

APPENDIX B

Speed Flow Curves

B.Speed Flow Curves

INTRODUCTION

B.1 This appendix describes the implementation of speed flow curves within a SATURN model. Speed-flow curves are used within the model to reflect constraint on demand in line with available network capacity. This is achieved by applying a speed flow curve relationship which represents decreases in link speeds with flow increases, with the characteristics of the road determining the nature of this relationship.

COBA SPEED FLOW CURVES

B.2 Speed flow curves are used in the Department of Transport's COBA appraisal for road schemes.

B.3 The Department of Transport speed flow curves take the following form:

S_0	$V \leq F$
$S(V)$	$S_1 + (S_1 - S_0)(V - F)/(C - F)$
	$S_1 / (1 + S_1(V - C)/8dC)$
	$F < V \leq C$
	$V > C$

Where:

- t is the link time (in hours);
- d is the link distance (in kilometres);
- S is the link speed (in kph); $S = d / t$
- V is the link flow (in PCU per hour);
- S0 is the 'free-flow' speed;
- S1 is the speed at capacity;
- F is the maximum flow at which 'free-flow' conditions hold; and
- C is the capacity

B.4 The characteristics of the road determine the type of speed flow relationship which exists. COBA splits roads into four types and gives typical speed flow curves for each type, in Part 5 Chapter 9 of DMRB Vol. 13, as follows:

- Rural Figure 9.1 and Figure 9.2;
- Sub-Urban Figure 9.4;
- Urban Figure 9.3;
- Small town or Village Figure 9.5.

SATURN SPEED FLOW CURVES

B.5 SATURN uses a curve fitting procedure to create speed flow curves. The formula within SATURN is as follows

$$t = t_0 + a V^n$$

where

- t is time on link (analogous to speed)
- t_0 is free flow time (analogous to free flow speed)
- a is a constant (determined from speed and flow at capacity)
- V is link flow
- n is the power of the curve (determines the length of the flat part and how quickly the curve falls)

B.6 The speed-flow curves used in COBA have been converted for use within SATURN. This has subsequently been incorporated into the documentation of speed flow curves given in the SATURN manual (Section 15.9.3).

B.7 The speed flow curves used in the Bristol Model are based on those used in COBA, converted to SATURN format. The parameters entered into SATURN are given in Table B.1 together with link indices. Speed flow curves for each index are illustrated in Figures B.1 to B.6 where:

Figure B.1 - Rural Buffer and Simulation (Indices 1 to 9 & 44);

Figure B.2 - Sub-Urban Buffer (Indices 10 to 15);

Figure B.3 - Urban Buffer (Indices 16 to 21);

Figure B.4 - Small Town or Village Buffer and Simulation (Indices 22 to 24);

Figure B.5 – Sub-Urban Simulation (Indices 30 to 37); and

Figure B.6 – Urban Simulation (Indices 40 to 42).

