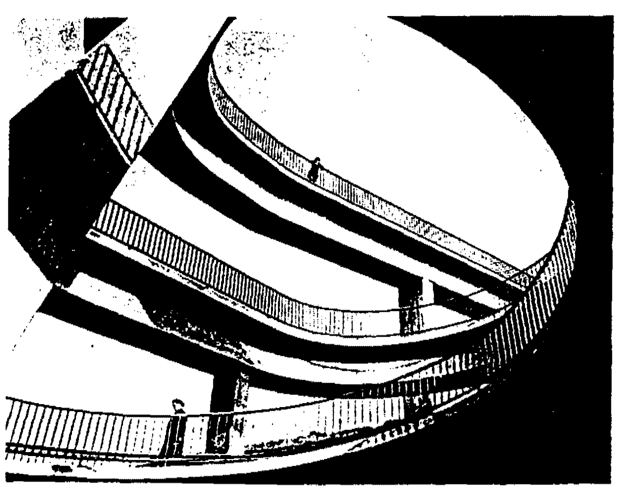


8.42

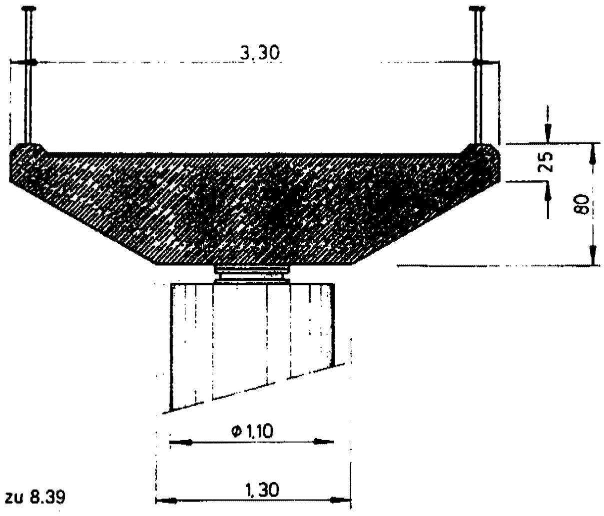
8.41 Wendelrampe an der Brücke über die Himmelgeisterstraße in Düsseldorf.
8.42 Fußgängerbrücke an der Nürnberger Straße, Düsseldorf.
8.43/8.44 Elegante Fußgängerbrücke, Hardy Street foot bridge, in Perth, Australien.
8.45 Weniger gelungene Wendelrampe in Wuppertal.

8.41/8.42 Helical ramps at overpasses in Düsseldorf.
8.43/8.44 Elegant prestressed concrete overpass bridge, (Hardy Street) in Perth, Australia.
8.45 Curved ramps in Wuppertal – not very pleasing.

An anderer Stelle schwenkt der Fußweg auf die überführte Straße ein (Bild 8.39). Der Spannbetonbalken mit trapezförmigem Querschnitt ist schon über der Straße gekrümmt. Wieder sind die Stützen unauffällig schlank. Die Brücke läuft fast wieder bis auf Null aus, das heißt am Ende steht nur ein kleines Widerlager, um auch dort Masse zu vermeiden. Bei solchen Fußgängerbrücken ist es wichtig, daß sie fast bis zum Boden auslaufen und nicht zwischen hohe Dämme und Widerlager eingeklemmt werden.
Wenn kein Raum für lange gerade Rampen vorhanden ist, dann kann man mit Wendelrampen einen schönen Aufgang schaffen, wie dies erstmals an der *Theodor-Heuss-Brücke* (Nordbrücke) in Düsseldorf geschah (Bild 8.40). Wieder beruht das schlanke Aussehen auf der guten Proportion zwischen dem Gesims und der restlichen Höhe des Trapezquerschnitts. Auch hier trägt das bescheiden geformte Geländer mit nur gleichen dünnen vertikalen Stäben zur schönen Wirkung bei.
Ähnliche, in der Krümmung sehr weitgespannte Wendelrampen hat die Brücke über die Himmelgeister Straße (Bild 8.41). Auch die Brücke über die Nürnberger Straße zeigt den Düsseldorfer Stil in einer anderen Variante – stets mit stetigem Krümmungswechsel aller durchweg parallelen Linien (Bild 8.42).
Die wohl schwungvollste Fußgänger-Überführung mit Wendelrampen (Neigung 10%) steht in Perth, Australien (Bilder 8.43 und 8.44) (Ingenieur K. C. Michael). Die sechsspurige Autobahn ist mit ℓ = 48 m frei überspannt, die Stützen sind 8 m vom Straßenrand zurückgesetzt – man scheute sich nicht vor der vergrößerten Spannweite. Kräftige, 1,8 m hohe Vouten über den Stützen erlaubten es, den Spannbetonbalken über der Mitte der Straße mit 60 cm so dünn zu machen, daß man beinahe an der Tragfähigkeit zweifelt und dennoch von der



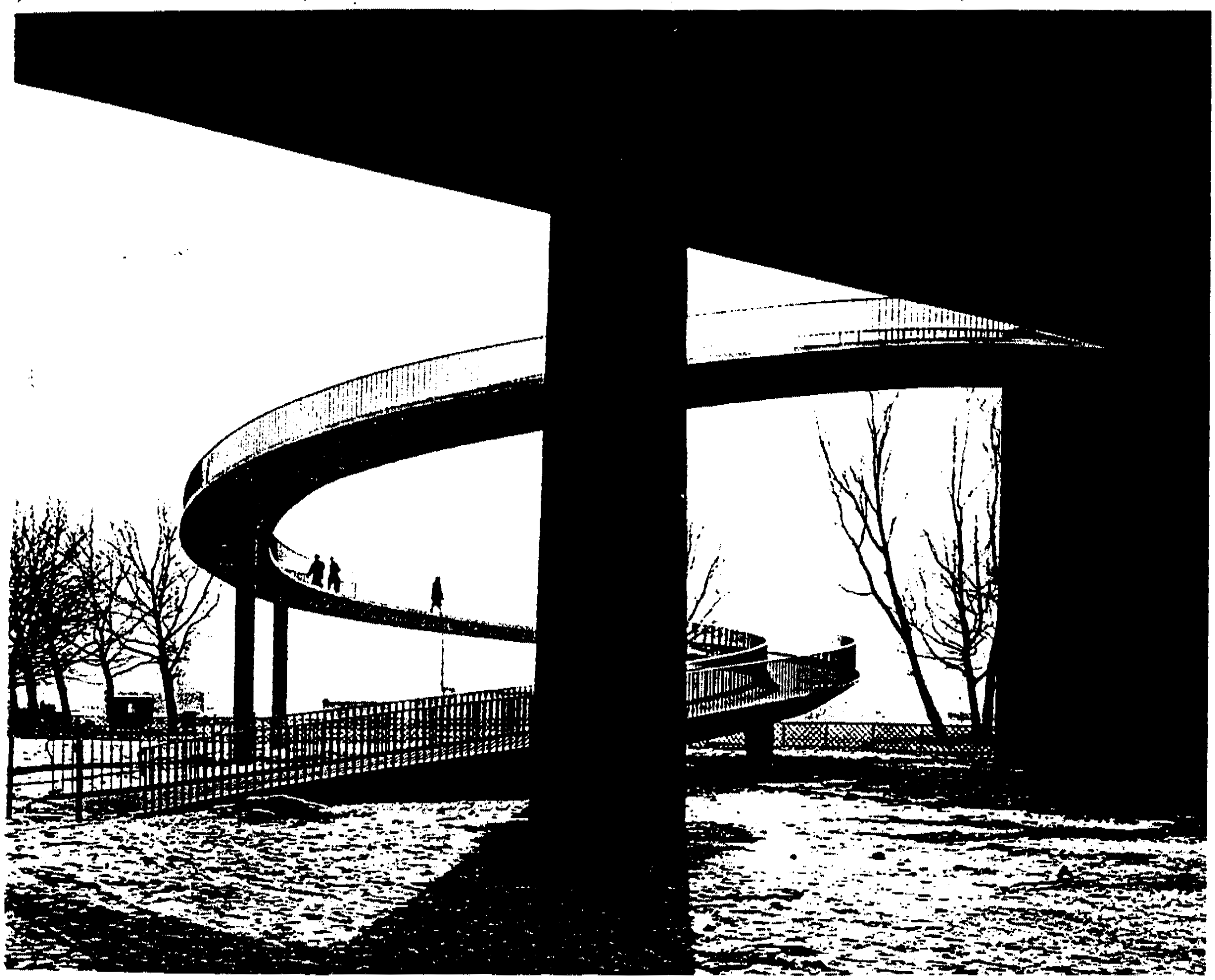
At another place the footpath turns into the dire
street below (fig. 8.39). The precast concrete b
pezoidal cross-section, begins to curve over
The supporting piers are again slender and th
conspicuous. The bridge ramp continues to a
height, so that at the end a small abutment is
avoiding mass even there. At such pedestrian l
important that they continue almost to the grou
not squeezed between high solid ramps and a
If there is no space for long straight ramps, th
achieve a good access with helically shaped
used for the first time at the Theodor Heuss Bric
seldorf (fig. 8.40). Again the slender appearanc
a good balance of proportions between the fas
remaining depth of the trapezoidal cross-se
modest railing of identical thin vertical steel b
utes to the pleasing appearance.
The bridge crossing the Himmelgeister Stre
spans and similar helical ramps (fig. 8.41). The
the Nürnberger Street is also a variation on the
style, and has steadily changing curvature with
edges parallel (fig. 8.42).
The most "floating" pedestrian overpass
ramps stands in *Perth, Australia* (fig. 8.43 anc
signed by K. C. Michael). The six-lane freewa
in one span of 48 m, and the piers stand 8 m
edges of the lanes, not fighting shy of increasi
length. The sturdy haunches above the pi
depth) allow a beam depth of 60 cm over the r
of the freeway, so thin that one almost doubts
capacity, but is nevertheless impressed with i
All lines run along smooth curves with steac
with no break of the elegant flow. The balust
the overslender structure almost as though th
gravity, every eighth bar is thicker than the
tween, which does cause a little unrest in the
grid.
How significantly the type of cross-section aff
pearance of such curved ramps is illustrated b
ison with the ramp at the *Stockmannsmühle* fo
ing on federal highway 326 in Wuppertal (fi
stead of a trapezoidal cross-section, a T-shap
vertical webs was chosen here, which gives a
The curvature does not change steadily and t
ded disturbing feature.
At the slender overpasses over the *Schloss*
Karlsruhe, it was possible to lead the ramps
the crossing (fig. 8.46). Long flat haunches
the top of the columns, propping up the thin c
which is continuous over the total length. O
derline the slenderness effect here by painti



zu 8.39

8.39 Fußgängerbrücke am Nordpark in Düsseldorf.
8.40 Wendelrampen für Fußgänger, hier an der Theodor-Heuss-Brücke in Düsseldorf.

