Calming New York City Intersections

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ABSTRACT

In 1993, the New York City Department of Transportation (DOT) received a federal grant (under the Intermodal Surface Transportation Efficiency Act of 1991, Congestion Mitigation and Air Quality) to research, design and test innovative traffic calming devices. This was part of a larger program to enhance the pedestrian environment in the city. Under this program, crash statistics analysis and policy codification were used to "sell" traffic calming within the DOT. This paper presents a crash analysis of Leading Pedestrian Intervals (LPI), a crash analysis of neckdowns, and the new neckdown policy.

INTRODUCTION

There are two fundamental ways to calm intersections—spread them out or make them narrower. Each can be accomplished through alterations in space or time. Larger intersections consist of, for instance, roundabouts, medians and islands, turning bays, staggered signals, and overpasses. These work to arrange potential conflict points in spatial sequences so that users may address each point in the series, thus raising the concentration level at each. Think of the left-turning driver who must simultaneously observe oncoming traffic on his right and pedestrians on his left.

This method is particularly useful when intersections are accommodating various and unequal modes of traffic (e.g., pedestrians, cyclists, trams, and drivers). The downside is that enlarging an intersection requires not only additional space but also time—a resource that is not always available or desirable. To wit, for every second given to one direction, a corresponding second must be subtracted from another. This decrease often translates into lost time for all users, for they must now navigate an unusually large intersection, or stare an unusually long time at a red light.

The opposite approach is to make the crossing small and quick—not necessarily faster, but more natural and organic. Think of all the wasted green time at the end of a cycle when the cars have passed through an intersection and people could (and often do) cross the street. Examples of devices used to narrow intersections are neckdowns, mini-roundabouts, raised intersections, all-yield/stop control, leading pedestrian intervals, etc. These work to narrow the crossing, but provide more opportunities to cross. Traffic is forced into a constrained time-space that is more forgiving when crashes do occur, for drivers must exercise better discipline and drive more slowly.

Given the density of New York City, where building lines and rights of way have long been established, traffic calming is generally restricted to narrowing intersections, but enabling quicker operations.

DANGER: CROSSWALK AHEAD

Every year in New York City, 2 out of 3 people hit in the crosswalk were crossing *with* the signal. Of 14,245 pedestrians killed or injured in New York City in 1996, 3,337 (23.4%) were crossing with the signal and 1,823 (12.8%) were crossing against the signal (*1*). Not surprisingly, the number one cause of pedestrian fatality is the driver turning into the pedestrian in the crosswalk (17%) (*2*). Faced with these sobering statistics, DOT constantly looks at ways to get pedestrians, who are the vast majority of New York City street users (*3*), across the street alive.

(In spite of all this carnage, the reader is mindful to note that New York City, because of the high percentage of walking in the city, has been rated the fifth safest city in America for those who go by foot.) (*4*)

LEADING PEDESTRIAN INTERVALS

Description

One approach is to (re)examine the allocation of time given to various movements at signalized intersections. It is general traffic engineering practice to allow as much time as possible to each flow of vehicular traffic in order to minimize stop and start-up time. Yet for every second that is added to flow A, a corresponding second must be added to the delay of flow B. (Time is circular!) For drivers, cyclists and pedestrians alike, more delay increasingly means more red light running and jaywalking. The Leading Pedestrian Interval (LPI) keeps the cycle lengths short, and staggers the phases, thereby making the intersection "quicker" (see Table 1). This is consistent with other research and standards that show that people are not willing to wait more than about 30 seconds to cross the street or get in an elevator (*5*).

An LPI simply entails retiming the signal splits so that the pedestrian WALK signal begins a few seconds before the vehicular GREEN. As the vehicle signal is still red, this allows the pedestrians to establish their presence in the crosswalk before the turning vehicles, thereby enhancing the pedestrian right of way. The LPI is also known as a Pedestrian Head Start or a Delayed Vehicle Green. In New York City, the LPIs range from 5 to 19 seconds and have been used for at least 20 years.

TABLE 1 Typical LPI Signal Timing Layout, 90-Sec Cycle, 40-Foot Road

crosswalk		
W	24 (6 LPI)	
FDW	15	
DW	6	
vehicle		
G	33	
Y	3	
R	LPI	54

Key:
W = Walk, FDW = Flashing Don't Walk, DW = Don't Walk
G = Green, Y = yellow, R = Red
Numbers indicate signal split in seconds.

