APPENDIX H
ALTERNATIVES

APPENDIX H-1
ALTERNATIVES—LESSER DENSITY TRAFFIC

Appendix H-1

Proposed Project Comparsion with Lower Density Alternative - AM Peak Hour

		No Build Condition			Build Condition							
	LANE GROUP				Proposed Project				Lower Density Alternative			
		V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS	\	V/C RATIO	Delay (sec.)	LOS	
Riverside Dr.												
Riverside Dr. (N-S) @ W. 79th St. (E-W)	EB-LTR	0.46	14.3	B	0.48	14.6	B		0.48	14.5	B	
	WB-LTR	0.34	12.9	B	0.34	12.9	B		0.34	12.9	B	
	NB-LTR	0.46	26.5	C	0.49	27.1	C		0.48	27.0	C	
	SB-LTR	0.99	62.7	E	1.02	67.9	E	*	1.01	66.6	E	
12th Avenue												
12th Ave. (NB) @ W. 59th St. (WB) UNSIGNALIZED 2-WAY STOP	EB-LT	0.00	8.5	A	0.00	8.9	A		0.00	8.8	A	
	NB-LTR	1.23	144.7	F	1.65	320.7	F	*	1.57	287.2	F	*
12th Ave. (N-S) @ W. 57th St. (E-W)	NB-T Main Line	0.77	29.5	C	0.73	28.2	C		0.73	28.2	C	
	NB-T Service	0.73	28.2	C	0.91	46.6	D	*	0.90	44.3	D	
	WB-R	0.38	32.6	C	0.38	32.6	C		0.38	32.6	C	
	NB-R Service unsignalized	0.92	35.9	E	0.92	35.9	E		0.92	35.9	E	
12th Ave. (N-S) @ W. 56th St. (EB)	NB-T	1.08	82.2	F	1.11	96.4	F	*	1.11	93.9	F	*
	SB-L	0.95	48.8	D	1.00	58.5	E	*	0.99	56.5	E	*
	NB-TR Service	0.65	33.9	C	0.69	36.8	C		0.65	33.9	C	
12th Ave. (N-S) @ W. 52nd St. (EB)	EB-LTR	1.05	109.4	F	1.05	109.4	F		1.05	109.4	F	
	NB-TR	1.03	54.5	D	1.06	63.8	E	*	1.05	62.0	E	*
	SB-L	0.87	96.8	F	0.87	96.8	F		0.87	96.8	F	
	SB-T	1.03	27.4	C	1.05	36.6	D		1.05	34.9	C	
12th Ave. (N-S) @ W. 42 nd St. (E-W)	EB-LTR	0.04	46.2	D	0.04	46.2	D		0.04	46.2	D	
	WB-L	0.35	53.2	D	0.35	53.2	D		0.35	53.2	D	
	WB-R	0.54	33.2	C	0.56	34.1	C		0.56	33.9	C	
	NB-T	0.99	54.7	D	1.02	62.4	E	*	1.01	60.9	E	*
	NB-R	0.29	26.7	C	0.29	26.7	C		0.29	26.7	C	
	SB-L	0.47	53.9	D	0.47	53.9	D		0.47	53.9	D	
	SB-T	0.74	4.4	A	0.76	4.8	A		0.76	4.7	A	
12th Ave. (N-S) @ W. 41 st St. (E-W)	EB-LR	0.00	38.2	D	0.00	38.2	D		0.00	38.2	D	
	WB-L	0.07	50.6	D	0.07	50.6	D		0.07	50.6	D	
	WB-R	0.31	54.7	D	0.34	55.3	E		0.33	55.2	E	
	NB-T	1.16	150.7	F	1.19	163.9	F	*	1.18	161.6	F	*
	SB-T	1.06	84.1	F	1.10	99.4	F	*	1.09	96.8	F	*
12th Ave. (N-S) @ W. 37 th St. (EB)	EB-LR	0.12	52.5	D	0.12	52.5	D		0.12	52.5	D	
	EB-R	0.13	53.1	D	0.13	53.1	D		0.13	53.1	D	
	NB-L	0.10	63.7	E	0.10	63.7	E		0.10	63.7	E	
	NB-T	0.95	37.8	D	0.98	42.1	D		0.97	41.3	D	
	SB-TR	1.05	105.8	F	1.09	119.8	F	*	1.08	117.3	F	*
11th Avenue/West End Avenue												
West End Ave. (N-S) @ W. 72nd St. (E-W)	EB-LT	0.53	30.0	C	0.54	30.3	C		0.54	30.3	C	
	EB-R	0.51	34.3	C	0.53	34.9	C		0.52	34.7	C	
	WB-LTR	0.85	47.3	D	0.92	56.8	E	*	0.91	55.5	E	*
	NB-L	0.50	30.6	C	0.51	32.0	C		0.51	31.7	C	
	NB-TR	0.44	16.7	B	0.46	16.9	B		0.46	16.8	B	
	SB-TR	0.64	25.8	C	0.66	26.1	C		0.66	26.1	C	
West End Ave. (N-S) @ W. 66 th St. (E-W)	EB-LR	0.51	27.9	C	0.52	28.3	C		0.52	28.2	C	
	WB-L	0.55	29.6	C	0.59	31.0	C		0.59	30.7	C	
	WB-T	0.73	35.4	D	0.76	36.9	D		0.75	36.6	D	
	WB-R	0.36	24.8	C	0.36	24.8	C		0.36	24.8	C	
	NB-L	0.83	68.5	E	0.88	81.1	F	*	0.87	79.1	E	*
	NB-T	0.35	17.3	B	0.37	17.5	B		0.37	17.5	B	
	SB-TR	0.65	18.3	B	0.67	18.7	B		0.67	18.6	B	