Table B.1 – Speed Flow Indices

Link Index	Description	Simulation (S) or Buffer (B)	SO (kph)	S2 (kph)	F (pcu/hr/lane)	C (pcu/hr/lane)	N (power of the curve)
1	Rural D3 Motorway	S/B	116	45	1200	2520	3.81
2	Rural D2 Motorway	S/B	112	45	1200	2430	3.85
3	Rural D2/D3 AP (A Trunk)	S/B	109	45	1080	2260	3.66
4	Rural D2/D3 AP (including Motorway Slips)	S/B	88	45	1080	2180	3.63
5	Rural S3 (Good A)	S/B	91	45	1100	1860	2.24
6	Rural S3 (Avg. A)	S/B	84	45	1100	1660	2.13
7	Rural S2 (Good A)/S3 Poor	S/B	87	45	880	1640	2.16
8	Rural S2 (Avg. A, Good/Avg. B, Good C -50 mph)	S/B	78	45	850	1380	2.07
9	Rural S2 (Poor A, Avg. B, Good C – 40 mph)	S/B	67	45	770	1010	1.79
10	Suburban D2 (Good A – 50 mph) Good - Minor Access (15/km), Intersections (0.4/km)	B	76	35	1050	1540	2.79
11	Suburban D2 (Avg. A - 40 mph) Typical - Minor Access (30//km), Intersections (0.8/km)	B	71	35	1000	1285	2.65
12	Suburban D2 (Poor A – 40 mph) Poor - Minor Access (40/km), Intersection (1.2)	B	68	35	950	1030	1.94
13	Suburban S2 (Good A - 50 mph) Good - Minor Access (15/km), Intersections (0.4/km)	B	66	25	1050	1540	3.75
14	Suburban S2 (Avg. A - 40 mph) Typical - Minor Access (30//km), Intersections (0.8/km)	B	61	25	1000	1285	3.76
15	Suburban S2 (Poor A – 40 mph) Poor - Minor Access (40/km), Intersection (1.2)	B	58	25	950	1030	2.32
16	Urban Non-Central S2 (Good A – 30 mph) Low Development (50%).	B	54	25	490	980	1.67
17	Urban Non-Central S2 (Good A – 30 mph) Medium Development (80%)	B	49	25	390	780	1.56
18	Urban Non-Central S2 (Good-Avg. A, Good B - 30 mph) High Development (90%)	B	45	25	325	650	1.48
19	Urban Central S2 (Avg. A, Good B - 30 mph) Good Road – 2 junctions/km	B	37	15	370	740	1.83
20	Urban Central S2 (Poor A, Avg. B, Good C - 30 mph) Typical Road – 4.5 junctions/km	B	34	15	315	630	1.73
21	Urban Central S2 (Poor A, Poor B, Poor C – 30 mph) Centre Poor Road – 9 junctions/km	B	29	15	225	450	1.55
22	Rural S2 (Village 40 mph) Light Development (35%)	S/B	66	30	700	1300	3.00

Link Index	Description	Simulation (S) or Buffer (B)	SO (kph)	S2 (kph)	F (pcu /hr/ lane)	C (pcu /hr/ lane)	N (power of the curve)
23	Rural S2 (Village 40 mph) Typical Development (60%)	S/B	57	30	700	1000	3.39
24	Rural S2 (Village 30 mph) High Development (90%)	S/B	47	30	700	880	2.45
30	Suburban D2 (Good A - 50 mph) Good - Minor Access (15/km), Intersections (0.4/km)	S	78	35	1050	1820	2.94
31	Suburban D2 (Avg. A – 40 mph) Typical - Minor Access (30//km), Intersections (0.8/km)	S	73	35	1050	1760	3.18
32	Suburban D2 (Poor A – 40 mph) Poor - Minor Access (40/km), Intersection (1.2)	S	68	35	1050	1725	3.47
33	Suburban S2 (Good A - 50 mph) Good - Minor Access (15/km), Intersections (0.4/km)	S	65	25	1050	1800	2.71
34	Suburban S2 (Avg. A/ Good B - 40 mph) Typical - Minor Access (30//km), Intersections (0.8/km)	S	60	20	1050	1750	2.01
35	Suburban S2 (Poor A /Avg B– 30 to 40 mph) Poor - Minor Access (40/km), Intersection (1.2)	S	55	20	1050	1600	1.65
36	Suburban S2 - Residential	S	45	21	1050	1200	1.38
37	Suburban S2 - Residential	S	45	21	875	1000	1.38
40	Urban Central S2 (Avg. A, Good B - 30 mph) Good Road – 2 junctions/km	S	62	25	1048	1800	2.75
41	Urban Central S2 (Poor A, Avg. B, Good C – 30 mph) Typical Road – 4.5 junctions/km	S	55	20	983	1700	2.65
42	Urban Central S2 (Poor A, Poor B, Poor C - 30 mph) Centre Poor Road – 9 junctions/km	S	47	20	918	1600	2.55
44	D2 All Purpose Road Climber Lane	S	75	35	900	1950	3.68
88	Centroid Connectors	S	30	30	9999	9999	
Note:	1 - In the Highway Model in the simulation that Urban Non-central are not used because the speed – flow curves are very similar to the Suburban S2 index 34 / 35.						
	2 – Simulation speed flow curves exclude junction delay. Thus suburban and urban non-central curves are very similar.						

