**Model V0.2 Equations**

Note: ZZ is a prefix for model constants to facilitate the translation pipeline into R

The reason is to use a global space for the ode function, rather than passing all constants to the ode function directly. This allows for more flexibility in manipulating the environment sim\_env.

(001) Actual Pulse Flag = PULSE TRAIN ( ZZPulse Start Time , ZZPulse Duration

, Pulse Repeat , ZZPulse End )

Units: Dmnl

(002) Additional ICU Places Required = max ( 0, Total Severe in NonICU Hospital

- Total Severe in ICU )

Units: People

(003) AR1 = Awaiting Results 01 / ZZAverage Wait for Results

Units: People/Day

(004) ASI1 = Asymptomatic Infected 01 / ( Net Infectious Period for Infection Compartments

/ 2)

Units: People/Day

(005) ASI2 = Asymptomatic Infected 02 / ( Net Infectious Period for Infection Compartments

/ 2)

Units: People/Day

(006) Asymptomatic Infected 01 = INTEG( IP02a - ASI1 , 0)

Units: People

Model Equation (4) - Compartment 1

(007) Asymptomatic Infected 02 = INTEG( ASI1 - ASI2 , 0)

Units: People

Model Equation (4) - Compartment 2

(008) Asymptomatic Infectious Period = ZZIncubation Period C - ZZLatent Period L

Units: Day

(009) Awaiting Results 01 = INTEG( IP02c - AR1 , 0)

Units: People

Model Equation (6)

(010) Awaiting Results 02 = INTEG( AR1 - EntHos - EntRem , 0)

Units: People

Model Equation (7)

(011) Beta = Beta Intermediate \* Physical Distancing Smoothed Value \* Beta Pulse Reduction Factor

Units: 1/Day

Transmission parameter = R0/Total Infectious Period

(012) Beta From R0 = ZZR0 Input / ( Numerator Term 1 + Numerator Term 2 + Numerator Term 3

)

Units: \*\*undefined\*\*

(013) Beta Intermediate = IF THEN ELSE ( ZZR0 Fixed Flag = 1, Beta From R0

, ZZBeta Calibrated )

Units: \*\*undefined\*\*

(014) Beta Pulse Reduction Factor = 1 - Step ( 0.2, ZZSwitch Time )

Units: Dmnl

An assumption that there is limited social distancing during the

reopen phase

(015) C01 Total Infected Presymptomatic = Infected Presymptomatic 01 + Infected Presymptomatic 02

Units: People

Total Presymptomatic Infected (Subclinical infectious)

(016) C02 Total Asymptomatic Infected = Asymptomatic Infected 01 + Asymptomatic Infected 02

Units: People

(017) C03 Total Symptomatic Immediate Isolation Infectious = Symptomatic Immediate Isolation 01

+ Symptomatic Immediate Isolation 02

Units: People

(018) C04 Total Awaiting Results Infectious = Awaiting Results 01

Units: People

(019) C05 Total Isolated After Test Infected = Awaiting Results 02

Units: People

(020) C06 Total Not Quarantining Infected = Not Quarantine Infectious 01 +

Not Quarantine Infectious 02

Units: People

(021) CEICUE = Error Delta / ZZAT

Units: People/(Day\*Day)

(022) Checksum Cumulative Flows = Cumulative Immediate Isolation + Cumulative Infectious Asymptomatic

+ Cumulative Not Quarantined + Cumulative Tests Positive

Units: People

(023) CheckSum Population = Susceptible + Total Exposed + Total Infectious

+ Total Removed + Total in Hospital

Units: People

(024) CPDSV = PDSVG / ZZPDAT

Units: Dmnl/Day

(025) Cumulative Immediate Isolation = INTEG( ICII , 0)

Units: People

(026) Cumulative Infectious Asymptomatic = INTEG( ICIA , 0)

Units: People

(027) Cumulative Model Infected = INTEG( ICI , 0)

Units: People

Keep track of the total number infected (cumulative)

(028) Cumulative Not Quarantined = INTEG( ICNQ , 0)

Units: People

(029) Cumulative Test Incidence = INTEG( ICTI , 0)

Units: People

Model Equation (10)

(030) Cumulative Tests Positive = INTEG( ICTP , 0)

Units: People

(031) E01 = Exposed 01 / ( ZZLatent Period L / 2)

Units: People/Day

Exit rate from Exposed 01

(032) E02 = Exposed 02 / ( ZZLatent Period L / 2)