Appendix H-1

Proposed Project Comparsion with Lower Density Alternative - AM Peak Hour

		No Build Condition			Build Condition							
	LANE				Proposed Project				Lower Density Alternative			
	GROUP	V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS	\	V/C RATIO	Delay (sec.)	LOS	
West End Ave. (N-S) @ W. 59 th St. (E-W)	EB-LT				0.96	82.2	F		0.93	76.1	E	
	EB-R				0.21	26.3	C		0.19	26.0	C	
	EB-LTR	0.97	82.6	F		68.4	E			64.4	E	
	WB-LTR	1.12	114.4	F	1.81	411.1	F	*	1.77	393.2	F	*
	NB-L	0.29	11.9	B	0.55	21.5	C		0.51	19.4	B	
	NB-TR	0.56	11.8	B	0.56	11.8	B		0.56	11.8	B	
	SB-L	0.02	4.0	A	0.02	4.0	A		0.02	4.0	A	
	SB-TR	0.74	9.9	A	0.77	10.8	B		0.76	10.7	B	
11th Ave. (N-S) @ W. 57 th St. (E-W)	EB-L	0.71	32.7	C	0.73	34.3	C		0.73	34.0	C	
	EB-TR	0.67	31.0	C	0.67	31.0	C		0.67	31.0	C	
	WB-L	0.76	37.5	D	0.76	37.5	D		0.76	37.5	D	
	WB-TR	0.72	33.7	C	0.75	35.1	D		0.75	34.9	C	
	NB-L	0.40	24.5	C	0.41	25.1	C		0.41	24.9	C	
	NB-TR	0.63	21.8	C	0.64	22.2	C		0.64	22.1	C	
	SB-L	0.81	48.3	D	0.94	72.6	E	*	0.91	66.6	E	*
	SB-TR	0.75	21.8	C	0.76	22.2	C		0.76	22.1	C	
10th Avenue/Amsterdam Avenue												
Amsterdam Ave. (NB) @ W. 59 th St. (E-W)	EB-L	0.61	38.4	D	0.71	46.9	D	*	0.69	44.5	D	
	WB-T	0.39	24.2	C	0.41	24.5	C		0.41	24.5	C	
	WB-R	0.05	19.9	B	0.05	19.9	B		0.05	19.9	B	
	NB-LT	0.46	9.1	A	0.48	9.2	A		0.47	9.2	A	
10th Ave. (NB) @ W. 57 th St. (E-W)	EB-LT	0.95	46.0	D	0.98	53.6	D	*	0.98	52.4	D	*
	WB-TR	0.65	23.6	C	0.68	24.2	C		0.67	24.2	C	
	NB-LTR	0.73	17.7	B	0.74	17.9	B		0.74	17.8	B	
9th Avenue/Columbus Avenue												
Columbus Ave. (SB) @ W. 60 th St. (E-W)	EB-R	1.14	128.6	F	1.23	164.0	F	*	1.22	156.6	F	*
	WB-L	0.53	28.2	C	0.55	28.5	C		0.54	28.4	C	
	WB-LT	0.23	22.8	C	0.23	22.8	C		0.23	22.8	C	
	SB-TR	0.66	18.2	B	0.67	18.2	B		0.66	18.2	B	
9th Ave. (SB) @ W. 57 th St. (E-W)	EB-TR	1.27	164.7	F	1.29	176.4	F	*	1.29	174.1	F	*
	WB-DefL	1.03	74.9	E	1.03	81.3	F	*	1.03	81.3	F	*
	WB-T	0.87	36.3	D	0.92	42.2	D		0.91	41.1	D	
	SB-L	0.48	28.3	C	0.50	29.0	C		0.50	28.9	C	
	SB-T	0.77	27.7	C	0.78	27.9	C		0.78	27.9	C	
	SB-R	0.66	36.5	D	0.66	36.5	D		0.66	36.5	D	
Central Park W.												
Central Park W. (N-S) @ W. 66 th St. (WB)	WB-L	0.44	29.2	C	0.44	29.2	C		0.44	29.2	C	
	WB-T	1.16	124.2	F	1.19	136.7	F	*	1.19	134.3	F	*
	WB-R	0.85	51.4	D	0.85	51.4	D		0.85	51.4	D	
	NB-LT	0.64	15.2	B	0.65	15.4	B		0.65	15.4	B	
	SB-TR	0.83	25.3	C	0.83	25.8	C		0.83	25.7	C	

Notes:
EB-Eastbound, WB-Westbound, NB-Northbound, SB-Southbound
L-Left, T-Through, R-Right, Dfl-Analysis considers a Defacto Left Lane on this approach
V/C Ratio - Volume to Capacity Ratio, sec. - Seconds
LOS - Level of Service
* -Denotes Impacted Location
(1) -Total approach delay (provided due to changes in lane configuration)
Analysis is based on the 2000 Highway Capacity Manual methodology (HCS+, version 5.4)
This table has been revised for the FSEIS