Figure A.1 Speed Flow Curves : Rural Simulation and Buffer

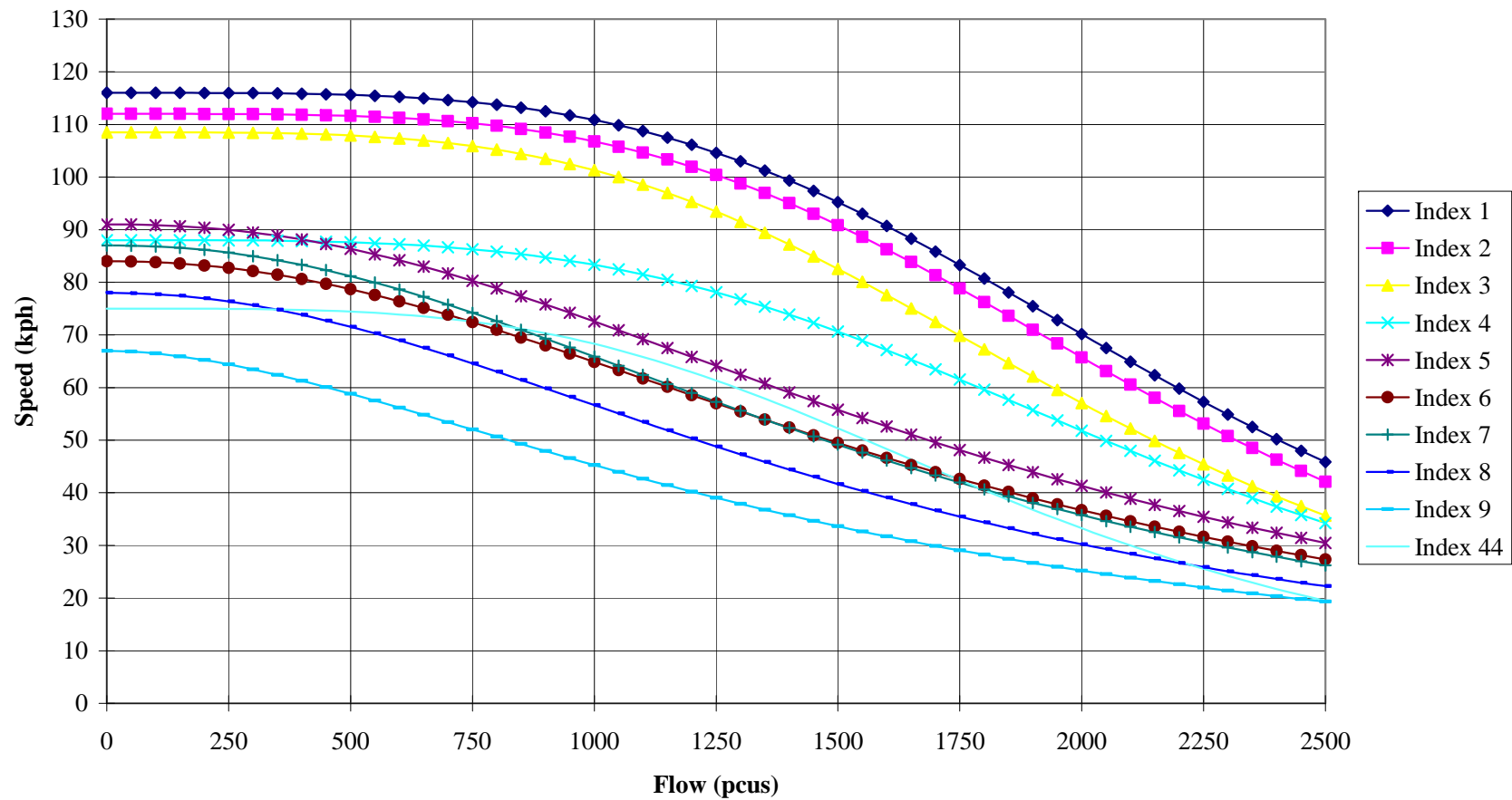