Crash Analysis

To understand how the LPI affects pedestrian safety, DOT analyzed crash rates at 26 locations with LPIs. The data were taken directly from the New York State (NYS) Department of Transportation's CLASS crash mapping database. DOT obtained up to 10 years worth of data (5 years "before" and 5 years "after") when possible. In order to assess the relative difference in crash rates, data also were collected at surrounding intersections with similar characteristics. This totaled 192 vehicle/pedestrian crashes at the LPI intersections, and 352 crashes at the control sites. The data represent the sum of 10 years worth of data in New York City, the most pedestrian-rich city in the United States.

From this data, DOT was able to note vehicle and pedestrian action, categorized into the following types:

- *Total*—all reported crashes involving a vehicle,
- *Injury*—crashes involving injuries,
- *Driver Error*—crashes classified as "driver error," e.g., driver inattention, failure to yield right-of-way, disregard for traffic control, turning improperly,
- *Ped in XW*—crashes where a vehicle hits a pedestrian(s) in the crosswalk,
- *Ped xing w/Sig*—crashes involving a pedestrian(s) crossing with the signal, and
- *Veh Turn*—crashes involving vehicles turning left or right.

Theoretically the installation of an LPI will help to prevent and/or minimize all crashes, especially those involving people crossing in crosswalks and crossing with the signal. However, the LPI has a direct influence on crashes involving turning vehicles and pedestrians, therefore the "Veh Turn" is used in assessing the performance of the LPI (Table 2).

DOT also noted the severity factor, a numerical value based on the cost of a crash to the public (ambulances, police, road repair, etc.) according to the NYS-DOT's CASIUS severity mapping program (Fatality = 2,729, serious = 1,214, hospitalized = 303, minor injury = 76, no injury = 1). This allows one to more appropriately compare crashes; for example, one person hospitalized with broken bones is a severity factor equal to about 16 people who walk away with slight concussions.

The basic analysis established eight crash rates for each intersection with an LPI: before absolute, after absolute, before factored for severity, after factored for severity,

TABLE 2 Effect of LPIs on Crash Rates in NYC

1982-1995	All Crashes		Vehicle / Pedestrian Crashes			
	Total	Injury	Driver Error	Ped in XW	Ped xing w/Sig	Veh Turn
Absolute rate change, percent	2	7	2	-22	-17	**-12**
Factored for severity		15	-10	-38	-35	**-55**
Relative to control sites, percentage points	0	0	-39	-25	-29	**-28**
Factored for severity		15	-88	-44	-27	**-64**

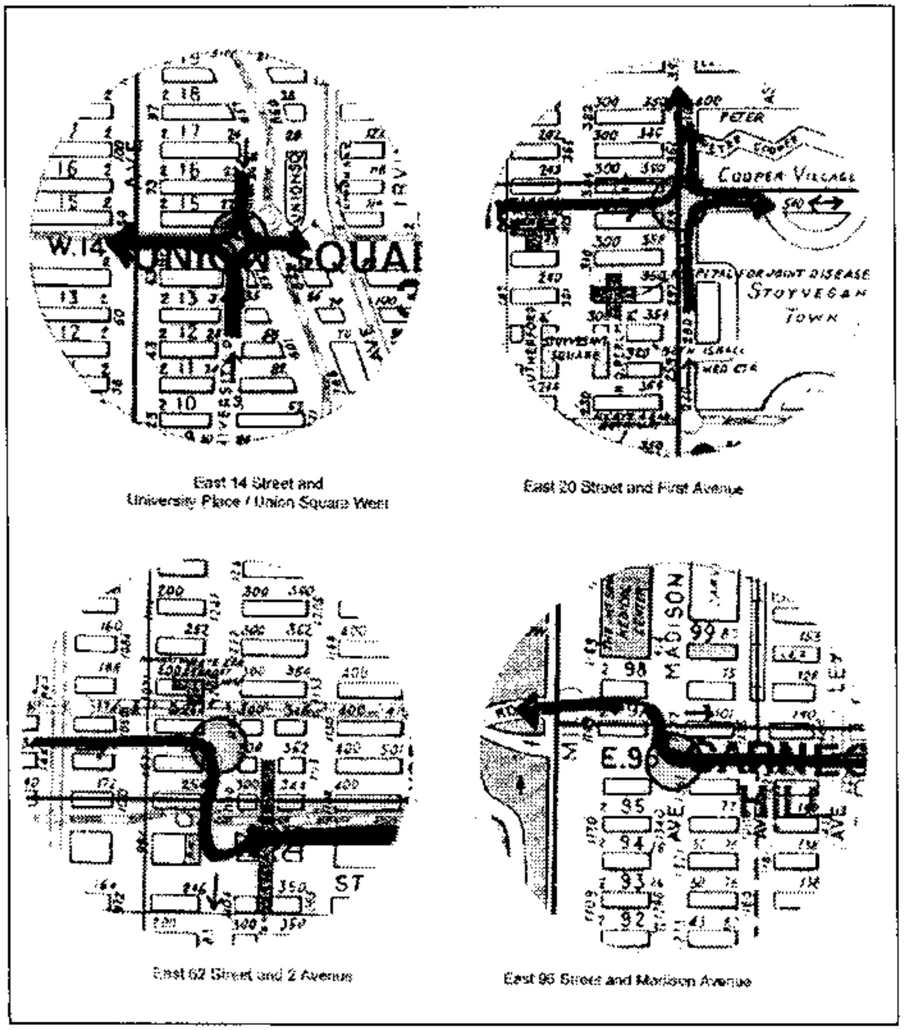
before absolute at control sites, after absolute at control sites, before factored for severity at control sites, after factored for severity at control sites. The rates at each LPI intersection were compared to give an absolute rate of change, which was then factored for severity. Similar calculations were performed for the control site locations. The absolute numbers were then compared to those at the control sites to provide a relative rate of change, which was then factored for severity. Of the 26 locations, 14 contained substantial before, after, and control site data (Figure 1).