8.39 Curved overpass in Düsseldorf, concrete.
8.40 Helical ramps for pedestrians at a Rhine bridge in Düsseldorf.



e Düsseldorfer Stege gehören dazu – dank der künstle-chen Beratung durch F. Tamms. Soweit die Bebauung is erlaubte, wurden hier die Rampen mit mäßiger Stei-ng weit ausgezogen und die Straße mit einem äußerst lanken Balken (max. $\ell:h = 50$) überspannt (Bilder 8.37 u 8.38). Der Ausrundungsradius ist mit R = 310 m groß … Im Querschnitt haben wir einen schmalen stäh-en Kastenträger, über den die Platte beidseitig weit skragt. Das 20 cm hohe Gesims ist hell, der Balken nkel gestrichen, um die Schlankheit zu betonen. Das ander verschwindet fast gegen den Himmel. Die Stüt-n sind sehr schlank, so daß man sie beinahe suchen iß. So schwebt das dünne Band leicht und frei hinüber. solchen überschlanken Stahlbrücken muß genügend …

The overpasses of *Düsseldorf* belong to the best, thanks to the artistry of F. Tamms. The ramps were extended with a slope up to 12% as far as the neighbouring buildings allow and an extremely slender beam was spanned across the street (fig. 8.37 and 8.38). (Span to depth ratios down to 1:50 were used). The radius for the vertical alignment was chosen as large as 310 m. The cross section of the beam shows a narrow steel box from which the deck slab cantilevers far to both sides. The 20 cm fascia is brightly painted, the beam dark, to emphasize the slenderness. The railing almost disappears against the sky. The columns are so slender that one must search for them and so the thin fascia ribbon floats light and free over the street. In such extremely light and slender steel bridges one must …

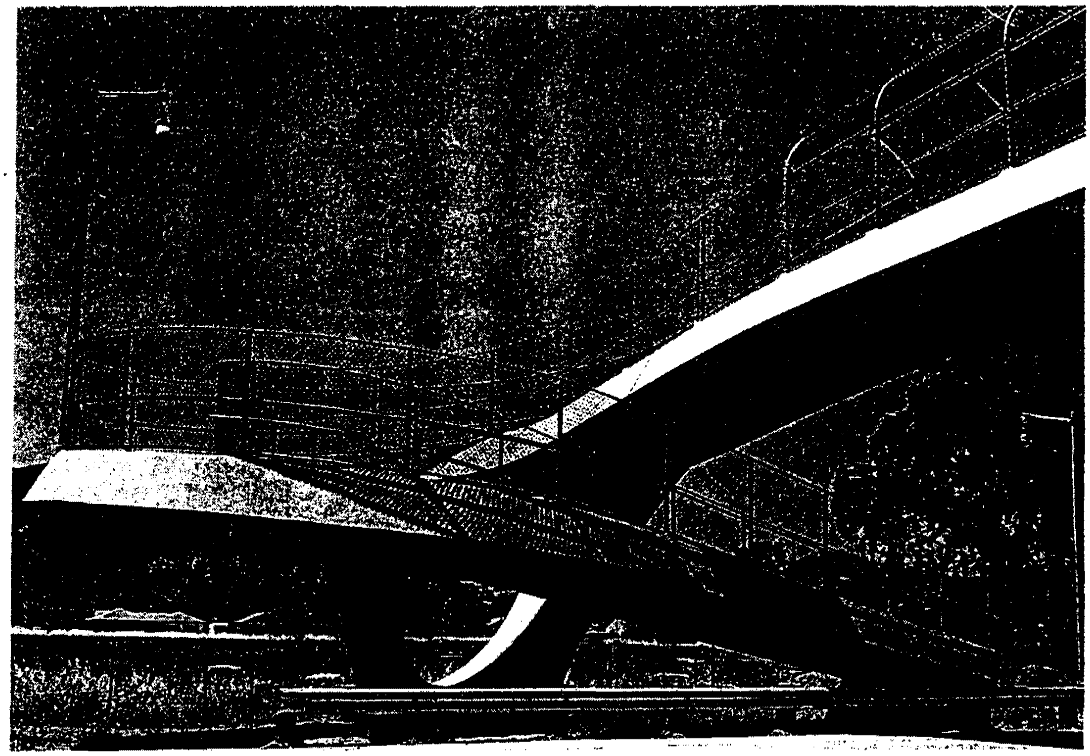


FIGURE 14 Oak Manor Pedestrian Overcrossing, Mendocino County, California.

tent textured panels. Precasting panels 4 in. m) thick with exposed coarse aggregate faces ısing them as the front form of the wall creates eresting effect and saves on form costs.

:STRIAN STRUCTURES

lestrian bridges are regarded as minor projects in lge designer's repertoire, but they are aesthetically tant and have a solid impact on the aesthetics of ighway. Some ugly pedestrian structures have built with a flight of stairs at each end and a ht box truss across the roadway.

lestrian structures lend themselves nicely to a ai·· design that seems to float across the space. very thin pedestrian structures have been built rope, where the deflection restrictions are not as as they are in the United States. Our required de- ɔn ratio of 1:1,000 results in a somewhat stiffer ure, but there is ample opportunity for artistic ex- . Steps are no longer used, but long, straight

dren from walking on top of the cage. A light, galvanized 2-in. (5-cm) mesh seems to be the best material. Clear plastics have been tried, but they ended up dirty, with scratched-in initials and other graffiti. Efforts have been made to make the fence less objectionable by making the supports in a wishbone pattern or framing the fence into panels. These help the appearance, but still an unsightly fence must be tolerated as long as some individuals find pleasure in dropping things on passing cars. It is also essential that the sides be visually open down to the deck surface so that there are no concealed areas.

SIGN BRIDGES

Another source of pain to the designer is signs mounted by traffic engineers on an otherwise beautiful bridge. Here again, the facts of life seem to govern. Sign bridges are expensive, so it is often necessary and logical to use bridge structures to hold directional signs. One concession that can usually be required is

FIGURE 5 Beijing River Bridge, Guang Zhou, Guang Tong Province.

combine straight lines and curved li
lines and soft lines in rhythm and ha
the rhythm of strength and grace be
achieved.

The composition of a bridge cont
the lines of the members, but also t
closed surfaces or masses and their
ors, all of which deserve careful stuc

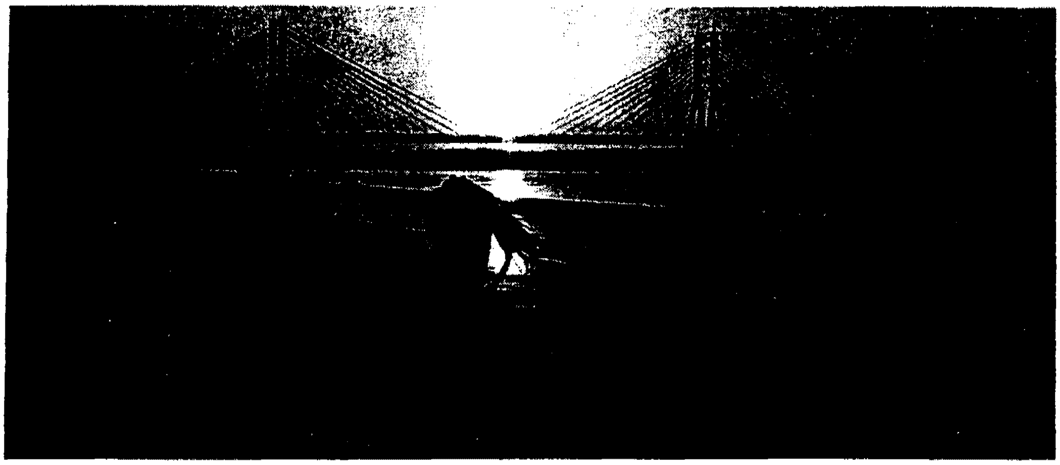


FIGURE 6 Ye
Bridge, Ji Nan
Province, the fi
stayed bridge
in China.

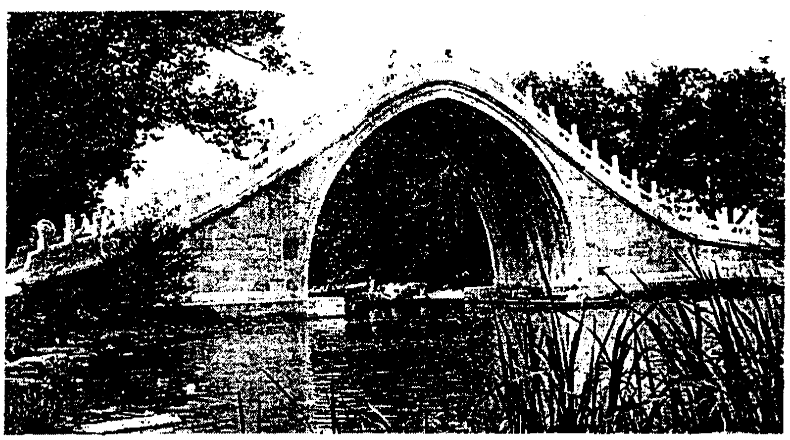


FIGURE 7 Jade Belt stone arch bridge, Summer Palace, Beijing, considered by some to be the most splendid and charming of its type in the world.