Units: People/Day

Exit rate from Exposed 02

(033) EntHos = ZZProportion Hospitalised \* Total Exiting AR02

Units: People/Day

(034) EntRem = ( 1 - ZZProportion Hospitalised ) \* Total Exiting AR02

Units: People/Day

(035) Error Delta = ICU02 - Expected ICU Exits

Units: People/Day

(036) EXH01a = ZZFraction in Risk Group \* ZZFraction In Hospital Severe \* Total Exiting Hospital 01

Units: People/Day

(037) EXH01b = ( 1 - ZZFraction In Hospital Severe ) \* Total Exiting Hospital 01

Units: People/Day

(038) EXH02 = In Hospital 02 / ( ZZAverage HLOS / 3)

Units: People/Day

(039) EXH03 = In Hospital 03 / ( ZZAverage HLOS / 3)

Units: People/Day

(040) Expected ICU Exits = INTEG( CEICUE , 0)

Units: People/Day

(041) Exposed 01 = INTEG( IR - E01 , 0)

Units: People

Model Equation (2) First Compartment

(042) Exposed 02 = INTEG( E01 - E02 , 0)

Units: People

Model Equation (2) Second Compartment

(043) FINAL TIME = 200

Units: Day

The final time for the simulation.

(044) ICI = IR

Units: People/Day

(045) ICIA = IP02a

Units: People/Day

(046) ICII = IP02b

Units: People/Day

(047) ICNQ = IP02d

Units: People/Day

(048) ICTI = AR1

Units: People/Day

(049) ICTP = IP02c

Units: People/Day

(050) ICU Available Space = ICU Daily Freed Up Space + ZZICU Available Capacity

- Total Severe in ICU

Units: People

(051) ICU Daily Freed Up Space = Expected ICU Exits / ZZLag Time

Units: People

(052) ICU01 = Severe Cases ICU 01 / ( ZZICU Residency Time / 2)

Units: People/Day

(053) ICU02 = Severe Cases ICU 02 / ( ZZICU Residency Time / 2)

Units: People/Day

(054) IHS01 = min ( ICU Available Space , Total Exiting Hospital Severe )

Units: People/Day

(055) IHS02 = Total Exiting Hospital Severe - min ( ICU Available Space , Total Exiting Hospital Severe

)

Units: People/Day

(056) In Hospital 01 = INTEG( EntHos - EXH01a - EXH01b , 0)

Units: People

(057) In Hospital 02 = INTEG( EXH01b - EXH02 , 0)

Units: People

(058) In Hospital 03 = INTEG( EXH02 - EXH03 , 0)

Units: People

(059) In Hospital Severe = INTEG( EXH01a - IHS01 - IHS02 , 0)

Units: People

(060) Infected Presymptomatic 01 = INTEG( E02 - IP01 , ZZNumber Seeds )

Units: People

Model Equation (3) - Compartment 1

(061) Infected Presymptomatic 02 = INTEG( IP01 - IP02a - IP02b - IP02c - IP02d

, 0)

Units: People

Model Equation (3) - Compartment 2

(062) INITIAL TIME = 1

Units: Day

The initial time for the simulation.

(063) IP01 = Infected Presymptomatic 01 / ( Asymptomatic Infectious Period

/ 2)

Units: People/Day

Exit rate from Infected Presymptomatic 01

(064) IP02 Outflow Total Exiting Checksum = IP02a + IP02b + IP02c + IP02d

Units: People/Day

(065) IP02a = Total Exiting IP02 \* ZZProportion Asymptomatic f

Units: People/Day

(066) IP02b = Total Exiting IP02 \* ( 1 - ZZProportion Asymptomatic f ) \* ZZProportion Quarantined q

Units: People/Day

(067) IP02c = Total Exiting IP02 \* ( 1 - ZZProportion Asymptomatic f ) \* ZZProportion Tested t

Units: People/Day

(068) IP02d = Total Exiting IP02 \* ( 1 - ZZProportion Asymptomatic f ) \* (

1 - ZZProportion Tested t - ZZProportion Quarantined q )

Units: People/Day

(069) IR = Lambda \* Susceptible

Units: People/Day

Infection rate (indicence) in the population

(070) Lambda = ( ( Beta \* C01 Total Infected Presymptomatic ) + ( Beta \* ZZBeta Multiplier h

\* ZZBeta Multiplier k \* C02 Total Asymptomatic Infected ) +

( Beta \* ZZBeta Multiplier i \* C03 Total Symptomatic Immediate Isolation Infectious

) + ( Beta \* C04 Total Awaiting Results Infectious ) + ( Beta

\* ZZBeta Multiplier j \* C05 Total Isolated After Test Infected )

+ ( Beta \* C06 Total Not Quarantining Infected ) ) / ZZTotal Population

Units: 1/Day

Force of infection, with contributions from all of the infected

compartments.