Specific Results

Of the Manhattan locations with a significant decrease in LPI crashes, four have easily identifiable vehicle traffic characteristics (shown in Figure 2):

- Both University Place and Union Square West are one-way into 14th Street. Therefore all vehicles must turn.
- LPI installed in 1993; 5-second LPI on 14 Street leg; 6-second LPI on University Place / Union Square West leg; (See Table 3) 16 vehicle/pedestrian crashes; Control site data not available.
- East 20 Street at First Avenue is the only through street between 14th and 23rd Streets; therefore drivers wishing to access the intermediate blocks must turn at this intersection.
- LPI installed in 1989. 5-second LPI on 1st Avenue leg; 20 vehicle/pedestrian crashes; 33 vehicle/pedestrian crashes at control sites (see Table 4).
- On East 62nd Street, drivers wishing to access the Queensboro Bridge must turn onto 2nd Avenue. Especially in the PM peak hours, this movement is heavy.
- LPI installed in 1985; 6-second LPI on 62nd Street leg; 13 vehicle/pedestrian crashes; 52 vehicle/pedestrian crashes at control sites (see Table 5).
- Vehicles traveling on East 96th Street to the 97th Street Central Park traverse must make a right turn on Madison Avenue, and then a left at East 97th Street. This movement is heavy.
- LPI installed in 1985; 11-second LPI on Madison Avenue leg; 17 vehicle/pedestrian crashes; 21 vehicle/pedestrian crashes at control sites (see Table 6).

FIGURE 1 Relative effect of LPIs on crash rates in New York City.



East 14 Street and University Place / Union Square West

East 20 Street and First Avenue

East 62 Street and 2 Avenue

East 96 Street and Madison Avenue

FIGURE 2 Heavy turns at LPI locations in Manhattan.

Conclusions

The data show that Leading Pedestrian Intervals have a positive effect on pedestrian safety, especially where there is a heavy concentration of turning vehicles. This evidently occurs regardless of pedestrian volume.

TABLE 3 Effect of LPI on Crash Rates at East 14th Street and University Place/Union Square West

1989-1994	All Crashes		Vehicle / Pedestrian Crashes			
	Total	Injury	Driver Error	Ped in XW	Ped xing w/Sig	Veh Turn
Relative to control sites, percentage points	n/a	n/a	n/a	283	-83	-159
Factored for severity			n/a	14	-222	-178

TABLE 4 Effect of LPI on Crash Rates at East 20th Street and First Avenue

1986-1995	All Crashes		Vehicle / Pedestrian Crashes			
	Total	Injury	Driver Error	Ped in XW	Ped xing w/Sig	Veh Turn
Relative to control sites, percentage points	36	98	-193	-126	-57	-52
Factored for severity		8	244	-118	-2315	-5604

TABLE 5 Effect of LPI on Crash Rates at East 62nd Street and Second Avenue

1982-1988	All Crashes		Vehicle / Pedestrian Crashes			
	Total	Injury	Driver Error	Ped in XW	Ped xing w/Sig	Veh Turn
Relative to control sites, percentage points	-19	28	-68	-38	-82	-28
Factored for severity		56	-219	-27	-154	-138

The negative effect on all injury crashes at the intersections needs further investigation, but raises the question of whether one should seek to assist unprotected pedestrians crossing the street or drivers and occupants of 2000+ pound vehicles.

Other studies have found similar results (*6*), leading DOT to install more LPIs, especially at locations of high turning movements.