Although not so evident as in a painting, the emotion of the bridge designer can be reflected in the form of the structure.

Curved lines suggest soft features, but fluent variation always gives us pleasure. The bridge of curved lines, such as the arch or suspension bridge, looks

Beat and Rhythm

Vitruvius indistinctly related archite
and by the beginning of the twentietl
the fashion to consider architecture
sic. Some have said that architecture
music and music was flowing archite
the latter is open to debate. These tv
based on different materials, means,
certain aesthetic principles appear to
both. In both music and architecture
ery type of work that can be conside
rhythm is the quintessence of aesthe

Rhythm permeates all of human li
meaning. The pulsing of the heart ar
the lungs are slow when one is sad c
normal or a little quicker when one is
and rather fast when one is excited,
On a broader scale, we notice rhythn
setting of the sun, the transition from
ter, and the inexorable passage from
Rhythm is perceivable in the inner re

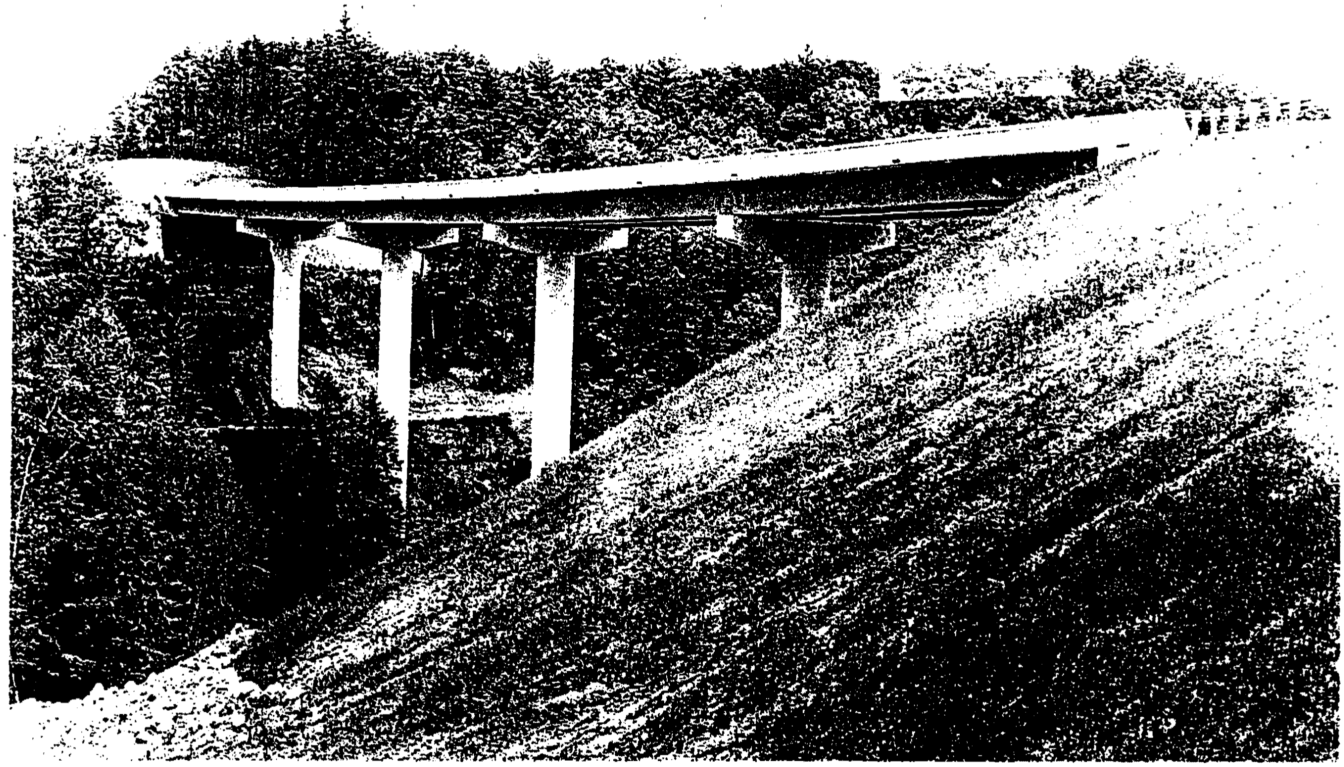


PLATE 25 State Route 62 over White's Creek, Morgan County, Tennessee.

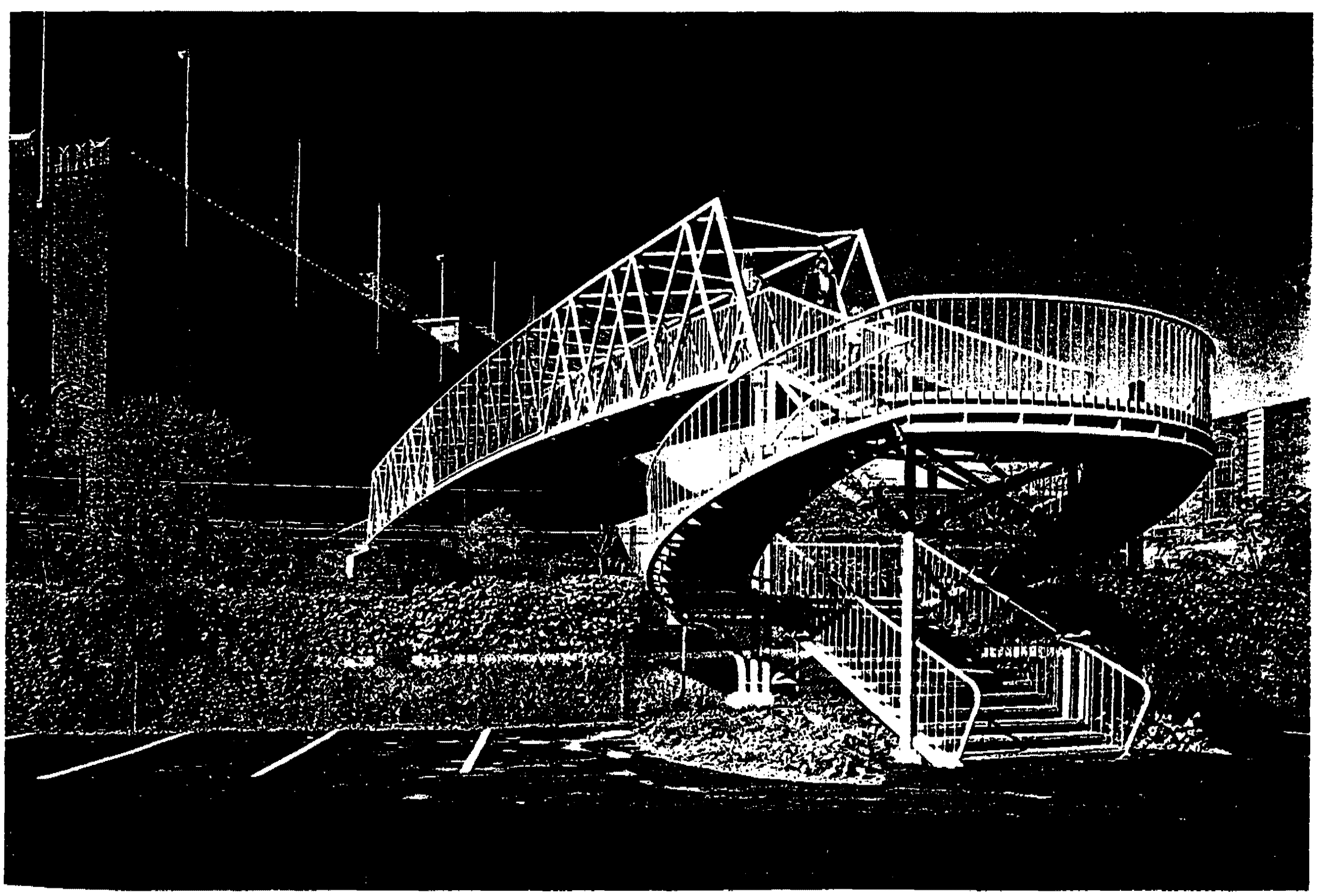


PLATE 26 University of Pennsylvania Recreation Bridge, Philadelphia.