Figure B.1 – Rural Simulation and Buffer

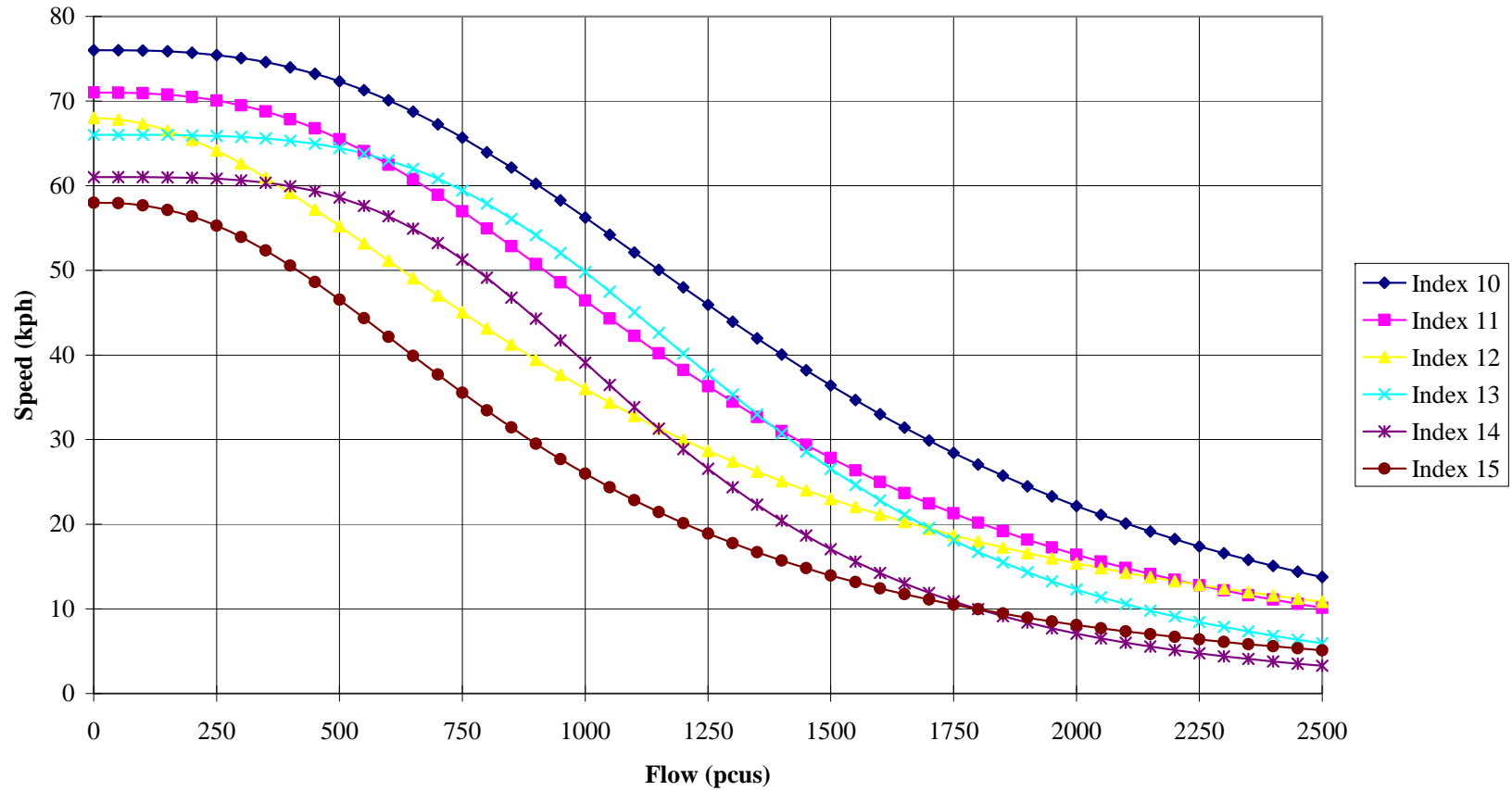