Discussion

In terms of the potential safety benefit of a wide scale LPI program, DOT considers the following: There are about 11,000 traffic signals in the city; about 85% have pedestrian indicators. About 36% of the 14,000+ vehicle/pedestrian crashes in New York City every year involve pedestrians crossing at signalized intersections. If the LPI reduces this number by 12%, then 514 vehicle/pedestrian crashes per year could be prevented.

TABLE 6 Effect of LPI on Crash Rates at East 96th Street and Madison Avenue

1982-1988	All Crashes		Vehicle / Pedestrian Crashes			
	Total	Injury	Driver Error	Ped in XW	Ped xing w/Sig	Veh Turn
Relative to control sites, percentage points	-31	-78	30	-50	-14	-36
Factored for severity		-17	-40	-36	15	-11

Repeatedly, though, the question arises of how to justify the adjacent loss of green time for vehicles. Yet all the LPI really does is electronically enforce the legal responsibility of drivers, especially turning drivers, to yield to pedestrians in crosswalks. At corners with high pedestrian volumes, the drivers are already suffering a loss of green time as they wait for pedestrians to cross. Furthermore, if an LPI is saving xx amount of pedestrians from being hit by cars, then it is fundamentally appropriate that the car should wait.

In accommodating the needs of all users, there is a possible solution: Trade the LPI seconds at the beginning of the cycle for seconds at the end of the cycle. If the pedestrians cross first, then they will be out of the crosswalk by the end of the cycle. Then the cars may turn, without pedestrian delay (see Table 7). One could also utilize the all-red time to reduce delay for both pedestrian movements. The effect is that all movements get less green time, but that time is optimized.

NECKDOWNS

Description

Neckdowns, also known as corner extensions, bulb-outs, and sidewalk expansions, narrow intersections by extending the curb at the corner. New York has been necking down intersections (in a traffic calming sense) since 1968. Generally these have been installed by the economic development arms of government as commercial streetscape improvements. DOT recently documented these efforts, evaluated their effect on traffic and safety, and established a coordinated policy (Figure 3).

Installed at corner and mid-block crossings, neckdowns highlight the pedestrian crosswalk. They permit less signal time to be devoted to the pedestrian phase and reduce the roadway available for illegal or aggressive motorist activities such as failing to yield

TABLE 7 Possible, More Efficient LPI Signal Timing, 90-Sec Cycle, 40-Foot Road

N/S crosswalk										
W	6					6				
FDW		12					12			
DW			27					27		
N/S vehicle										
G			21							
Y				3						
R	66							66		
E/W crosswalk										
W	6					6				
FDW		12					12			
DW			27					27		
E/W vehicle										
G								21		
Y									3	
R			66							

Key:
W = Walk, FDW = Flashing Don't Walk, DW = Don't Walk
G = Green, Y = yellow, R = Red
Numbers indicate signal split in seconds.