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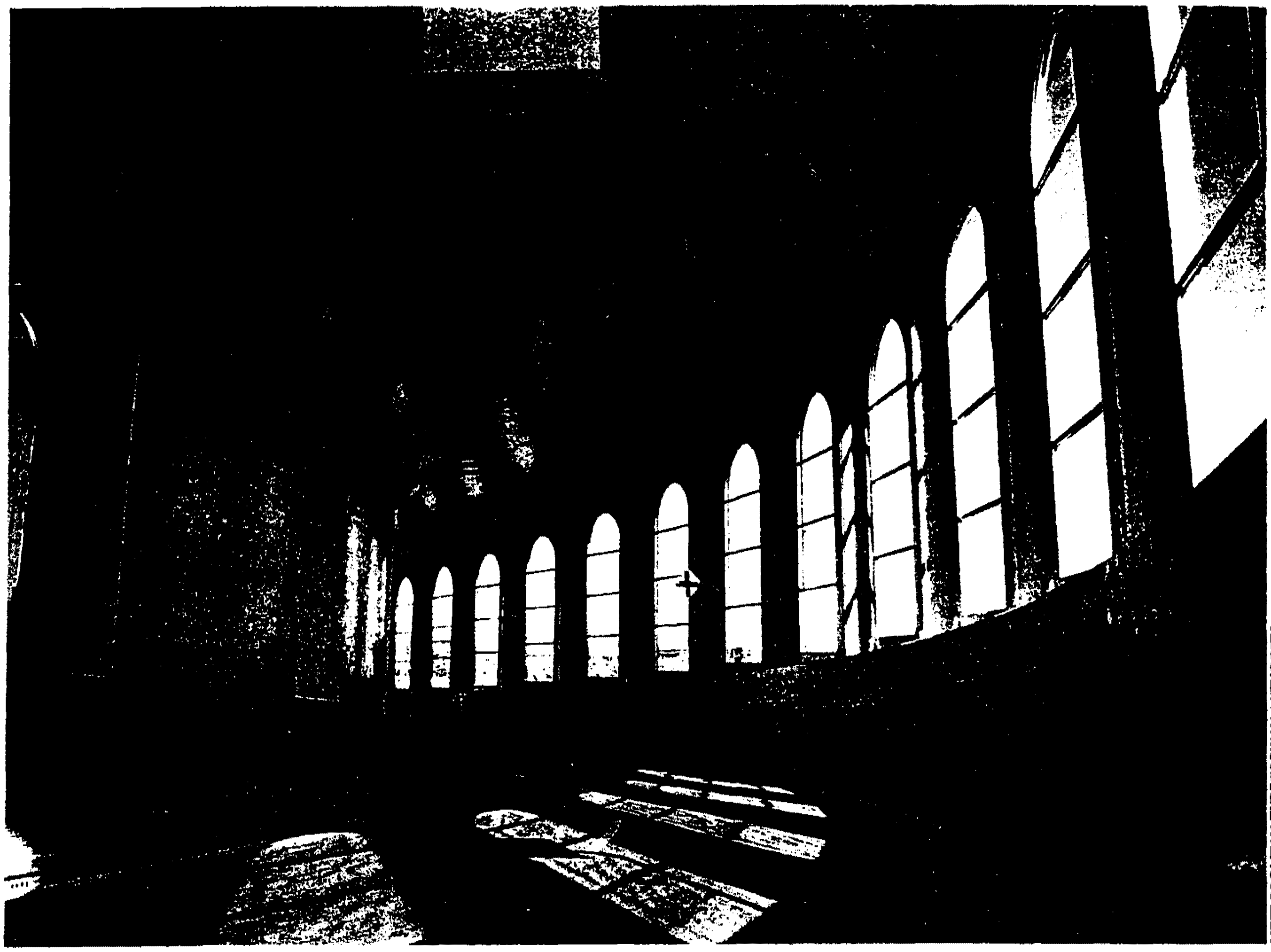

METROPOLITAN EXPRESSWAY AUTHORITY

FIGURE 5 Interior surface treatment, Kahei Ramp.

It is obvious that uniqueness is not an aesthetic value. Nevertheless, the innovative design of the Kahei Ramp (which brings to mind the Roman Colosseum) is not only functionally sound, but also a unified and reasonable structure.

ACKNOWLEDGMENTS

Appreciation is expressed to the Komai Iron Works for furnishing one photograph (Figure 1) and to the Metropolitan Expressway Authority for furnishing four photographs (Figures 2 through 5).

REFERENCE

1. B. J. Allan. Some Notes on Significance of Form in Bridge Engineering. *Proceedings of the Institution of Civil Engineers*. Part 1, Vol. 60, 1976, pp. 79–94.

Pedestrian Bridges in the City

YOSHIO NAKAMURA and YOICHI KUBOTA, Japan

Japan has had a long history of foot traffic, which characterizes the spatial quality of its cities. The street environment could be considered a seedbed that has nourished many vivid daily experiences. Almost everyone took for granted the freedom to walk with safety in the streets, without fear of vehicular traffic. The delicate configurations of the terrain and the expressive vegetation of the mild climate give birth to seasonal changes enjoyed by people attuned to the scenic beauty. Bridges for pedestrians and vehicular traffic were placed across rivers and canals that were filled with boat traffic moving freight and people upstream and downstream. These spots became points of both natural interest and human activities. Consequently, spaces on and near a bridge tended to be spectacular places, attracting people and commerce to form marketplaces or plazas before the modern systems of society were introduced in the Meiji Era in the 1860s (Figure 1). This humanized image of bridges for people has been revived in recent years along with efforts to improve the urban environment for pedestrians.

Rapid motorization after the 1950s caused a deterioration of the street environment. Pedestrian space in cities diminished. The prevalent planning and design concept in the 1960s was "separation of pedestrians and vehicles." This movement was based on the findings about the Radburn System by C. A. Perry in 192 and a report by Colin D. Buchanan in 1963 (*1*). Since the late 1960s, pedestrian bridges have been rapidly constructed to replace crosswalks on the streets, especially in Tokyo, by the Amelioration Project of Facilities for Traffic Safety. This project was designed to cope with the motorization caused by economic growth, and it contributed greatly toward the decrease in vehicle-pedestrian traffic accidents. However, the stairways of crossover bridges were physical obstructions, especially for the aged or handicapped and for bicycles, baby carriages, and wheelchairs. Moreover, many had complained that the crossover bridges, designed for function and economy and primarily to facilitate the movement of vehicular traffic, resulted in bridges that disturbed the townscape. Because of such criticism, bridge designers and engineers in the late 1970s realized the need to construct pedestrian bridges that enhanced the city environment.

Hasune Crossover Bridge (Figure 2), completed in 1978, is one of the first elaborate works in Japan. It consists of curvilinear steel box girders connected in plan to an equilateral triangle with a round hole at its center. It crosses over a large intersection of major streets near several housing developments. Contrived to appear slender, the bridge provides a tense atmo-

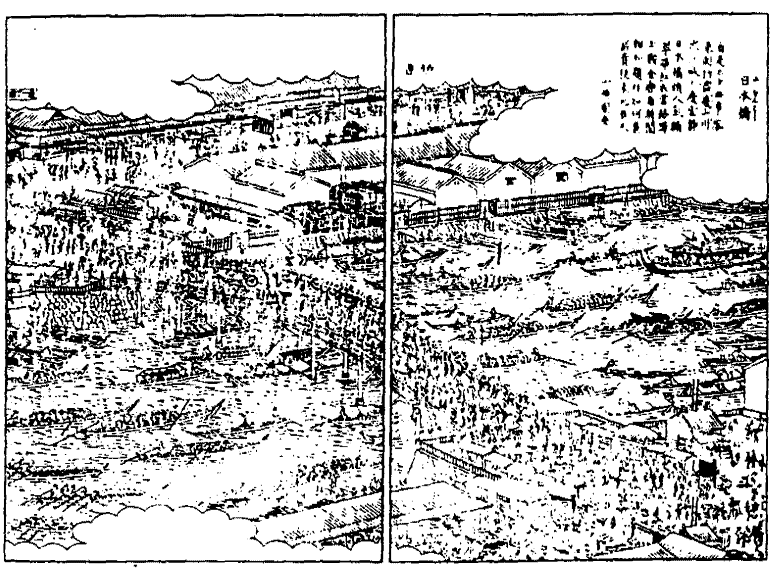

FIGURE 1 Old print of the scenery at Nihon Bashi (Japan Bridge) in Edo (present Tokyo) [from *Edo Meisho Zue (Places of Interest in Edo)*, published early in the nineteenth century].

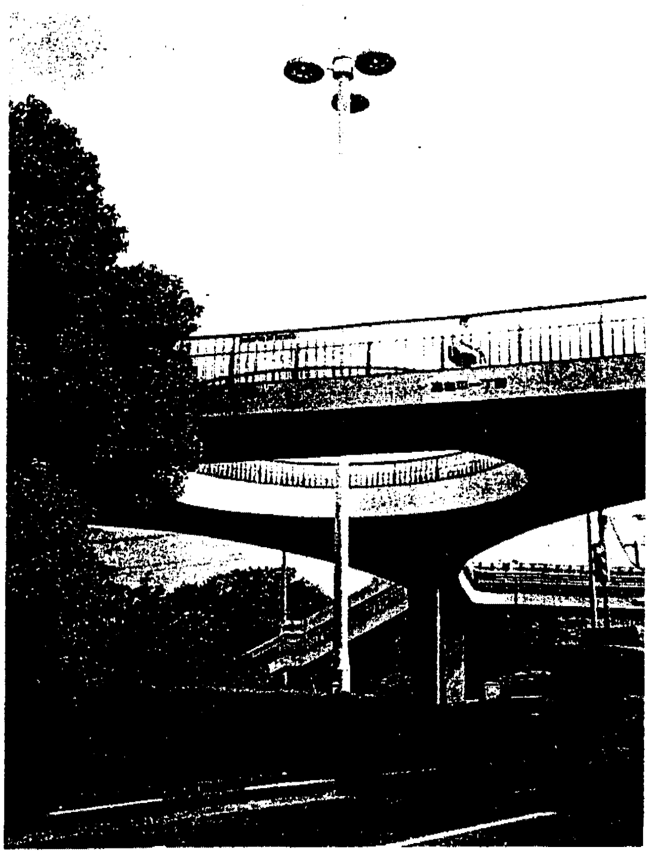

FIGURE 2 Hasune Crossover Bridge, Japan.

sphere with its fine form. It was designed to take into account the surrounding environment. Trees and shrubs are planted around its piers, which stand on traffic islands, and the pattern in the bridge pavement is arranged so that children can play stepping-stone games. Benches were placed on the bridge at its wide corners, and Braille tapes were attached to railings for the convenience of the visually handicapped. Gentle slopes (i.e., ramps) were provided beside the stairways. The concept of designing a pedestrian bridge as a community plaza gave birth to innovative trends in bridge design in Japan. One of these new trends evolved in the so-called New Towns, which were planned to separate pedestrian and vehicular traffic.

NEW TOWNS

Since 1960, rushing waves of urbanization compelled people to live in suburban areas, and many housing projects called "New Towns" were developed by public corporations and private companies around large cities. The Housing and Urban Development Corporation, formerly Nihon Jataku Kodan (Japan Housing Corporation), led in developing the concepts for the planning and design of pedestrian space. Primarily, this concept required separation of pedestrians and vehicles.

Tama New Town is the largest of these planned cities in Japan, lying on the hillside areas between 25 and 40 km (15.5 and 25 mi) west of the central district of Tokyo, with a planned future population of 310,000. The rolling topography of the Tama Hills required engineers to build many bridges on the network of pedestrian streets, which were completely separate from the streets carrying vehicular traffic (*2, 3*). Construction of bridges in Tama New Town began about 1970. About 90 bridges have been constructed at present, with plans for up to 150. Approximately 90 percent of the completed bridges are exclusively for pedestrians. In the transition of the design concepts for these bridges, three periods can be identified. They can be compared with the transition in the planning theory for community blocks and park systems.

