$$\frac{dS}{dt} = -\frac{\beta_I SI + \beta_H SH + \beta_F SF}{N}$$

$$\frac{dE}{dt} = \frac{\beta_I SI + \beta_H SH + \beta_F SF}{N} - \alpha E$$

$$\frac{dI}{dt} = \alpha E - [\gamma_H \theta_1 + \gamma_I (1-\theta_1)(1-\delta_1) + \gamma_D (1-\theta_1)\delta_1] I$$

$$\frac{dH}{dt} = \gamma_H \theta_1 I - [\gamma_{DH} \delta_2 + \gamma_{IH} (1-\delta_2)] H$$

$$\frac{dF}{dt} = \gamma_D (1-\theta_1)\delta_1 I + \gamma_{DH} \delta_2 H - \gamma_F F$$

$$\frac{dR}{dt} = \gamma_I (1-\theta_1)(1-\delta_1) I + \gamma_{IH} (1-\delta_2) H + \gamma_F F$$