Appendix H-1

Proposed Project Comparsion with Lower Density Alternative - MD Peak Hour

		No Build Condition			Build Condition							
					Proposed Project				Lower Density Alternative			
	LANE GROUP	V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS		V/C RATIO	Delay (sec.)	LOS	
12th Avenue												
12th Ave. (NB) @	EB-LT	0.00	8.2	A	0.00	8.5	A		0.00	8.5	A	
W. 59th St. (WB)	NB-LTR	0.78	29.2	D	1.14	109.3	F	*	1.07	85.9	F	*
UNSIGNALIZED 2-WAY STOP												
12th Ave. (N-S) @	NB-T	0.75	12.6	B	0.77	13.2	B		0.77	13.1	B	
W. 56th St. (EB)	SB-L	1.10	115.6	F	1.21	159.8	F	*	1.20	152.3	F	*
	NB-TR Service	0.27	7.0	A	0.27	7.0	A		0.27	7.0	A	
12th Ave. (N-S) @	EB-LTR	0.65	45.8	D	0.65	45.8	D		0.65	45.8	D	
W. 52nd St. (EB)	NB-TR	1.13	89.2	F	1.16	103.0	F	*	1.15	100.6	F	*
	SB-L	0.84	86.4	F	0.84	86.4	F		0.84	86.4	F	
	SB-T	0.64	12.4	B	0.66	12.9	B		0.66	12.8	B	
12th Ave. (N-S) @	EB-LTR	0.07	32.4	C	0.07	32.4	C		0.07	32.4	C	
W. 42 nd St. (E-W)	WB-L	0.61	45.9	D	0.61	45.9	D		0.61	45.9	D	
	WB-R	0.64	25.3	C	0.67	26.3	C		0.66	26.2	C	
	NB-T	1.08	82.4	F	1.12	97.1	F	*	1.11	94.6	F	*
	NB-R	0.31	28.5	C	0.31	28.5	C		0.31	28.5	C	
	SB-L	0.26	40.0	D	0.26	40.0	D		0.26	40.0	D	
	SB-T	0.75	17.0	B	0.78	18.0	B		0.78	17.8	B	
12th Ave. (N-S) @	EB-LR	0.02	24.9	C	0.02	24.9	C		0.02	24.9	C	
W. 41 st St. (E-W)	WB-L	0.08	37.7	D	0.08	37.7	D		0.08	37.7	D	
	WB-R	0.37	42.5	D	0.41	43.1	D		0.40	43.1	D	
	NB-T	1.05	68.8	E	1.08	80.3	F	*	1.08	78.2	E	*
	SB-T	0.92	31.9	C	0.96	36.4	D		0.95	35.5	D	
12th Ave. (N-S) @	EB-LR	0.14	43.1	D	0.14	43.1	D		0.14	43.1	D	
W. 37 th St. (EB)	EB-R	0.14	43.7	D	0.14	43.7	D		0.14	43.7	D	
	NB-L	0.20	50.4	D	0.20	50.4	D		0.20	50.4	D	
	NB-T	0.78	19.8	B	0.80	20.6	C		0.79	20.4	C	
	SB-TR	0.98	39.5	D	1.02	49.0	D	*	1.01	47.3	D	*
11th Avenue/West End Avenue												
West End Ave. (N-S) @	EB-LT	0.28	29.9	C	0.31	30.2	C		0.30	30.2	C	
W. 72nd St. (E-W)	EB-R	0.44	40.4	D	0.48	42.7	D		0.47	41.9	D	
	WB-LTR	0.99	79.2	E	1.04	93.2	F	*	1.03	90.0	F	*
	NB-LTR	0.44	16.5	B	0.47	16.9	B		0.46	16.8	B	
	SB-TR	0.79	35.6	D	0.82	37.2	D		0.81	36.9	D	
West End Ave. (N-S) @	EB-LT				0.29	26.8	C		0.27	26.6	C	
W. 59 th St. (E-W)	EB-R				0.23	26.6	C		0.20	26.2	C	
	EB-LTR	0.34	27.8	C		26.7	C			26.4	C	
	WB-LTR	0.81	44.8	D	0.97	68.5	E	*	0.95	64.5	E	*
	NB-L	0.15	8.6	A	0.33	11.8	B		0.30	11.2	B	
	NB-TR	0.27	8.6	A	0.27	8.6	A		0.27	8.6	A	
	SB-L	0.02	6.9	A	0.02	6.9	A		0.02	6.9	A	
	SB-TR	0.42	10.0	B	0.44	10.2	B		0.44	10.2	B	
9th Avenue/Columbus Avenue												
Columbus Ave. (SB) @	WB-LT	0.49	12.0	B	0.51	12.2	B		0.50	12.2	B	
W. 66 th St. (E-W)	SB-TR	1.18	121.5	F	1.19	127.1	F	*	1.19	126.4	F	*
Columbus Ave. (SB) @	EB-R	0.85	55.7	E	0.98	79.6	E	*	0.95	74.2	E	*
W. 60 th St. (E-W)	WB-L	0.72	34.7	C	0.73	35.5	D		0.73	35.4	D	
	WB-LT	0.26	23.2	C	0.26	23.2	C		0.26	23.2	C	
	SB-TR	0.68	21.6	C	0.68	21.6	C		0.68	21.6	C	
9th Ave. (SB) @	EB-TR	1.24	157.3	F	1.29	176.9	F	*	1.28	172.4	F	*
W. 57 th St. (E-W)	WB-DefL	0.93	58.2	E	0.93	57.6	E		0.93	57.6	E	
	WB-T	1.16	112.8	F	1.21	134.3	F	*	1.20	130.8	F	*
	SB-L	0.43	27.3	C	0.46	28.1	C		0.45	27.9	C	
	SB-T	0.77	28.3	C	0.78	28.5	C		0.78	28.5	C	
	SB-R	0.76	45.9	D	0.65	35.5	D		0.65	35.5	D	

