Problem #1

The pollutant emission rate E has been estimated to change with respect to time as $E = A(1 - e^{-Bt})$, where A and B are constants. Assuming a constant airflow F and a box volume V, apply the box model to express the pollutant concentration as a function of time. The initial concentration in the box at time t = 0 is K.

$$E = A(1 - e^{-Bt})$$

Eq. 10.2.1 becomes:

$$A(1 - e^{-Bt}) - FC = V\frac{dC}{dt}$$

or

$$\frac{dC}{dt} + \frac{F}{V}C = \frac{A}{V}(1 - e^{-Bt})$$

$$f(t) = e^{Ft/V}$$

$$C\,e^{Ft/V} = \frac{A}{V}\int (e^{Ft/V} - e^{(F-BV)t/V})dt$$

$$C\,e^{Ft/V} = \frac{A}{V}\left(\frac{V}{F}e^{Ft/V} - \frac{V\,e^{\frac{F-BV}{V}t}}{F-BV}\right) + D$$

At t = 0, C = K

$$K = A\left(\frac{1}{F} - \frac{1}{F-BV}\right) + D$$

$$D = K - A\left(\frac{1}{F} - \frac{1}{F-BV}\right) = K + \frac{BVA}{F(F-BV)}$$

and

$$C = \frac{A}{F} - \frac{A}{F-BV}e^{-Bt} + D\,e^{-Ft/V}$$

Problem #2

The flow on a highway consists of a 100 heavy trucks per hour traveling at 50 mph, 30 medium trucks per hour traveling at 40 mph, and 600 passenger cars per hour traveling at 50 mph. Assuming a highway width of 50 ft, specify the width of the buffer zone that ensures that the noise level in an adjacent park will not exceed the FHWA standard.

100 Heavy Trucks at 50 mi/h
30 Medium Trucks at 40 mi/h
600 Cars at 50 mi/h

The medium trucks are equivalent to
(30)(10) = 300 passenger cars

The FHWA standard for parks is 60 dBA (see Table 10.3.1, page 352)

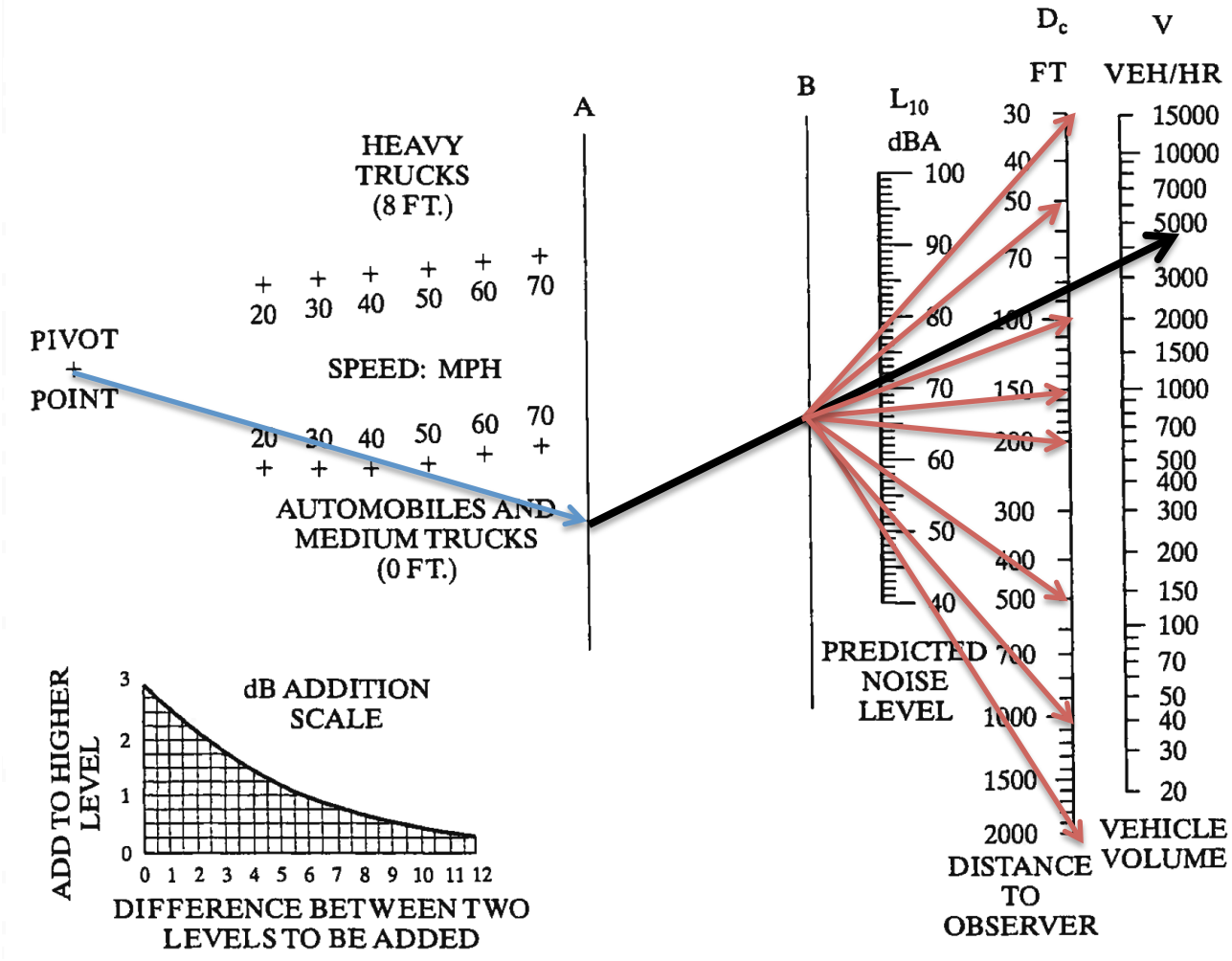
Use Fig. 10.3.4 (page 359) to get the following table:

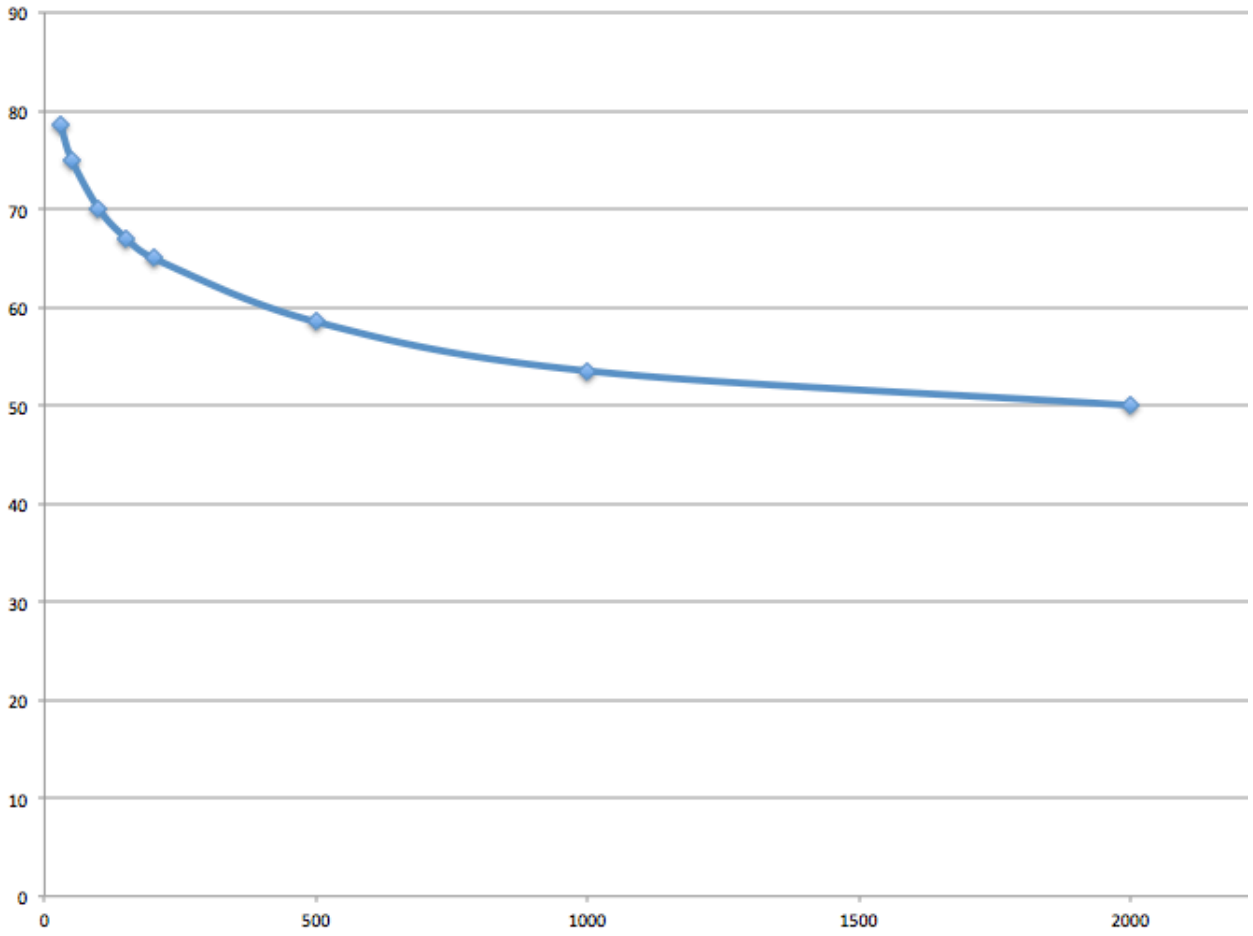
Dc (ft)	Heavy Trucks	Medium Trucks	Cars	Add
600	60	46.0	51	60.7
700	59	45.5	50	59.7
800	58	44.5	49	58.7
900	57	43.5	48	57.7

The minimum buffer zone extent should be about 700 from the center of the highway or 675 ft from the edge of pavement.

Problem #3

A straight at-grade highway accommodates 2800 passenger cars and 70 medium trucks per hour. The average speed of the two vehicle types is the same and equals 45 mph. Plot the relationship between the noise level, L_{10}, and the distance from the highway.




90
80
70
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