Figure B.2 – Suburban Buffer

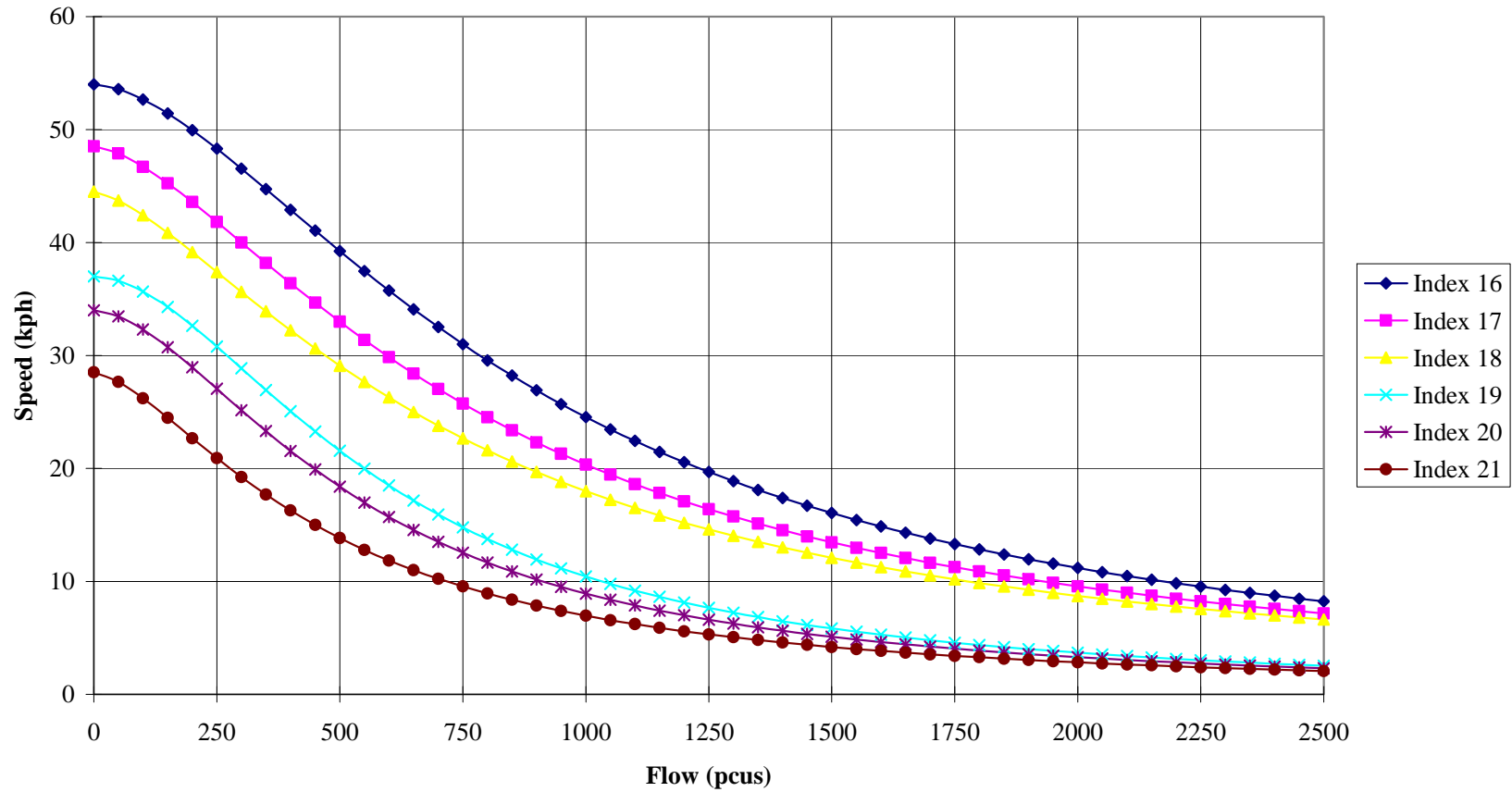


Figure B.3 –Urban Buffer