Appendix H-1
Proposed Project Comparsion with Lower Density Alternative - MD Peak Hour

		No Build Condition			Build Condition							
	LANE GROUP				Proposed Project				Lower Density Alternative			
		V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS		V/C RATIO	Delay (sec.)	LOS	
Central Park W.												
Central Park W. (N-S) @ W. 72 nd St. (E-W)	EB-L	0.22	20.2	C	0.23	20.2	C		0.23	20.2	C	
	EB-R	0.47	26.5	C	0.47	26.5	C		0.47	26.5	C	
	NB-LT	1.08	79.8	E	1.10	84.6	F	*	1.09	83.8	F	*
	SB-TR	0.65	18.5	B	0.67	18.9	B		0.67	18.8	B	
Central Park W. (N-S) @ W. 66 th St. (WB)	WB-L	0.59	33.2	C	0.59	33.2	C		0.59	33.2	C	
	WB-T	1.12	107.7	F	1.15	118.4	F	*	1.14	116.2	F	*
	WB-R	0.70	38.3	D	0.70	38.3	D		0.7	38.3	D	
	NB-LT	0.57	13.6	B	0.59	13.8	B		0.58	13.7	B	
	SB-TR	0.65	22.2	C	0.66	22.6	C		0.66	22.5	C	

Notes:
EB-Eastbound, WB-Westbound, NB-Northbound, SB-Southbound
L-Left, T-Through, R-Right, Dfl-Analysis considers a Defacto Left Lane on this approach
V/C Ratio - Volume to Capacity Ratio, sec. - Seconds
LOS - Level of Service
* -Denotes Impacted Location
(1) -Total approach delay (provided due to changes in lane configuration)
Analysis is based on the 2000 Highway Capacity Manual methodology (HCS+, version 5.4)
This table has been revised for the FSEIS

Appendix H-1

Proposed Project Comparsion with Lower Density Alternative - PM Peak Hour

	LANE GROUP	No Build Condition			Build Condition							
					Proposed Project				Lower Density Alternative			
		V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS		V/C RATIO	Delay (sec.)	LOS	
Riverside Blvd.												
Riverside Blvd. (N-S) @	WB-LR	NA	9.6	A	NA	10.5	B		NA	10.4	B	
W. 70th St. (WB)	NB-TR	NA	16.1	C	NA	35.6	E	*	NA	30.1	D	
UNSIGNALIZED All-WAY STOP	SB-LT	NA	9.4	A	NA	10.6	B		NA	10.4	B	
12th Avenue												
12th Ave. (NB) @	EB-LT	0.00	8.5	A	0.00	8.9	A		0.00	8.8	A	
W. 59th St. (WB)	NB-LTR	1.05	79.5	F	1.51	262.0	F	*	1.43	225.8	F	*
UNSIGNALIZED 2-WAY STOP												
12th Ave. (N-S) @	NB-T	1.04	35.8	D	1.07	49.3	D	*	1.07	46.9	D	*
W. 56th St. (EB)	SB-L	1.02	96.1	F	1.12	128.7	F	*	1.10	122.1	F	*
	NB-TR Service	0.29	3.7	A	0.29	3.7	A		0.29	3.7	A	
12th Ave. (N-S) @	WB-R	0.69	71.7	E	0.69	71.7	E		0.69	71.7	E	
W. 54th St. (EB)	NB-TR	1.06	40.1	D	1.08	52.9	D	*	1.08	50.6	D	*
	SB-L	0.45	58.3	E	0.45	58.3	E		0.45	58.3	E	
	SB-T	0.74	12.8	B	0.74	12.8	B		0.74	12.8	B	
	SB-T Service	0.16	6.3	A	0.25	7.0	A		0.24	6.9	A	
12th Ave. (N-S) @	EB-LTR	0.86	77.0	E	0.86	77.0	E		0.86	77.0	E	
W. 52nd St. (EB)	NB-TR	1.15	85.1	F	1.18	99.4	F	*	1.17	96.8	F	*
	SB-L	0.80	91.6	F	0.80	91.6	F		0.80	91.6	F	
	SB-T	0.73	11.8	B	0.76	12.5	B		0.76	12.3	B	
11th Avenue/West End Avenue												
West End Ave. (N-S) @	EB-LTR	1.09	87.2	F	1.09	87.2	F		1.09	87.2	F	
W. 79th St. (E-W)	WB-LTR	0.62	28.2	C	0.62	28.2	C		0.62	28.2	C	
	NB-LT											
	NB-R											
	NB-LTR	0.95	41.9	D	0.99	50.6	D	*	0.98	48.7	D	*
	SB-LTR	0.66	24.4	C	0.68	25.0	C		0.68	24.9	C	
West End Ave. (N-S) @	EB-LTR	0.62	30.4	C	0.64	31.1	C		0.63	31.0	C	
W. 70th St. (EB)	NB-LTR	0.49	14.0	B	0.52	14.3	B		0.52	14.2	B	
	SB-LTR	1.07	70.8	E	1.11	86.0	F	*	1.10	83.5	F	*
West End Ave. (N-S) @	EB-LT				0.58	36.0	D		0.57	35.5	D	
W. 59 th St. (E-W)	EB-L											
	EB-R				0.38	29.4	C		0.35	28.9	C	
	EB-LTR	0.82	52.6	D		33.1	C			32.7	C	
	WB-LTR	1.36	212.5	F	1.95	471.5	F	*	1.90	451.5	F	*
	NB-L	0.28	7.3	A	0.45	11.2	B		0.42	10.4	B	
	NB-TR	0.20	4.4	A	0.20	4.4	A		0.20	4.4	A	
	SB-L	0.03	7.0	A	0.03	7.0	A		0.03	7.0	A	
	SB-TR	0.52	11.3	B	0.54	11.5	B		0.53	11.5	B	
9th Avenue/Columbus Avenue												
Columbus Ave. (SB) @	WB-LT	0.55	12.8	B	0.57	13.1	B		0.56	13.1	B	
W. 66 th St. (E-W)	SB-TR	1.21	134.5	F	1.23	140.3	F	*	1.22	139.2	F	*
Columbus Ave. (SB) @	EB-R	1.28	181.5	F	1.42	239.2	F	*	1.39	228.1	F	*
W. 60 th St. (E-W)	WB-L	0.61	30.5	C	0.63	31.1	C		0.63	31.0	C	
	WB-LT	0.21	22.6	C	0.21	22.6	C		0.21	22.6	C	
	SB-TR	0.69	18.6	B	0.69	18.7	B		0.69	18.7	B	
9th Ave. (SB) @	EB-TR	1.22	150.3	F	1.28	172.9	F	*	1.27	169.0	F	*
57 th St. (E-W)	WB-DefL	0.86	48.7	D	0.86	47.7	D		0.86	47.8	D	
	WB-T	1.01	62.6	E	1.06	78.6	E	*	1.05	76.0	E	*
	SB-L	0.42	26.7	C	0.45	27.5	C		0.44	27.3	C	
	SB-TR	0.70	27.3	C	0.70	27.4	C		0.70	27.4	C	