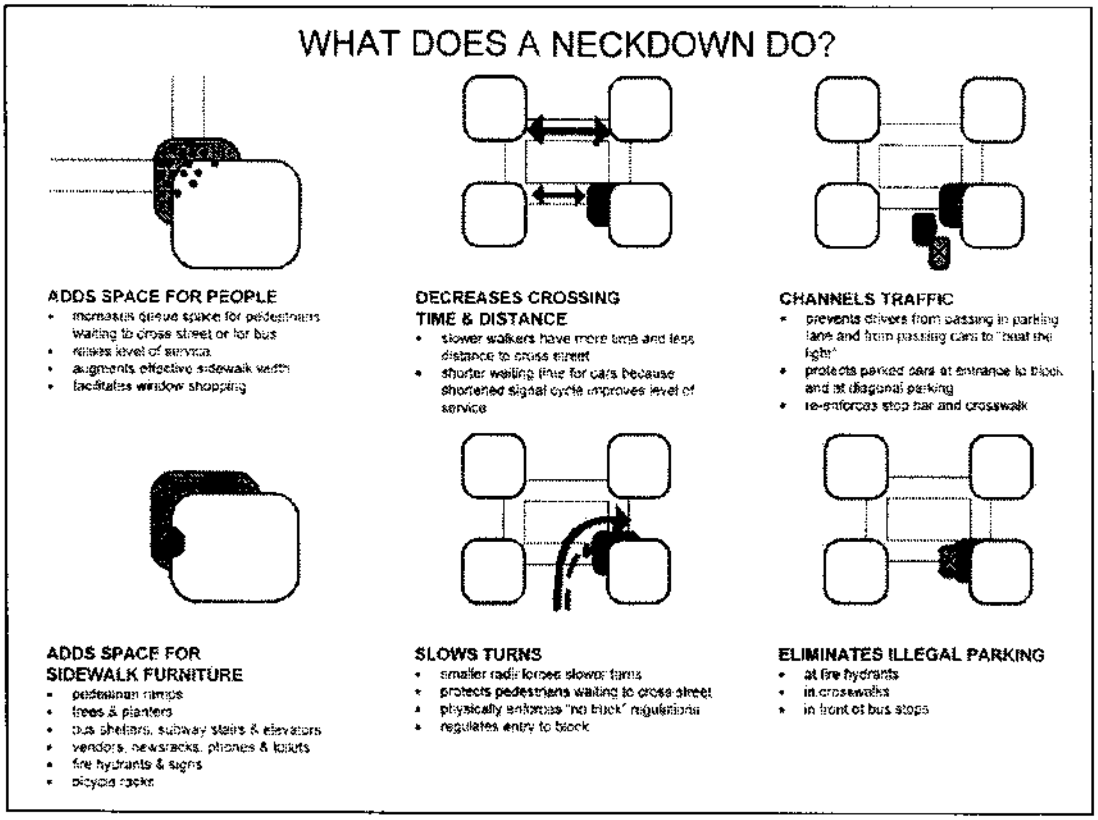


FIGURE 3 Explanation of a neckdown.

to pedestrians, making high speed turns and passing in the parking lane. It has also been observed that motorists are more inclined to stop behind the crosswalk at a neckdown, and that pedestrians are more inclined to wait on the neckdown than in the street.

Crash Analysis

A criticism of neckdowns centers on the fact that a neckdown places people waiting to cross the street closer to moving traffic. To determine whether this translated into a higher crash rate, DOT analyzed six locations around the city. These were chosen because they were each part of a sizable and planned intervention, represented a cross section of New York City (from Staten Island to Manhattan), and had similarly designed neckdowns. From the New York State Department of Transportation's CLASS crash mapping database, DOT obtained 5 to 10 years of crash data. This totaled 204 vehicle/pedestrian crashes, a relatively sparse sampling, yet the sum of 10 years' worth of data in New York City, the most pedestrian-rich city in the United States. Nevertheless, the numbers of recorded vehicle/bicycle crashes and vehicle/pedestrian crashes at some locations were too few (<30) to be statistically relevant.

To augment the research further, DOT factored each crash for severity, according to the NYS-DOT's CASIUS severity mapping program (Fatality = 2,729, serious = 1,214, hospitalized = 303, minor injury = 76, no injury = 1). Because each installation had different traffic, geometric and other characteristics, it was decided not to aggregate them together. DOT also secured data from the surrounding intersections, so as to determine whether any rise or fall in the crash rate at the neckdowns was independent of an area-wide fluctuation.

The basic analysis calculates the monthly rate of all crashes, and of just vehicle/pedestrian crashes, both before and after the neckdowns were installed. This rate is then factored for severity. These numbers were compared to the crash rate of the surrounding intersections. Table 8 shows the resultant “relative” numbers.

Results

In Table 8, one can see that in two locations (Nassau / Norman and Port Richmond) neckdowns positively affected the safety of the intersections in terms of all crashes. As these areas have relatively low pedestrian activity, even with 10 years of data, there are simply not enough vehicle/pedestrian crashes to draw a statistically accurate conclusion.

In Jackson Heights and on Restaurant Row the neckdowns caused the crash rate to rise, but their overall severity was lowered. Because there is a tremendous amount of pedestrian activity on Restaurant Row (West 46 Street between Eighth and Tenth Avenues in Manhattan, four blocks away from the Port Authority Bus Terminal), the positive reduction in the severity of vehicle/pedestrian crashes suggests that neckdowns are very useful in a highly urban environment.

Flatbush Avenue saw mixed results. The overall crash rates went down, but their severity rose; vehicle/pedestrian crashes went up while their severity fell. Flatbush Avenue is a very congested through street in downtown Brooklyn with a large amount of pedestrian activity. In the end, one could argue that a safer pedestrian environment is a good trade-off.