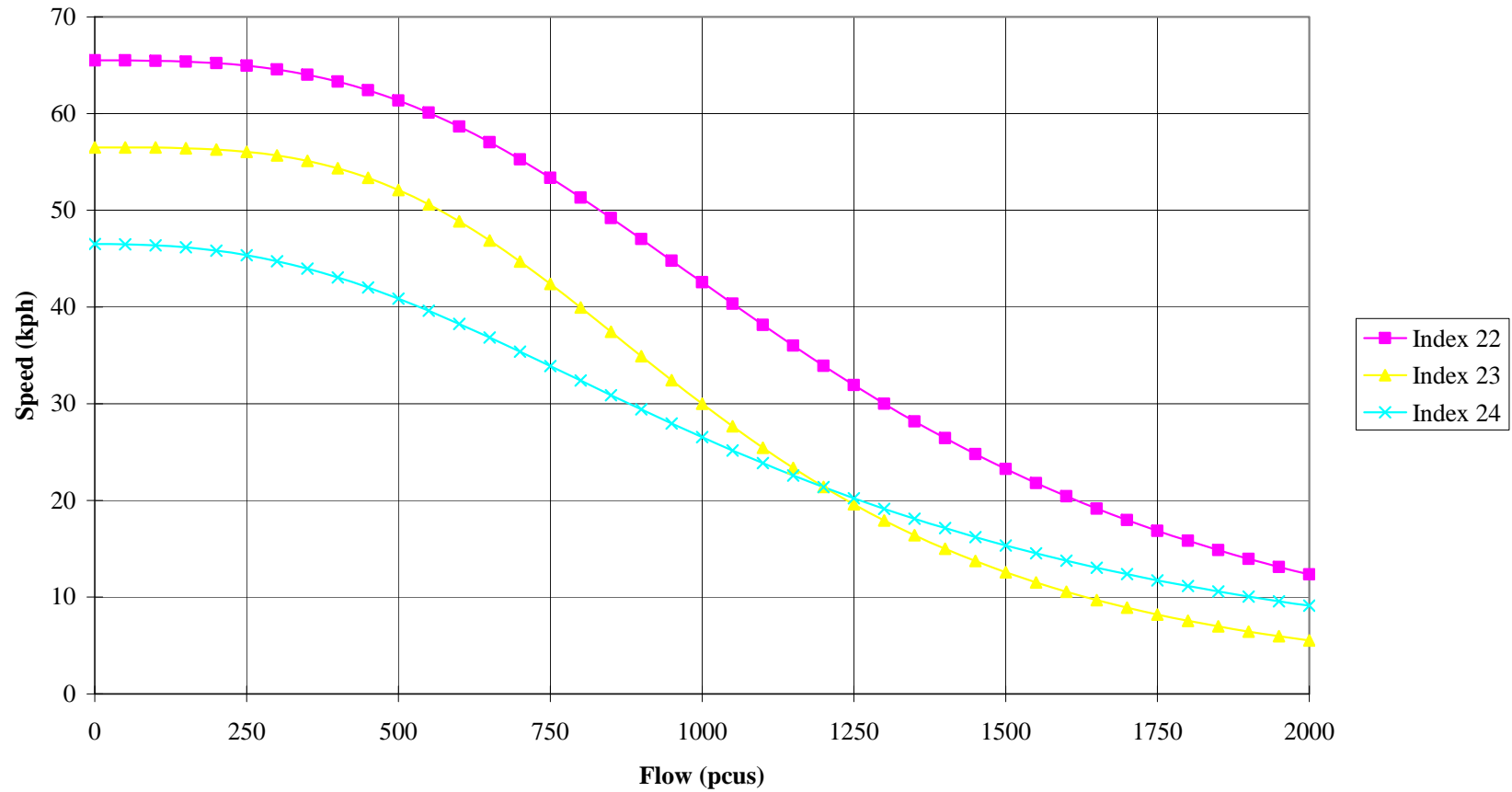


Figure B.4 – Small Town or Village Simulation or Buffer