Appendix H-1

Proposed Project Comparsion with Lower Density Alternative - PM Peak Hour

Central Park W.												
Central Park W. (N-S) @	WB-L	0.23	25.0	C	0.23	25.0	C		0.23	25.0	C	
W. 66 th St. (WB)	WB-T	1.15	119.8	F	1.18	131.8	F	*	1.18	129.7	F	*
	WB-R	1.02	82.1	F	1.02	82.1	F		1.02	82.1	F	
	NB-LT	0.93	26.2	C	0.95	28.7	C		0.94	28.2	C	
	SB-TR	1.03	57.8	E	1.04	63.3	E	*	1.04	62.4	E	*

Notes:
EB-Eastbound, WB-Westbound, NB-Northbound, SB-Southbound
L-Left, T-Through, R-Right, Dfl-Analysis considers a Defacto Left Lane on this approach
V/C Ratio - Volume to Capacity Ratio, sec. - Seconds
LOS - Level of Service
* -Denotes Impacted Location
(1) -Total approach delay (provided due to changes in lane configuration)
Analysis is based on the 2000 Highway Capacity Manual methodology (HCS+, version 5.4)
This table has been revised for the FSEIS

Appendix H-1
Proposed Project Comparsion with Lower Density Alternative - Sat MD Peak Hour