In the first period, from 1970 to 1975, bridges were designed and constructed in a Spartan way, that is, to be functional and economical only. One by one, they were constructed over the major streets of the cities experiencing the most pedestrian traffic accidents. This point-by-point construction resulted from the segregated and staged plan of community blocks based on the Neighborhood Theory, in which the allotment of parks and pedestrian ways was short of a regional point of view.

The second period, from 1975 to 1980, was characterized by the pursuit of a formative variation for each bridge. The structural aesthetics of each individual bridge was considered one of the major factors in enhancing the nodal points located along the pedestrian networks. Pedestrian ways evolved into the park systems, which were planned at the regional level. However, adventurous shapes for bridges did not emerge because of economic conditions.

Under these circumstances, the pedestrian decks built in front of Tama Center Station (Figure 3) in 1979, composed of multiple reinforced concrete beams of light proportion, can be regarded as representative of this period. The deck was furnished with neatly designed street furniture, and the underside was painted with a light color. This design became the prototype for pedestrian decks in front of railway stations in later years.

The third period was from 1980 to 1985, when a keen awareness of the environmental quality of urban

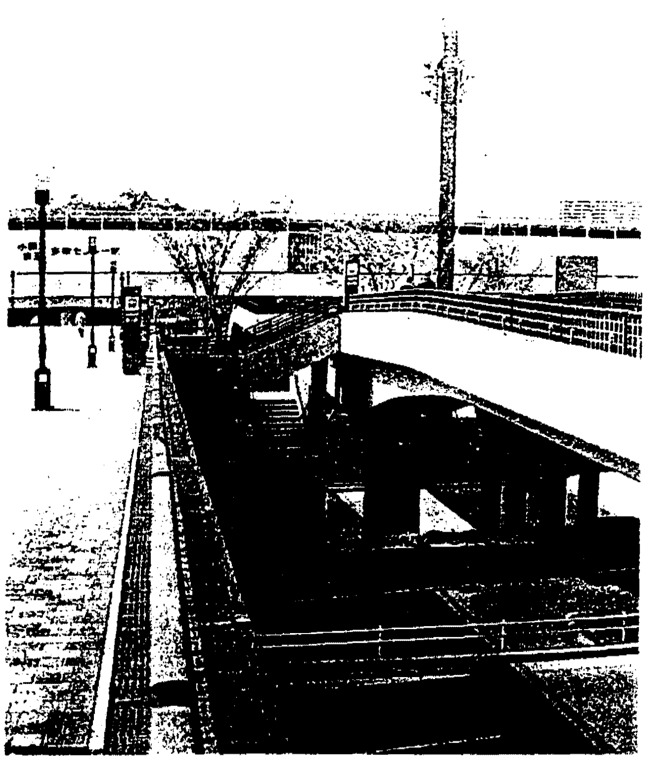

FIGURE 3 Tama Center Oh-hashi (main bridge at Tama Center District), Japan.

torical area of Tama Hills and the newly developed areas. and it symbolizes the connection between the two cultures.

Tsuru no Hashi (Crane Bridge), shown in Figure 5, is a masterpiece, also completed in 1983. It is a cantilevered prestressed concrete bridge with a sharp and dynamic form. Drivers heading to the lake area north of Mt. Fuji view this bridge as a landmark as they pass beneath it. The high abutment walls function as barriers, ensuring the privacy of adjacent houses. This bridge was awarded the Tanaka Prize by the Japan Society of Civil Engineers (JSCE) in 1986.

Summing up, these three design philosophies correspond to areas developed in Japan during each period. The first period (1970 to 1975) was function oriented, to ensure pedestrian passage separate from vehicular traffic along with strictly economical construction. The second period (1975 to 1980) was form oriented, pursuing moderate structural evolution and attempting to enhance the scenic beauty by introducing bridge aesthetics. This phase repeated the experience of the 1920s, when the modern technology of Japanese bridge engineering came into its own. The third phase (1980 to 1985) was environment oriented, emphasizing the importance of land use planning in

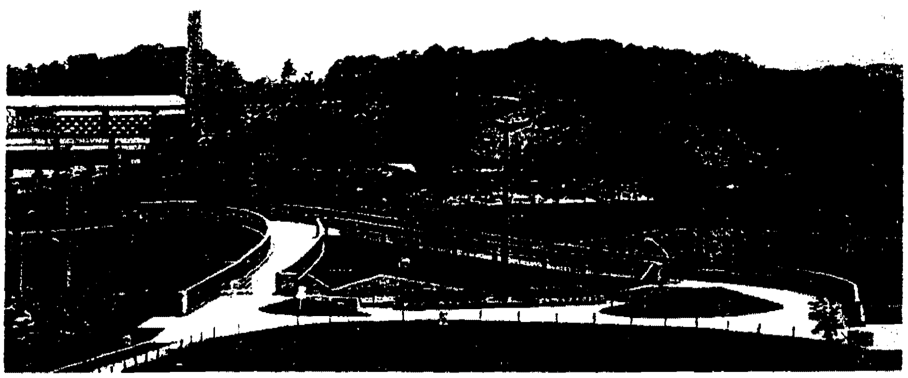

FIGURE 4 Y-shaped bridge.

spaces was shared by people in general. Finely sophisticated finishes were applied to bridge surfaces as an independent challenge to structural variations. In addition, adjoining land uses, background landscape, bridgehead plazas, and spaces on the bridge were all taken into account as factors for environmental design.

The single-span Y-shaped bridge shown in Figure 4, as yet unnamed, is an elegant adventure in curvilinear box girder design made of weatherproof steel. It was built in 1983. This bridge is located between the his-

bridge design and making efforts to keep the bridge in harmony with the surrounding townscape.

The present stage of bridge design may be characterized as a comprehensive scheme—in short, the "contextual approach." This design philosophy incorporates the spatial, social, and historical meanings of a place, as well as the design theme of a town. As a result, various unique bridges have been built.

Tsukuba New City is a unique place, exclusively planned for the concentration of scientific research in-

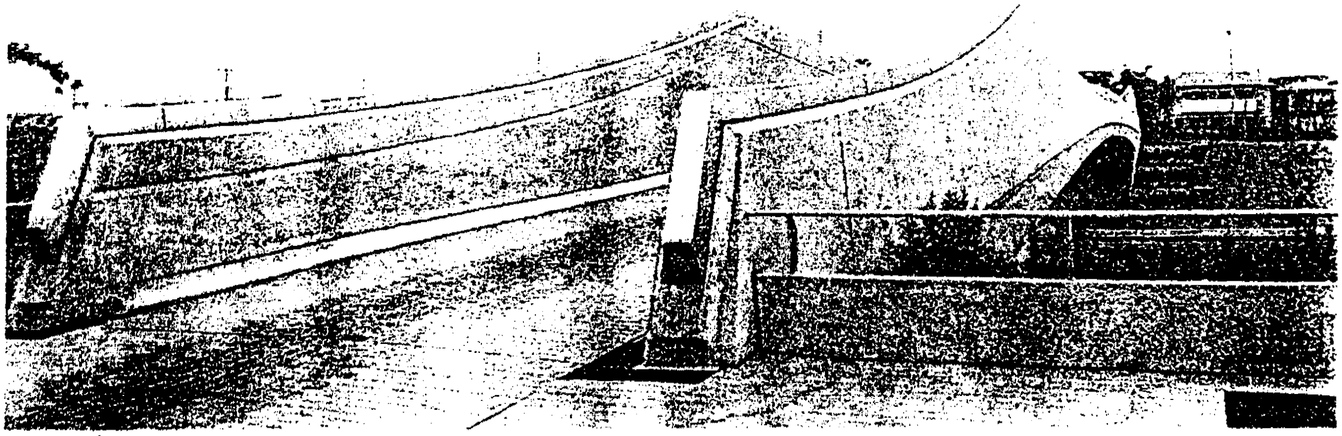

FIGURE 5 Tsuru no Hashi (Crane Bridge), Japan.

stitutes under the auspices of the government of Japan. This experimental city, designed in a modernistic way, has a systematic network of pedestrian ways similar to those in Tama New Town (*4*). Several structural types have been used to span the streets where pedestrians must cross roadways with heavy vehicular traffic.

In the central zone of this town, an artistic ambience has been introduced for the enrichment of daily life, in contrast with the academic and technical activities of the governmental institutions. Sakura Oh-hashi (Cherry Blossom Large Bridge), shown in Figure 6, is itself a kind of sculpture. The profile of the bridge has the shape of a sailboat, a theme derived from the image of a sailboat floating on nearby Lake Kasumigaura. A monumental obelisk forms the mast, and the hull is patterned after the bending moment required for the girders. Stone sculptures modeled after Mt. Tsukuba and the rippling waves at Kasumigaura adorn the bridgehead plazas.