In Sunnyside the results were mostly negative (see Figure 4). While overall crashes fell, their severity rose. The rate of vehicle/pedestrian crashes rose only 4%, but

TABLE 8 Effect of Neckdowns on Crash Rates at Intersections in New York City

1983-1995		ALL CRASHES		VEH/PED CRASHES	
		relative change	**factored for severity**	**relative change**	**factored for severity**
LOCATION	NOTES				
Brooklyn: Nassau / Norman	(low pedestrian, trucks)	-12 %	-31 %	*	*
Staten Island: Port Richmond	(low pedestrian, low vehicle, some signals)	-45 %	-42 %	*	*
Queens: Jackson Heights	(high pedestrian, signals)	14 %	-41 %	*	*
Manhattan: Restaurant Row (W 46 St)	(high pedestrian, signals)	14 %	-2 %	**7 %**	**-7 %**
Brooklyn: Flatbush Avenue	(high pedestrian, low speed, some signals diagonal)	-4 %	30 %	**31 %**	**-24 %**
Queens: Sunnyside	(high pedestrian, high speed, some signals, diagonal)	-42 %	25 %	**4 %**	**97 %**

* Number of crashes statistically irrelevant (<30).

their severity almost doubled. Reasons for these results can be found in the diagonal street network, the elevated train and speed of vehicles along Queens Boulevard or the design of the neckdowns themselves.

Conclusions

Neckdowns have reduced overall severity rates in four out of six surveyed areas in New York City. In two of three locations, they reduced the *injury severity* when a vehicle does crash into a pedestrian. This is attributed to the fact that the neckdown limits the space available for undisciplined driving and subsequent vehicle speed.

Discussion

When a city is planning and designing neckdowns, two objections are consistently raised. The first arrives when a community thinks that neckdowns remove precious on-street parking spaces. Yet often the corner extensions would only remove parking that was already illegal—at the corner, in a crosswalk, or at a fire hydrant. Further investigation usually reveals that illegal parking or legal standing (as with the case of limos and taxis) is rampant, and a proposal to enforce the law physically forces a community to reevaluate the notion of how the street space is allocated. In New York, the Fire Department supports neckdowns in front of hydrants as a way to eliminate illegal parking that blocks access.

Sunnyside, Queens: Greenpoint Av. between 44th and 48th Streets

	Before implementation Jan 1991 to May 1994							After implementation June 1994 to Dec 1997								
injury severity	K	A	B	C	non-injury	total	monthly rate	K	A	B	C	non-injury	total	monthly rate	absolute rate change	relative rate change
All accidents:																
neckdown totals	0	6	23	42	169	248	0.74	2	11	11	34	145	210	0.63	-15%	-42%
non-neckdown totals	10	29	65	124	554	782	0.62	4	29	73	141	745	988	0.85	38%	
factored neckdown totals	0	10926	6787	3192	168	23073	63.67	5453	13364	3333	2583	145	25131	74.94	8%	25%
factored non-neckdown totals	27290	35208	19695	9424	554	92169	60.98	10916	33382	21210	10716	745	77579	51.31	-16%	
Pedestrian accidents:																
neckdown totals	0	5	8	20	0	33	0.15	2	9	7	11	0	29	0.09	-40%	4%
non-neckdown totals	7	10	11	33	1	62	0.04	4	15	13	19	0	52	0.03	-15%	
factored neckdown totals	0	6070	2424	1820	0	10314	29.65	5458	10926	2121	836	0	19341	57.58	93%	97%
factored non-neckdown totals	19103	12140	3333	2508	1	37085	24.53	10916	18424	3939	1444	0	35723	23.63	-4%	
Bicycle accidents:																
neckdown totals	0	0	2	1	1	4	0.01	0	0	0	1	0	1	0.00	-75%	-155%
non-neckdown totals	0	0	2	2	1	5	0.00	0	0	6	4	0	9	0.01	80%	
factored neckdown totals	0	0	606	78	1	685	2.03	0	0	0	76	0	76	0.23	-89%	-229%
factored non-neckdown totals	0	0	606	152	1	759	0.50	0	0	1818	204	0	1819	1.20	140%	

6 survey neckdown locations; 35 non-neckdown locations

definitions:

K = Killed (factor *2729)
A = Incapacitated (factor *1214)
B = Visible injury (factor *303)
C = No visible injury (factor *76)
No injury (factor *1)

monthly rate: total accid. / # of months / # of sites
absolute rate change: monthly rate after / monthly rate before
relative rate change: neckdown minus non-neckdown absolute rate change

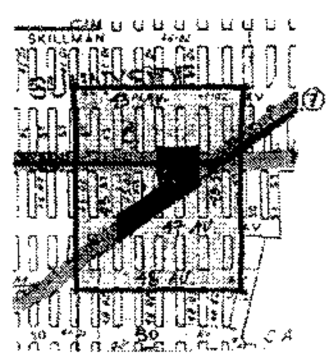


FIGURE 4 Sample neckdown crash analysis location.