		No Build Condition			Build Condition							
	LANE				Proposed Project				Lower Density Alternative			
	GROUP	V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS		V/C RATIO	Delay (sec.)	LOS	
Riverside Dr.												
Riverside Dr. (N-S) @	EB-L	0.21	22.2	C	0.26	23.2	C		0.25	23.1	C	
W. 72nd St. (E-W)	EB-T	0.04	19.1	B	0.06	19.3	B		0.06	19.3	B	
	WB-T	0.20	20.6	C	0.22	20.7	C		0.22	20.7	C	
	WB-R	0.12	2.0	A	0.14	2.1	A		0.13	2.1	A	
	SB-LR	0.72	30.3	C	0.92	50.8	D	*	0.90	47.5	D	*
12th Avenue												
12th Ave. (NB) @	EB-LT	0.00	8.5	A	0.00	8.6	A		0.00	8.5	A	
W. 59th St. (WB)	NB-LTR	1.05	79.5	F	1.11	96.8	F	*	1.06	80.4	F	
UNSIGNALIZED 2-WAY STOP												
12th Ave. (N-S) @	NB-T	0.70	11.7	B	0.73	12.3	B		0.73	12.2	B	
W. 56th St. (EB)	SB-L	0.73	51.5	D	0.86	60.0	E	*	0.85	58.9	E	*
	NB-TR Service	0.20	6.5	A	0.20	6.5	A		0.20	6.5	A	
12th Ave. (N-S) @	EB-LTR	0.53	43.0	D	0.53	43.0	D		0.53	43.0	D	
W. 52nd St. (EB)	NB-TR	0.97	37.7	D	1.01	46.8	D	*	1.01	45.8	D	*
	SB-L	0.75	77.9	E	0.75	77.9	E		0.75	77.9	E	
	SB-T	0.77	14.6	B	0.80	15.5	B		0.79	15.4	B	
12th Ave. (N-S) @	EB-LTR	0.09	32.6	C	0.09	32.6	C		0.09	32.6	C	
W. 42 nd St. (E-W)	WB-L	0.51	42.0	D	0.51	42.0	D		0.51	42.0	D	
	WB-R	0.61	24.2	C	0.64	25.5	C		0.63	25.2	C	
	NB-T	1.15	153.5	F	1.20	173.4	F	*	1.19	171.4	F	*
	NB-R	0.13	25.2	C	0.13	25.2	C		0.13	25.2	C	
	SB-L	0.55	45.0	D	0.55	45.0	D		0.55	45.0	D	
	SB-T	0.82	19.1	B	0.85	20.6	C		0.85	20.4	C	
12th Ave. (N-S) @	EB-LR	0.02	24.9	C	0.02	24.9	C		0.02	24.9	C	
W. 41 st St. (E-W)	WB-L	0.06	37.5	D	0.06	37.5	D		0.06	37.5	D	
	WB-R	0.37	42.0	D	0.40	42.6	D		0.40	42.6	D	
	NB-T	1.03	60.2	E	1.06	72.6	E	*	1.06	71.1	E	*
	SB-T	1.04	81.2	F	1.09	97.4	F	*	1.08	95.6	F	*
12th Ave. (N-S) @	EB-LR	0.16	43.3	D	0.16	43.3	D		0.16	43.3	D	
W. 37 th St. (EB)	EB-R	0.10	42.7	D	0.10	42.7	D		0.10	42.7	D	
	NB-L	0.26	51.6	D	0.26	51.6	D		0.26	51.6	D	
	NB-T	0.83	21.7	C	0.86	22.9	C		0.86	22.8	C	
	SB-TR	1.06	110.4	F	1.11	129.8	F	*	1.11	127.9	F	*
11th Avenue/West End Avenue												
West End Ave. (N-S) @	EB-LTR	0.47	26.1	C	0.49	26.6	C		0.49	26.5	C	
W. 70th St. (EB)	NB-LTR	0.40	16.2	B	0.43	16.7	B		0.43	16.6	B	
	SB-LTR	1.00	49.5	D	1.04	63.0	E	*	1.04	61.6	E	*
West End Ave. (N-S) @	EB-LT				0.26	26.6	C		0.25	26.5	C	
W. 59 th St. (E-W)	EB-L											
	EB-R				0.20	26.1	C		0.19	26.0	C	
	EB-LTR	0.28	26.8	C		26.4	C			26.3	C	
	WB-LTR	0.83	48.2	D	1.10	107.4	F	*	1.08	102.3	F	*
	NB-L	0.16	9.0	A	0.38	13.3	B		0.35	12.7	B	
	NB-T	0.30	8.8	A	0.30	8.8	A		0.30	8.8	A	
	NB-TR	0.05	7.3	A	0.05	7.3	A		0.05	7.3	A	
	SB-TR	0.49	10.7	B	0.50	11.0	B		0.50	10.9	B	

Appendix H-1

Proposed Project Comparsion with Lower Density Alternative - Sat MD Peak Hour

	LANE GROUP	No Build Condition			Build Condition							
					Proposed Project				Lower Density Alternative			
		V/C RATIO	Delay (sec.)	LOS	V/C RATIO	Delay (sec.)	LOS		V/C RATIO	Delay (sec.)	LOS	
9th Avenue/Columbus Avenue												
Columbus Ave. (SB) @ W. 66 th St. (E-W)	WB-LT	0.50	12.1	B	0.52	12.4	B		0.52	12.4	B	
	SB-TR	1.04	68.9	E	1.06	73.7	E	*	1.06	72.9	E	*
Columbus Ave. (SB) @ W. 60 th St. (E-W)	EB-R	0.88	54.8	D	1.02	84.7	F	*	1.01	80.8	F	*
	WB-L	0.29	23.2	C	0.31	23.4	C		0.31	23.4	C	
	WB-LT	0.19	22.3	C	0.19	22.3	C		0.19	22.3	C	
	SB-TR	0.61	20.3	C	0.62	20.3	C		0.62	20.3	C	
9th Ave. (SB) @ W. 57 th St. (E-W)	EB-TR	0.86	47.7	D	0.90	52.2	D		0.90	51.6	D	
	WB-DefL	0.80	33.2	C	0.81	35.0	C		0.81	34.8	C	
	WB-T	1.00	59.8	E	1.06	77.2	E	*	1.05	74.7	E	*
	SB-L	0.29	23.0	C	0.31	23.3	C		0.31	23.2	C	
	SB-T				0.66	25.5	C		0.66	25.4	C	
	SB-R				0.36	24.3	C		0.36	24.3	C	
Central Park W.												
Central Park W. (N-S) @ W. 66 th St. (WB)	WB-L	0.36	27.4	C	0.36	27.4	C		0.36	27.4	C	
	WB-T	1.12	108.1	F	1.18	131.7	F	*	1.18	130.1	F	*
	WB-R	0.94	66.3	E	0.94	66.3	E		0.94	66.3	E	
	NB-LT	0.73	12.2	B	0.74	12.6	B		0.74	12.6	B	
	SB-TR	0.70	20.5	C	0.72	21.0	C		0.72	21.0	C	