The unnamed No. 36 pedestrian bridge (Figure 7) is juxtaposed with Sakura Oh-hashi at a distance of one block. It has, in contrast, a sharp appearance, al-

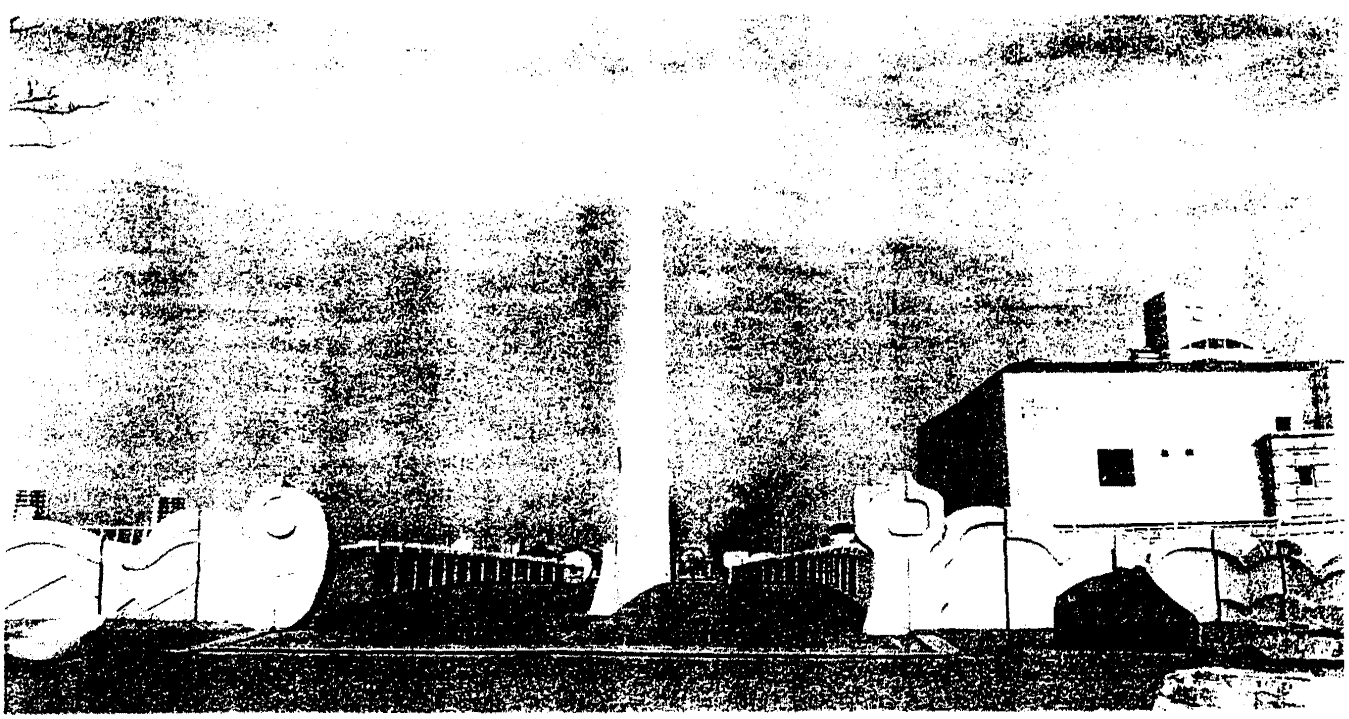

FIGURE 6 Sakura Oh-hashi (Cherry Blossom Large Bridge), Japan.

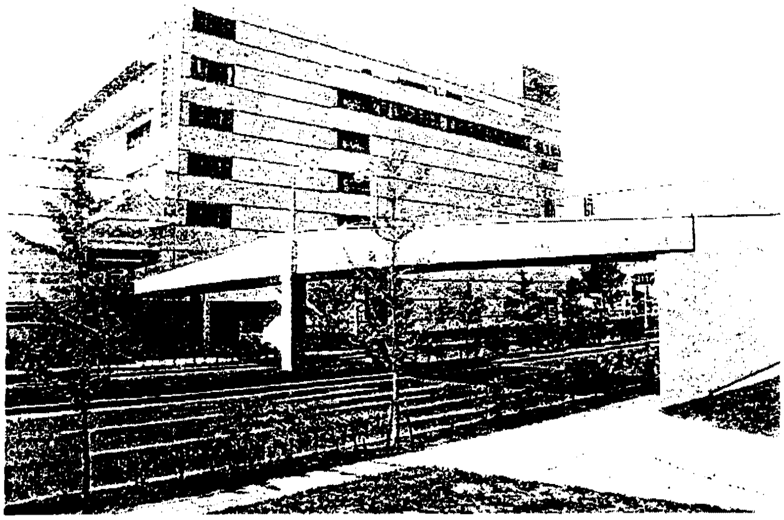

FIGURE 7 No. 36 pedestrian bridge, Japan.

though it is the same structural type as its neighbor. This bridge is architecturally coordinated with the buildings in the background (Figure 8), as well as with the pedestrian decks in the development districts.

OPEN SPACES

The reevaluation of pedestrian space in highly built-up cities, stimulated by the experience in New Towns, required pedestrian ways to be elevated to ensure pedestrian safety. Such a contrivance is necessary for plazas in front of railway stations that experience heavy traffic congestion. Along with redevelopment adjacent to railway stations, usually forming the central business districts, pedestrian decks have been introduced featuring spaces symbolizing the renewal of urban environments in the 1980s.

In front of the Ageo Station in Saitama Prefecture, about 30 km (18.5 mi) from Tokyo, a well-designed pedestrian deck was opened in 1983 (Plate 33). The structural features of this deck are fairly humble. Steel box girders are covered by finely welded plates with flush surfaces. Refinements for pedestrians, such as benches, planters, Braille tapes on handrails, automatic vocal guiding systems for the visually handicapped, and an elevator for wheelchairs, are prudently arranged.

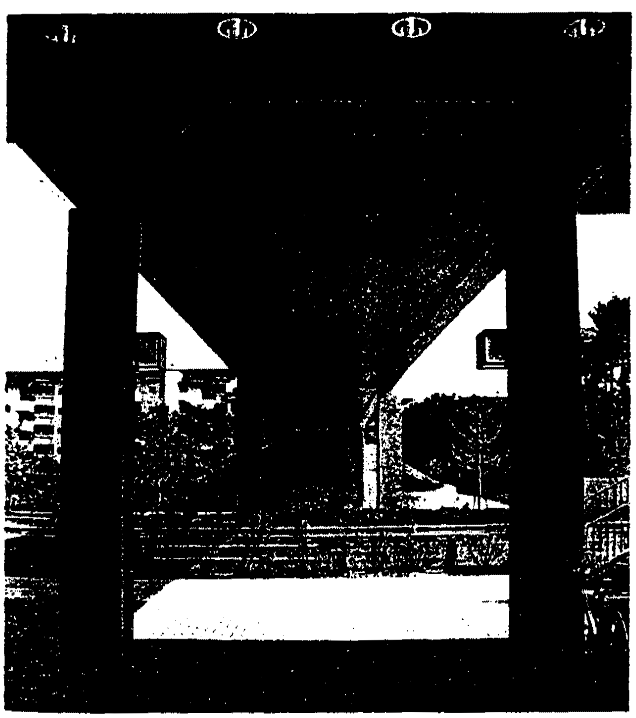

FIGURE 8 Underview of No. 36 pedestrian bridge. Piers are designed as gate of a building.

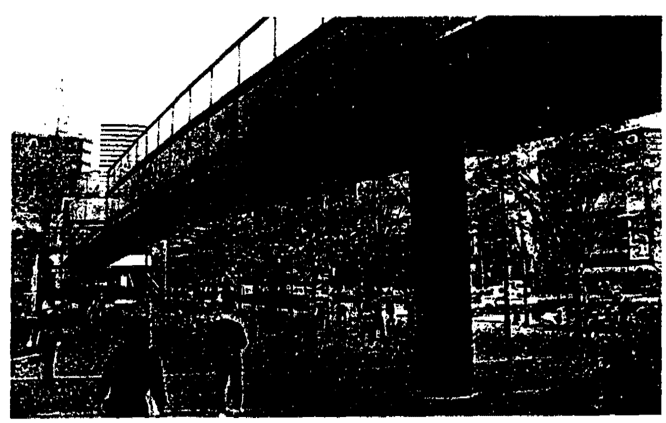

FIGURE 9 Pedestrian bridge connecting decks in Umeda Redevelopment District, Osaka, Japan.

Provision for refined pedestrian spaces has become a common-sense element in redevelopment projects. Architectural fusion of the visual qualities of bridges and buildings, including plantings, is an important theme in designing pedestrian bridges or decks. The bridge in the Umeda Redevelopment District in front of Osaka Station is sophisticated (Figure 9). Its beam is invisible, because it is finished like the walls and ceiling of the adjacent building. Cantilevered hemicylindrical balconies at the middle of the span contrast with the straight-line appearance of the bridge.

More commercialized pedestrian decks can be found in retail shopping areas. Bandai City in Niigata (Figure 10) is one such shopping center. Fancy arches for illumination and engraved external faces of reinforced concrete beams provide visual entertainment along the walk between the bus terminal, parking building, and department store.

The typical structural configuration for pedestrian decks is plain. However, additional features play a major role in enhancing the decks as open spaces. In several cases pedestrian bridges have been constructed with distinctive structural form, such as a cable-stayed bridge, to make its tower a symbol for the town. Regrettably, such attempts are rarely successful in densely built-up urban spaces except over wide rivers or major streets, because towers tend to be too conspicuous and inconsistent with the surrounding townscape of Japanese cities.

STRUCTURAL ENTERTAINMENT OR VISUAL PLAY

Recently, symbolic images have been required to satisfy the needs for mental and spiritual fulfillment, in consequence of the materialistic devastation of the physical environment. The desire for cozy experiences in urban spaces has also become one of the indispensable, intrinsic factors of environmental design in the 1980s.

Towers of cable-stayed bridges are a most attractive measure for expressing the new trends of environmental amelioration. The repetition of cables contrasts with the dreary mixture of an irregular townscape. A number of bridges of this type, with various tower shapes and cable patterns, have emerged with the expectation of providing visual interest. However, it is more interesting to observe examples of the transformation of conventional structures into charming styles by design elaboration.

An asymmetrical silhouette is the outstanding feature of Niji no Kakehashi (Rainbow Bridge), shown in Plate 34. Opened in 1984, it is located in Kuragaike Park, one of the largest parks in Toyota, the “city of automobiles,” in the Aichi Prefecture. Its rhythmical steel arch form connects a sight-seeing farm with the peak of Mt. Wakakusa. It crosses over the valley prefectural artery, dividing the central zone of this park. This bridge was awarded the Tanaka Prize in 1985 by JSCE for its unusual shape and elaborate construction.