Figure A.5 Speed Flow Curves : Suburban Simulation

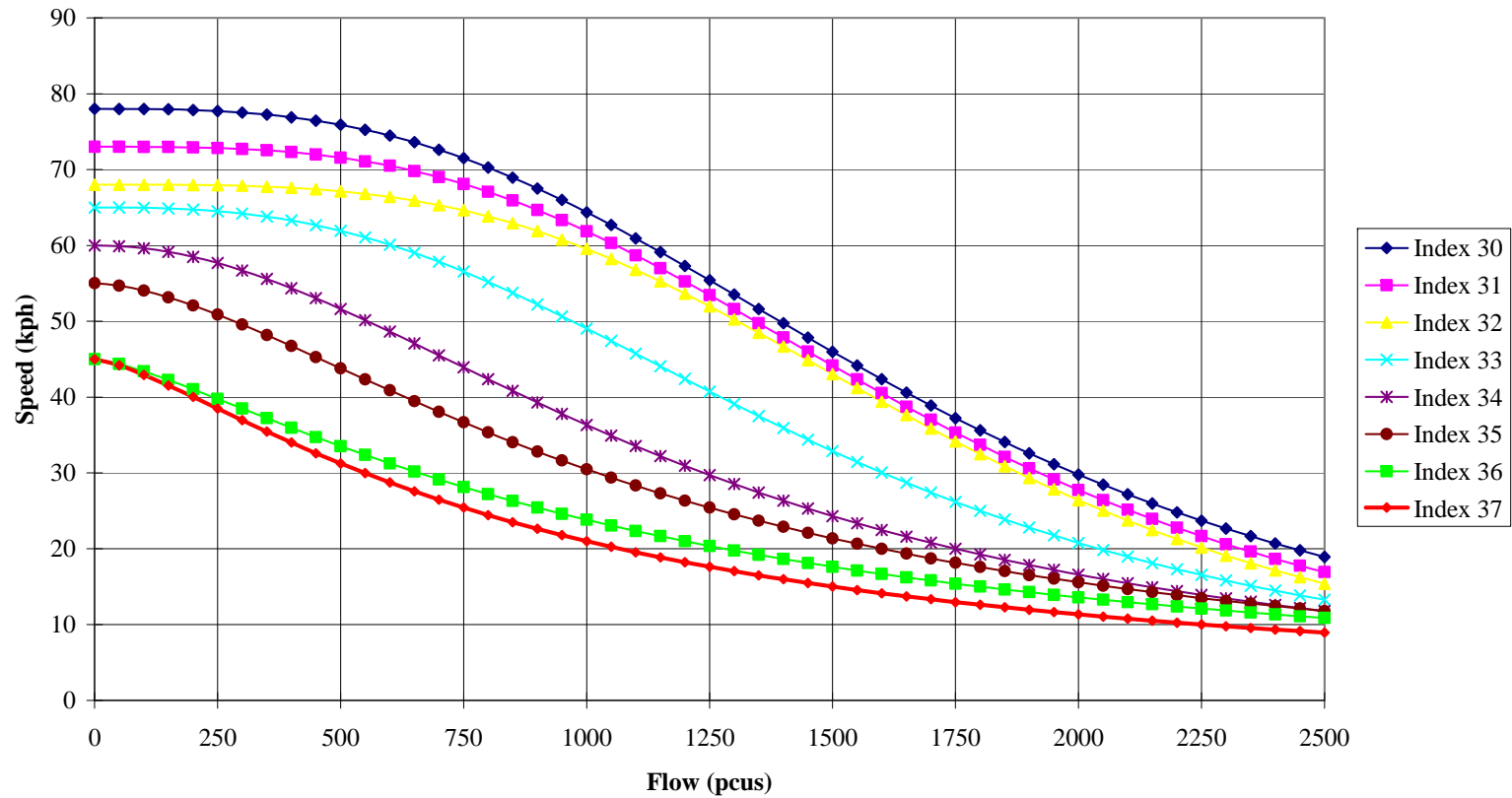