The second notion is that the “street” consists of all the space between the curbs—parking and driving lanes inclusive—and that it must be straight. In many perspective drawings, streets are usually rendered with curbs extending to the horizon. Another view holds that the street is only the space for moving vehicles: the “carriage way.” In this scenario, cars are parked on the sidewalk. As the latter view is less constrictive as to the location of the curbs, neckdowns and other urban design features are more welcome. In any event, since there is no parking within an intersection, and as long as the curb lane is not used for moving traffic and appropriate turns are accommodated, there should be few problems with necking intersections down.

Below is a copy of NYC-DOT’s new neckdown policy. In general, the idea is to design new and/or rebuilt streets narrower at intersections, fire hydrants, crosswalks, and wherever else there is no moving traffic or parked vehicles.

SUMMARY

Neckdowns and Leading Pedestrian Intervals are two devices which make intersections smaller—in both space and time. This has generally led to a safer urban environment for pedestrians in New York City, those most at risk.

ACKNOWLEDGMENTS

Thanks to the following colleagues at DOT for their efforts towards making these traffic calming devices possible:

- Glynis Berry for raising the funds for and directing the DOT Pedestrian Projects program.
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- Michael Primeggia for editing the Neckdown Policy.
- Solomon Assefa for editing the LPI report. John Tipaldo for his counsel.
- Jay Jabar and Ben Eliya for the new neckdowns.

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APPENDIX: NEW YORK CITY DOT NECKDOWN POLICY

(adapted from August 1998 policy)

INTENT

This policy establishes criteria for when and where neckdowns may be placed in New York City. The intent is to incorporate neckdowns into all roadway projects, including full road reconstruction, intersection redesign, sidewalk replacement and sub-surface infrastructure work. The goal is to incrementally return underutilized vehicular space to sidewalk space, to improve pedestrian, bicycle and vehicular safety, and to create a street environment that balances the needs of all users.

These guidelines are meant to inform the planning design process and set general standards. They are not intended to supersede professional engineering judgment and/or common sense.

DESCRIPTION

Neckdowns widen the sidewalk into the roadway, typically in the parking lane. A single neckdown exists only on one side of a corner. A double neckdown extends the sidewalk on both sides of a corner. Neckdowns may also be installed in the middle of the block.

USE

Neckdowns in New York City have been shown to reduce overall crash rates and injury severity. It has been demonstrated that motorists are more inclined to stop behind the crosswalk at a neckdown, and that pedestrians are more inclined to wait on the neckdown rather than in the street.

Installed at corner and at mid-block crossings, neckdowns will highlight the pedestrian crosswalk, thereby reducing jaywalking. Neckdowns also permit less signal time to be devoted to the pedestrian phase and reduce the roadway available for illegal or aggressive motorist activities such as failing to yield to pedestrians, making high-speed turns and passing in the parking lane.

At intersections, neckdowns:

- Add pedestrian space at the corner where pedestrian volumes are high. At many signalized intersections, a lack of storage space on the corner causes poor levels of service for pedestrians.

- Shorten the crossing distance for pedestrians. This is particularly helpful in areas with a strong elderly or youth presence, where signal time allocations are critical.
- Provide space for pedestrian ramps where underground vaults and hollow sidewalks prevent placement.
- Reinforce the stop bar and/or crosswalk by making them more apparent to the motorist. This is further assisted by stop signs, planters, trees, etc., which may be placed outside the sidewalk proper.
- Force drivers to maintain lane discipline as they pass through an intersection. This also dissuades drivers from jockeying for position and jumping the red signal. The safety issues must be balanced with accommodation of turning vehicles.
- Slow turning vehicles, emphasizing the legal right of way of crossing pedestrians.
- Prevent parking in crosswalks and daylight the corner so that vehicles and pedestrians can see each other, especially at the top of a "T" intersection.
- Define the ends of diagonal parking.
- Can reinforce "no truck" regulation, when designed so no vehicle larger than a 30-foot single unit truck may turn the corner.
- Can restrict entry to a block; for example, where a two-way street becomes a one-way street (block-buster).

At mid-block locations, neckdowns:

- Add sidewalk space for amenities, subway stairs, bicycle parking, outdoor cafes, street furniture, vendors, etc., without impinging upon space needed for pedestrian traffic.
- Can accentuate a mid-block crosswalk.

At fire hydrants, neckdowns:

- Guarantee emergency access to fire hydrants when placed in the "no parking" zone directly adjacent.

PLANNING

The following describes the general planning criteria for neckdowns:

1. Neckdowns may not be installed on streets where the curb lane is used for moving traffic (either full- or part-time) or where it is predicted that the curb lane will be used for such purposes. Examples include but are not limited to bus and bicycle lanes, and streets with peak period parking restrictions. A curb analysis may be required to assess whether peak period regulations are necessary. Future curb lane use should be justified with a definite, scheduled project.
2. Where turning movements equal or exceed 20 percent of the total through movements or three vehicles per cycle, a traffic analysis will be required before installing a neckdown.
3. An agreement regarding snow and litter removal with a responsible community or private group should be considered for each neckdown.