Another example of the variant arch bridge is Hisho Bashi (Soar Bridge, Plate 35), which crosses the old Yodo River (Oh-kawa) in Osaka. It was completed in 1984. On the right side of the river the viaduct of the Hanshin Expressway is visible. The proportion of the rise and span of this bridge was contrived to be lower than usual, to avoid visual interference at the end of the span. In the middle of the span, however, a supplementary arch with a high rise was adopted for both structural and aesthetic reinforcement. The arch ribs on both sides of this bridge have a basket-handle shape, slanted inward to a degree considered unobtrusive for pedestrians on the bridge. This design was introduced because arch bridges with parallel ribs of high rise appear to be unstable due to the apparent divergence of the ribs at the arch crown.

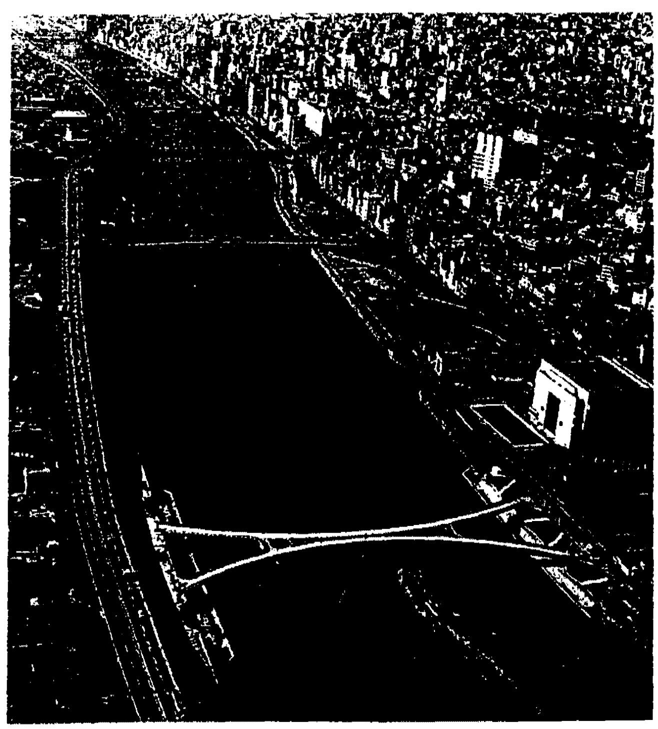

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FIGURE 11 Aerial view of Sumida River and Sakura Bashi (Cherry Blossom Bridge), east of Tokyo.

Completed in 1985, Sakura Bashi (Cherry Blossom Bridge), or "X Bridge"—named after its unique X-shaped plan—crosses the Sumida River east of Tokyo (Figure 11). The X-shaped deck is supported by curvilinear continuous steel box girders divided into three spans. Because the Sumida River is one of the historic spaces in Tokyo, special considerations were required in designing this bridge. Its plan was designed to facilitate access to parks and places of interest along both riversides. Because there is frequent traffic by sight-seeing boats on the river, the girders are provided with flush surfaces by full-sectional welding. Transparent panels of reinforced acril-glass are installed in the railings. Illuminating devices are placed under the handrails, and slanting lampposts are attached to the outsides of the bridge (Plate 36). Paved with granite, the space on the bridge is elegantly connected to bridgehead plazas on the waterfront, like other famous bridges built about 60 years ago on the Sumida River and adjacent canals.

CONTEXTUAL APPROACH IN URBAN SPACE

Ito states that there was an underlying theme in the planning and design of bridges constructed in Tokyo in the 1920s, after the Kanto earthquake disasters (5). Within seven years, 425 bridges were constructed in the downtown areas on both sides of the Sumida River. This incredible experience not only advanced structural engineering and construction technology, it also contributed to the modernization of urban space in the large cities of Japan. Sixty years after their completion, some of these bridges have been removed. Others have been replaced with new ones with different forms. However, many of the remaining bridges have become part of the established urban environment. In other words, they possess a historical context and a unique identity.

In the 1980s, rehabilitation of these historic structures has become one of the important themes in urban design. If a bridge must be replaced for some reason, imaginative conservation techniques should first be applied to try and save the existing bridge. Sendan no Ki Bashi in Osaka (Figure 12) is one such bridge, designed with a familiar motif in its ornamentation. It also has a commemorative epitaph placed in the bridgehead space to honor its predecessors.

This contextual approach, which takes into consideration the historic nature of a place where a bridge is to be built, has been applied to some newly designed bridges. Osaka-jo Shin-bashi (New Bridge at Osaka Castle, Figure 13), between Osaka Castle and Osaka

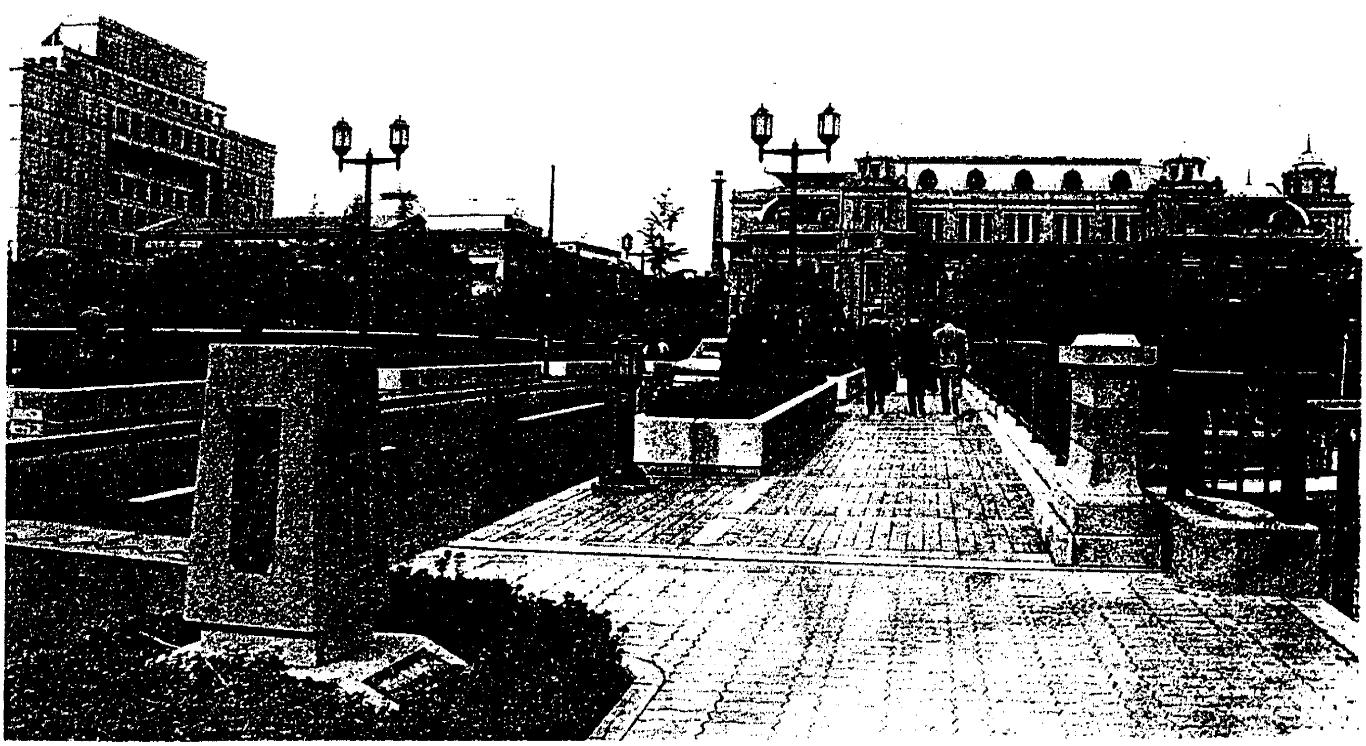


FIGURE 12 Sendan no Ki Bashi (Japanese Bead Tree Bridge), Osaka, Japan.

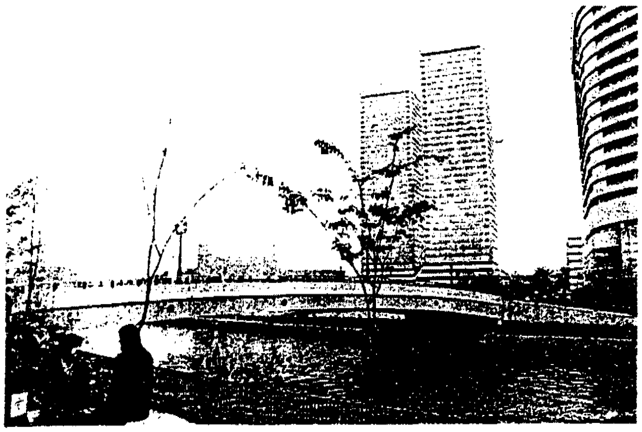


FIGURE 13 Osaka-jo Shin-bashi (New Bridge at Osaka Castle), Osaka, Japan.

Business Park, is designed to appear distinctly Japanese. Structurally, it consists of simple beams. Both sides, however, are covered with precast concrete walls tied to the bridge with brackets.

How far this postmodern tide should go is an unanswered question. If a place where a bridge lies has more than one notable quality, an anachronistic design may emerge. Hyakudai Bashi (Hundred Generation Bridge, Figure 14), built in 1986 in Soka, replicates the traditional form of a span of Kintai Bashi in Iwakuni, a famous wooden arch bridge. Surely it fits the line of old pine trees, planted along the Ayase River more than 200 years ago in the Edo Era, but the extreme retrospective style perplexes the viewer because there are modern buildings in the background. This solution would be right if the surrounding townscape were purely traditional.

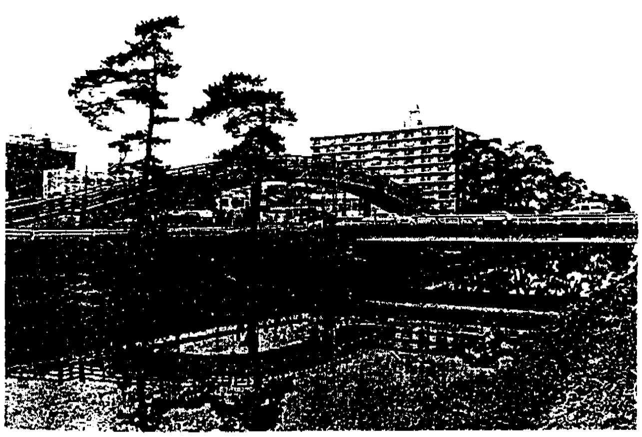


FIGURE 14 Hyakudai Bashi (Hundred Generation Bridge), Soka, Japan.