Figure B.5 – Suburban Simulation

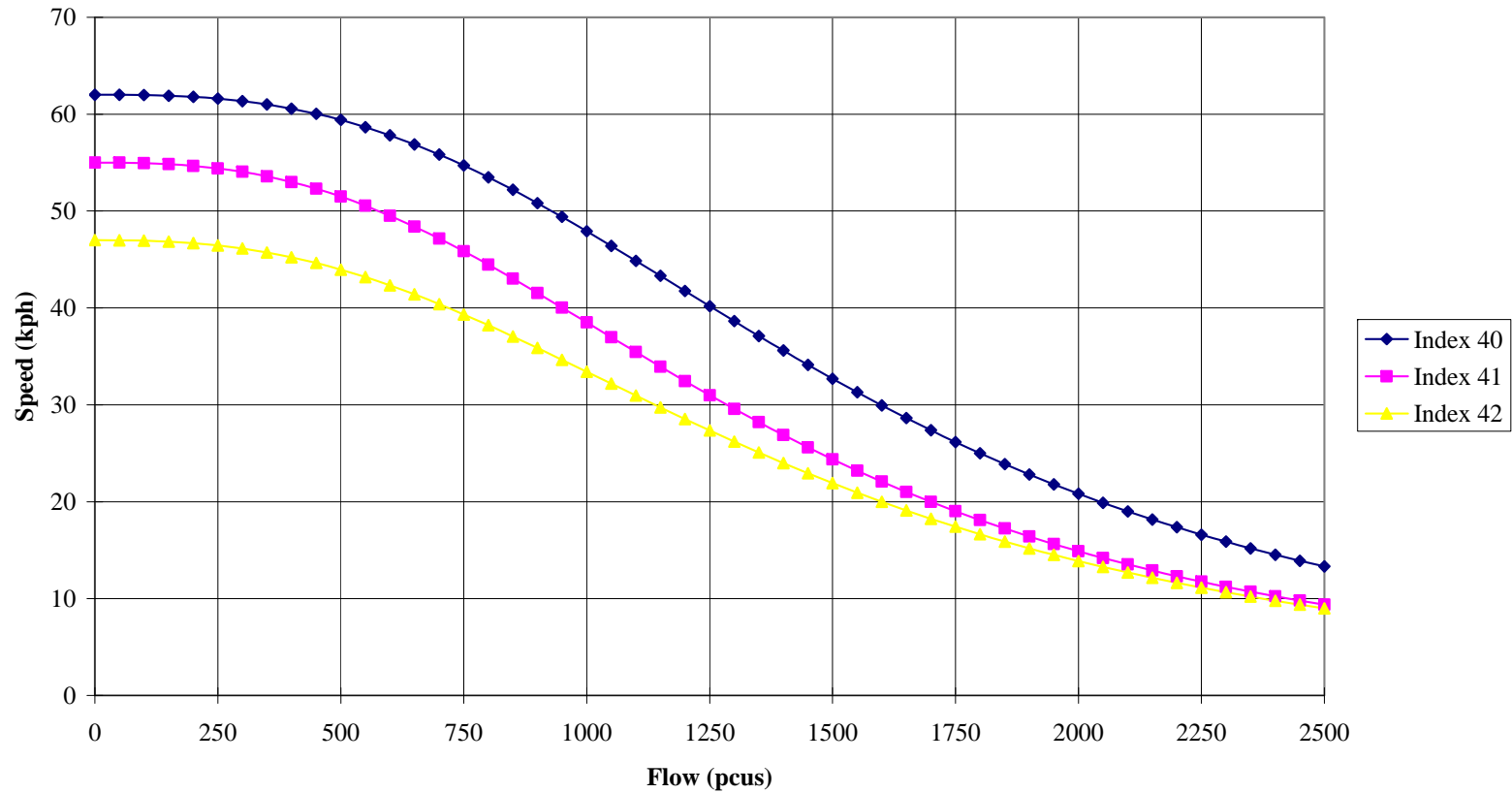


Figure B.6 – Urban Simulation