4. At fire hydrants, neckdowns may be installed provided they do not interfere with other normal and legal street and parking operations.

5. Neckdowns should be avoided in industrial zones, as truck movements may be unduly restricted.

DESIGN

The following describes general geometric design and construction guidelines for neckdowns:

1. The standard width of a neckdown shall be the width of the parking lane minus two feet.
2. The standard length of a neckdown shall be equal to the full width of the crosswalk.
3. The corner radius of a neckdown will be consistent with the other corners of the intersection, typically 12 feet. The corner radius may be increased to accommodate buses and trucks.

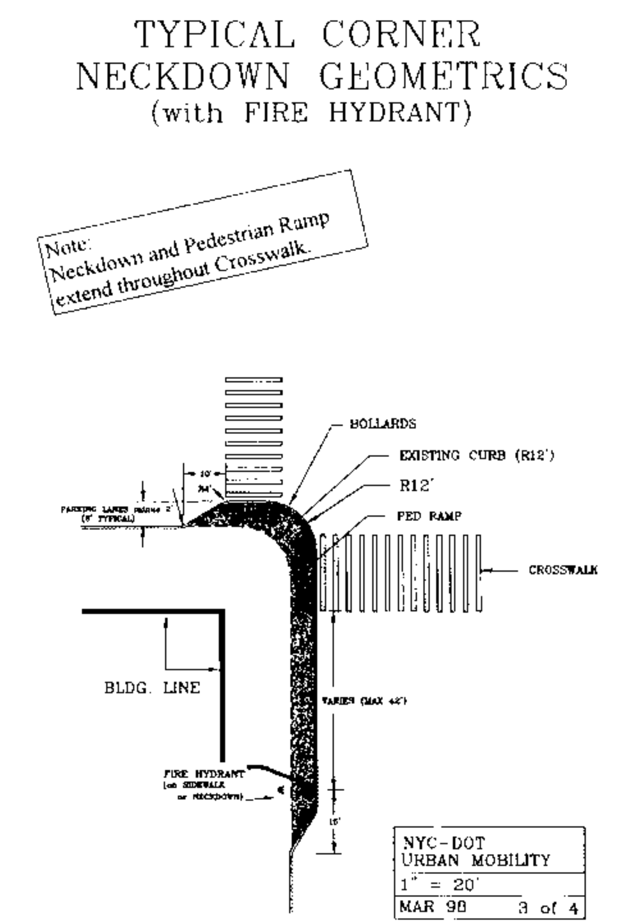

FIGURE 5 Sample detail.

4. The 30-foot single unit truck (SU-30) will be the standard design vehicle. On designated truck routes or where regularly scheduled buses must turn, the appropriate design vehicle will be used.

5. A fire truck turning zone with a 50-foot outside radius shall be maintained clear of physical obstructions (signs, planters, nonflexible bollards, trees).

6. Bollards, planters or other street furniture may be included on the neckdown. The design and placement of street furniture shall not impede pedestrian flow, present a trip hazard, or interfere with "daylighting" the intersection, emergency operations or sight lines. (See #5 above.)

7. A sign, bollard, or other vertical device shall be placed on the neckdown to alert drivers to the presence of the neckdown. The design and placement of the device shall not obstruct emergency operations or sight lines. (See #5 above.)

8. Where drainage conditions, future curb use, or cost of a neckdown is prohibitive, striping and fixed bollards/rails may serve as a substitute (Urban Oasis). In general, the Urban Oasis is a temporary measure that should be used sparingly.

9. In new construction, neckdowns shall be built to sidewalk standards, except at hydrants. (See #10 below.)

10. At fire hydrants, neckdowns shall adhere to the following requirements (see Fig. 5):

    a) The length of the neckdown shall be equal to the "no parking" zone (typically 15 feet in either direction).

    b) If the hydrant is not moved onto the neckdown, the neckdowns shall be built to regular street standards to support the weight of the fire truck, with appropriate provisions to allow fire trucks to mount the curb.

    c) There shall be no physical obstructions (signs, planters, benches, non-flexible bollards, trees) that block access to the hydrant and beyond.

    d) A 22-foot minimum roadway width (from curb to curb or parked vehicle) must be maintained at a fire hydrant, so that a fire truck may pass another parked at the hydrant. This applies if the hydrant is on the neckdown or on the sidewalk proper.