APPROACH FOR THE FUTURE

Aside from these independent examples, designed for specific locations in existing cities, a more systematic approach is needed in the planning and design of bridges for areas to be developed in the future. The following is an overview of a new approach taken for the design of a group of bridges in the planned extension area of Tama New Town. The planned bridges have not yet been constructed.

Basically, this approach is rather categorical, with the intention of extracting concepts for each bridge from the viewpoint of a regional and environmental context. It is influenced by the prevalent trends in bridge design, which determine their forms, avoiding whimsical structural inventions that are out of place.

The framework of the thinking process is outlined in Figure 15. It consists of a three-phase approach, with three steps in each phase:

1. The first phase approaches the problem from the standpoint of the theory of space recognition, to identify the locational characteristics of bridges and to establish design policies. Topological relationships among bridges are analyzed by means of abstract notions of point, line, and area.

2. The second phase adopts a set theory for the classification of environmental circumstances of specific bridges. It clusters bridges into several groups ac-

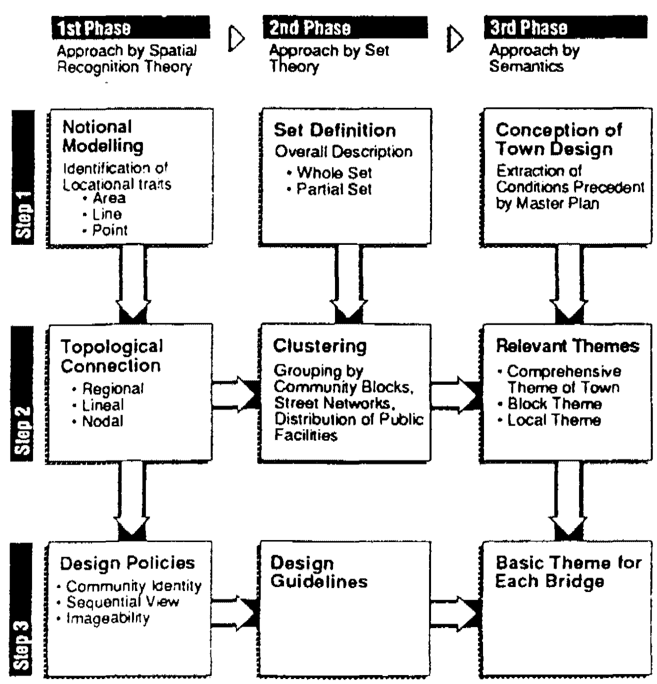


FIGURE 15 Framework of contextual approach (*6*).

cording to common properties to elucidate design guidelines.

3. In the third phase, a semantic approach is applied, extracting basic themes for each bridge from the concepts proposed in the master plan of the development project for the town.

These approaches will be verified in the coming decades.

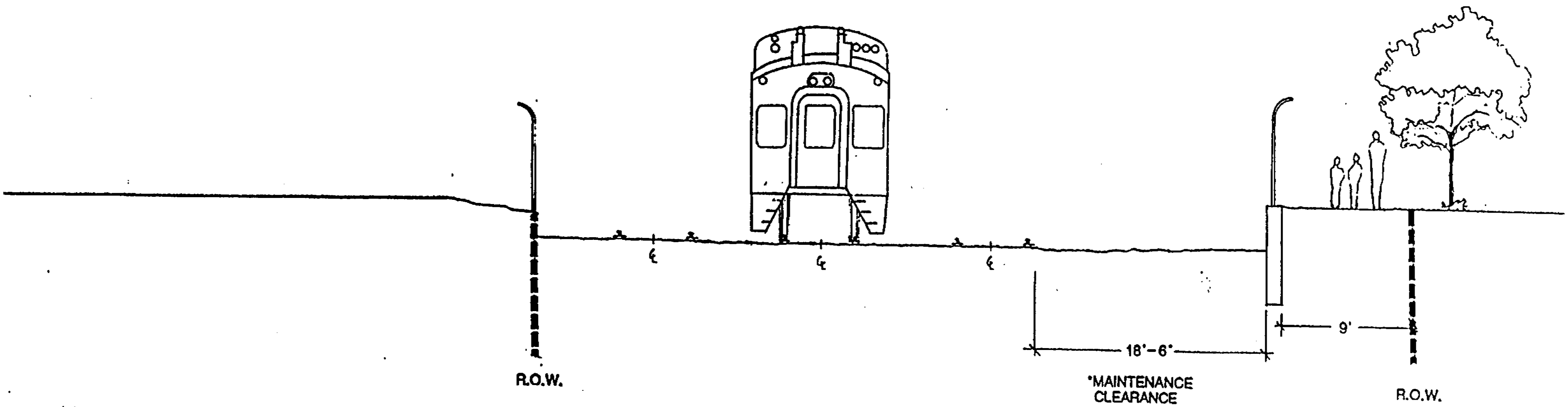
A bridge is not only a structure, but an entity signifying a wide range of meanings in the urban environment. Simmel stated that a bridge simultaneously denotes continuity and connotes separation of two sides (7). For the Japanese people, a bridge may also symbolize mental and spiritual values by its very existence. The word *hashi* in Japanese, meaning "bridge," also denotes the edge of something. The places spanned by bridges usually form domain boundaries of some sort in Japan (*8*).

This property, that of a nodal point on a boundary, is another side of the spatial significance of a bridge. That is, a bridge functions not only as a passage, but also as a place where people meet each other. In premodern days, open spaces of bridgehead plazas mediated things and people, as shown in Figure 1. This humanized aspect of a bridge as a unique place in the urban space should again be taken into account in the design of its space and its form.

REFERENCES

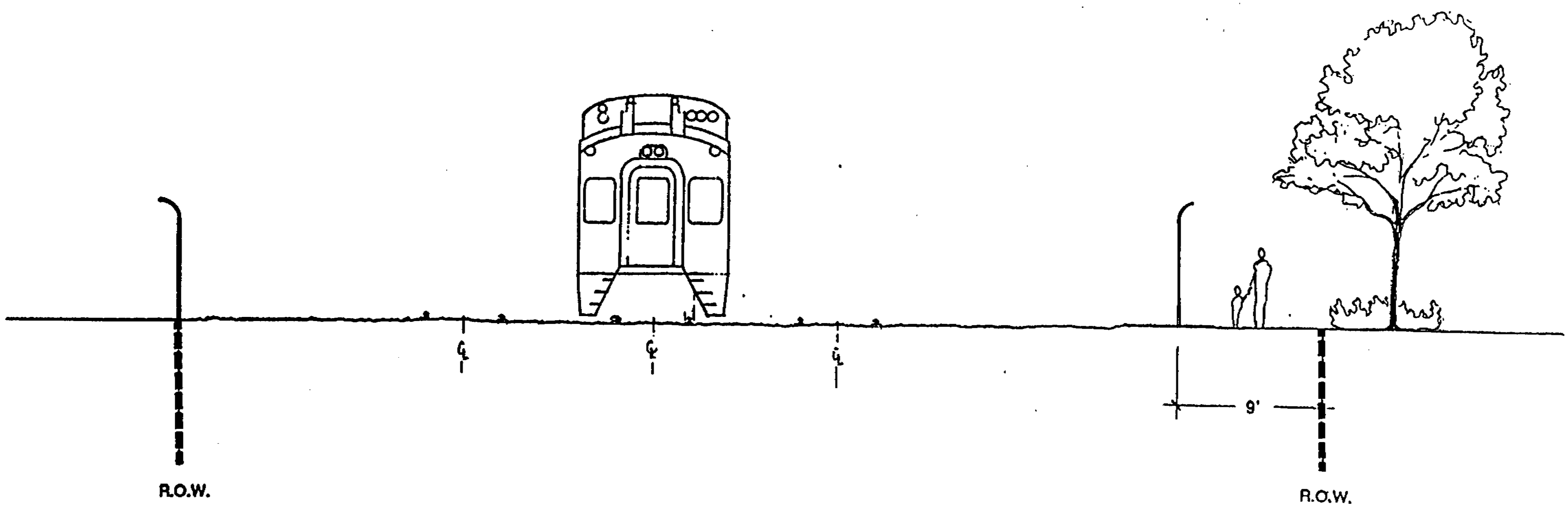
1. *Traffic in Towns: A Study of the Long Term Problems of Traffic in Urban Areas.* Ministry of Transport, London, 1963.
2. *Bridges in Tama New Town.* Minami-tama Branch Office, Housing and Urban Development Corporation, 1983.
3. *Collected Materials on Bridges in Tama New Town.* Minami-tama Branch Office, Housing and Urban Development Corporation, 1983.
4. *Planning and Design of Pedestrian Ways and Parks in Tsukuba New City.* Tsukuba Branch Office, Housing and Urban Development Corporation, 1982.
5. T. Ito. *Bridges in Tokyo.* Kajima Press, 1986.
6. *Report on the Master Plan of Bridges in B-4 and B-6 Areas in Minami-tama.* Minami-tama Branch Office, Housing and Urban Development Corporation, 1986.
7. G. Simmel. *Brücke und Tür* (trans. into Japanese by K. Sekata et al.). Hakusuisha Publishing, 1976.
8. A. Ueda. *Bridges and Japanese People.* Iwanami Books, 1984.

APPENDIX J



A RINDGE TOWERS
X-SECTION LOOKING WEST

(* IN ACCORDANCE WITH
<u>MBTA STANDARDS AND GUIDELINES</u>)



B SHERMAN STREET
X-SECTION WEST SIDE LOOKING WEST

(* IN ACCORDANCE WITH
MBTA STANDARDS AND GUIDELINES)