Notes:
EB-Eastbound, WB-Westbound, NB-Northbound, SB-Southbound
L-Left, T-Through, R-Right, Dfl-Analysis considers a Defacto Left Lane on this approach
V/C Ratio - Volume to Capacity Ratio, sec. - Seconds
LOS - Level of Service
* -Denotes Impacted Location
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Analysis is based on the 2000 Highway Capacity Manual methodology (HCS+, version 5.4)
This table has been revised for the FSEIS

APPENDIX H-2
ALTERNATIVES—COGEN FEASIBILITY STUDY

Riverside Center

Cogeneration Study

Supplementary Study Using Con Ed Steam for Heating

Considering:

Steam Micro-Turbines

Gas for Domestic Hot Water

Micro-Turbines for Cogeneration

Prepared for:

Extell Development Company
805 Third Avenue, 7th Avenue
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WSP Flack + Kurtz Reference No. N09.37030.00
October 13, 2009
October 23, 2009 REVISED
April 13, 2010 REVISED

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I. Background

II. Current Study

III. Executive Summary

IV. Assumptions and Calculation Results

V. Conclusions and Discussion

VI. Analysis

VII. Appendix

I. Background

A. A comprehensive and detailed cogeneration study has been done for this project. The study concluded that:

1. Large scale cogeneration facilities are not cost effective. This is largely due to the base HVAC system being based upon heat pumps. The heat pumps were supported by hot water generated using natural gas. (Building 2 used incremental A/C units and steam heating.) To use cogenerated heat year round the system would have to change to a central plant scheme with absorption chillers and the use of fan coil units in the apartments. The increase in capital costs for these system revisions in addition to the cost of the cogeneration plant made large scale cogeneration impractical.

2. Serving loads with cogenerated power other than Riverside Center is not cost effective. This is largely due to distribution costs and the low energy loads at the remote sites.

3. Individual small scale cogeneration plants in each building, sized to heat domestic hot water from the engine waste heat was economically feasible.

4. The Purpose and Scope and Conclusions and Executive Summary of the original cogeneration study dated March 13, 2009 is with the Appendix.

II. Current Study

A. This supplemental study investigates the feasibility of small scale cogeneration if the buildings were to use Con Ed steam instead of natural gas for heating. There are three conditions studied. They are:

1. Con Ed steam for heating and for domestic hot water. (This is the base case system).

2. Con Ed steam for heating, natural gas for domestic hot water. (Building five only. This building, has a hotel within it. Hence, it has a high domestic hot water load. The other buildings do not have sufficiently high domestic hot water loads to introduce gas domestic hot water heaters. In addition, there is a commitment to Con Ed to use steam).

3. The use of micro-turbines to provide a portion of the buildings' electric needs and to augment the heating of domestic hot water.

The use of packaged small scale steam turbine generators to reduce the Con Ed steam service pressure from 125psi to the working pressure of 15psi was also investigated. This bottoming cycle cogeneration concept generates electricity using the energy extracted by reducing the steam pressure.

The lessons learned in the initial study have been applied so that the study could focus on those issues that were likely to produce positive results; specifically, the impracticality of central cooling systems and the economically beneficial use of small scale cogeneration systems.

III. Executive Summary

A. Steam Micro-turbine

Steam is received from Con Ed at high pressure. Much of the steam is used at low pressure. Conventionally the pressure is reduced by valves. Alternately the pressure can be reduced in a steam micro-turbine. Electricity is produced as the steam pressure is reduced. This has proven cost effective in buildings that have high steam use throughout the year. (Steam is used for heating and cooling.) Riverside is planned to use heat pumps or air conditioning units within each apartment. Hence, there is no central chiller and no use for the winter levels of steam through the summer. The base study found that central chilling plants, with and without large scale cogeneration, are not competitive with heat pump systems. The use of steam micro-turbines at Riverside Center is not cost effective.

B. The Use of Gas

Riverside is using Con Ed steam to heat the buildings. Steam can also be used for heating domestic hot water. Although gas could serve as an alternate hot water heating source it is not being considered for that purpose, except in building five. Building five contains a hotel. This creates a high hot water demand compared to its size. The other buildings do not have enough need for domestic hot water to warrant consideration of introducing gas fired hot water heaters. If building five did not contain a hotel its hot water load would be drastically reduced and gas would not be considered for use in it either.

The study demonstrates that the use of gas for domestic hot water heating instead of steam domestic hot water heating in building five will save $46,000 per year and pay back the additional initial investment for the gas heaters in little over a year.

C. Gas Fuel Micro-Turbines

Cogenerating micro-turbines, using the electric to offset a portion of the building's electric purchases and the engines waste heat to heat the domestic hot water needs was studied. The initial and operating costs of the cogeneration system were compared to the cost of generating the hot water with Con Ed steam. Buildings one, two, three and four all have paybacks in excess of 14 years. Building five has a payback of 4.3 years. However, as indicated above, gas heated domestic hot water pays back (when compared to steam heated domestic hot water) in 1.1 years. It also has an initial cost premium over steam use of only $50,000. It is not prudent to use cogeneration which has an initial cost increment of $350,000 and a longer payback.

Having found gas fueled domestic hot water heating a feasible option for building five, cogeneration was also compared to gas heated domestic hot water. It has a 9.3 year payback.

IV. Assumptions and Calculation Results

A. The building descriptions and the assumptions upon which the calculations were performed are as shown on the following two pages.

B. The results of our calculations can be found in the chart following the assumptions.

V. Conclusions and Discussion

A. The packaged steam turbine generator is not cost effective. This is because steam is used in sufficient quantities to spin the turbine only during the heating season. In winter the cost of the steam heat energy is highest and the value of the electric produced is lowest. This turbine product is a practical device in buildings that have a summer steam load as well as a winter steam load. For Riverside to have a summer steam load it would have to have an HVAC system based on central cooling. The previous study found this not to be cost effective.

B. It is economically desirable to heat domestic hot water in building five with natural gas fired condensing hot water heaters. These devices add very little to the projects first cost after consideration of the cost saved from not requiring the heat exchangers that are needed to heat domestic hot water from steam. The condensing hot water heaters are very efficient. The gas that is used costs less than the cost of the steam that would be required to heat the required domestic hot water. The analysis that was performed demonstrates that the incremental first cost is paid back from operating cost savings in a little more than 1 year. The domestic hot water use in building five is high relative to its size. This is because there is a hotel in this building. This large domestic hot water load makes consideration of heating domestic hot water in a manner other than with Con Ed steam appropriate. In buildings one, two, three and four the domestic hot water load is not large enough to consider use of gas. Gas domestic hot water heating in building five saves $46,000 per year.

C. The addition of micro-turbines to produce domestic hot water from the turbines' waste heat while generating a portion of the buildings' electricity was performed for each building. When compared to the use of steam for heating domestic hot water, it is cost effective in building five because the incremental first cost is paid back from operating cost savings in little more than four years. When compared to the gas fired domestic hot water heater alternative, it is not cost effective because the payback period is 9.8 years. In either case, the use of micro-turbines is not economically prudent. Cogeneration requires a $350,000 incremental initial cost with a four year payback; alternatively the domestic hot water can be produced using gas with a $50,000 initial cost and little more than a 1 year payback. A cogenerating micro-turbine can not be justified on a purely economic design. Payback in the other buildings ranges from thirty to over one hundred years. The reason that building five has meaningful savings when using gas and when adding a micro-turbine is that its domestic hot water use is high because the hotel is in building five.

D. When Con Ed steam is used its condensate must be cooled prior of disposal in the sewer system. The cooling is often done by preheating the buildings domestic hot water. That will be done at Riverside. Hence the use of the gas domestic hot water heaters and the cogeneration waste heat is diminished in the winter heating season. This has been taken into account in the analysis of these systems.

VI. Analysis

A. Steam Turbine

The steam turbine electric costs savings was calculated in the following manner:

1. The steam use during the winter was calculated using the building model. These results were sorted by temperature so that the number of hours at each outside temperature and hence at each steam use was tabulated.

2. The electric production and the thermal energy extracted from the steam was calculated for each steam flow. The turbine characteristics supplied by the manufacturer were used to determine these values. The cost of the thermal energy converted to electricity and the value of the electricity produced was calculated using the appropriate rates.

3. The first cost of installation of the steam turbine, as determined from other projects is $550,000. The analysis demonstrates more than a 10 year payback for building 1. Because each of the other buildings has a lower winter fuel use their savings would be less but the initial cost the same. Hence no calculations for these buildings were done.

Note that if steam were used for domestic hot water heating in the non winter months the steam flow would not be sufficient to spin the turbine.

B. Gas Domestic Hot Water Production

The use of gas for domestic hot water was calculated in the following manner:

1. The cost of steam for heating the domestic hot water was calculated. Winter and summer costs of steam were used.

2. The cost of heating the domestic hot water using gas was calculated.

3. With Con Ed steam as the heating medium it is necessary to cool the condensate prior to putting it into the City's sewerage system. This can be accomplished by using the hot condensate to heat domestic hot water. In winter months much of the need for hot water can be met in this manner. This minimizes the gas needed for domestic hot water heating in winter and was taken into account in our calculations.

4. The capital cost difference between providing the heat exchangers and pumps to use steam and the cost of condensing hot water heaters needed for gas use was calculated. These costs where determined from historical data.

5. The simple payback was calculated by comparing first cost differentials to operating cost differentials.

C. <u>The Use of Micro-turbines</u>

Having calculated the economics of the use of gas for domestic hot water, we calculated the cost effectiveness of adding a micro-turbine in each building. This was determined by:

1. Selecting a micro-turbine that would be less than 15% of the buildings peak electric load. This will permit the turbine to be connected to the Con Ed electric service without any standby charges.

2. Determining how much of the turbine's thermal output can be used to heat hot water and subtracting that thermal use from the gas that would otherwise go into heating domestic hot water.

3. Calculating the gas input and gas cost to run the turbine and adding that gas cost to the gas and its cost that remains to be bought to heat the domestic hot water.

4. Adding the maintenance cost attendant to the turbine.
5. Subtracting the value of the electric that the turbine output will reduce the building's electric bill.
6. Comparing the incremental operating savings to the micro-turbine's first cost.

VII. Appendix

A. Steam Micro-turbine – Carrier Corp Information

B. Gas Fueled Micro-turbine Capstone Corp Information

C. Steam Micro-turbine Study

D. Heating Months – Heating and Domestic Hot Water Analysis (9 sheets)

E. Non-heating Months – Heating and Domestic Hot Water Analysis (3 sheets)

F. The Original Cogeneration Study dated March 13, 2009