(071) Net Infectious Period for Infection Compartments = ZZTotal Infectious Period D

+ ZZLatent Period L - ZZIncubation Period C

Units: Day

(072) Not Quarantine Infectious 01 = INTEG( IP02d - NQI1 , 0)

Units: People

Model Equation (8) - Compartment 1

(073) Not Quarantine Infectious 02 = INTEG( NQI1 - NQI2 , 0)

Units: People

Model Equation (8) - Compartment 2

(074) NQI1 = Not Quarantine Infectious 01 / ( Net Infectious Period for Infection Compartments

/ 2)

Units: People/Day

(075) NQI2 = Not Quarantine Infectious 02 / ( Net Infectious Period for Infection Compartments

/ 2)

Units: People/Day

(076) Numerator Term 1 = ( ZZIncubation Period C - ZZLatent Period L ) \* (

- ZZProportion Asymptomatic f \* ZZBeta Multiplier h + ( ZZProportion Asymptomatic f

- 1) \* ( ZZBeta Multiplier i - 1) \* ZZProportion Quarantined q

+ ZZProportion Asymptomatic f )

Units: Dmnl

(077) Numerator Term 2 = ( ZZProportion Asymptomatic f - 1) \* ( ZZBeta Multiplier j

- 1) \* ZZProportion Tested t \* ( ZZIncubation Period C - ZZLatent Period L

+ ZZAverage Wait for Results )

Units: \*\*undefined\*\*

(078) Numerator Term 3 = ZZTotal Infectious Period D \* ( ZZProportion Asymptomatic f

\* ( ZZBeta Multiplier h - ZZBeta Multiplier i \* ZZProportion Quarantined q

- ZZBeta Multiplier j \* ZZProportion Tested t + ZZProportion Quarantined q

+ ZZProportion Tested t - 1) + ( ZZBeta Multiplier i -

1) \* ZZProportion Quarantined q + ( ZZBeta Multiplier j

- 1) \* ZZProportion Tested t + 1)

Units: \*\*undefined\*\*

(079) PDSVG = Physical Distancing Fractional Reduction Amount - Physical Distancing Smoothed Value

Units: Dmnl

(080) Physical Distancing Fractional Reduction Amount = IF THEN ELSE ( Pulse Policy

= 1 :OR: ZZDistancing Flag = 1, 1 - ZZPercentage Reduction of Physical Distancing

, 1)

Units: Dmnl

If any policy is active, physical distancing occurs

(081) Physical Distancing Smoothed Value = INTEG( CPDSV , 1)

Units: Dmnl

(082) Population Attack Rate = Total Removed / ZZTotal Population

Units: Dmnl

(083) Pulse Policy = ZZPulse Strategy Flag \* Actual Pulse Flag

Units: Dmnl

The overall policy

(084) Pulse Repeat = ZZPulse Duration + ZZPulse Off Duration

Units: Day

The lag time between pulse peaks

(085) R0 = ( Numerator Term 1 + Numerator Term 2 + Numerator Term 3 ) \* Beta

Units: \*\*undefined\*\*

(086) Removed Asymptomatic = INTEG( ASI2 , 0)

Units: People

Model Equation (9) - First Term

(087) Removed Awaiting Results = INTEG( EntRem , 0)

Units: People

Model Equation (9) - Third Term

(088) Removed Hospital = INTEG( EXH03 , 0)

Units: People

(089) Removed Not Quarantine = INTEG( NQI2 , 0)

Units: People

Model Equation (9) - Fourth Term

(090) Removed Severe Cases Hospital = INTEG( SCH02 , 0)

Units: People

(091) Removed Severe Cases ICU = INTEG( ICU02 , 0)

Units: People

(092) Removed Symptomatic Immediate Isolation = INTEG( SII02 , 0)

Units: People

Model Equation (9) - Second Term

(093) Reported Incidence = AR1

Units: People/Day

(094) SAVEPER = TIME STEP

Units: Day

The frequency with which output is stored.

(095) SCH01 = Severe Cases Hospital 01 / ( ZZAverage HLOS / 2)

Units: People/Day

(096) SCH02 = Severe Cases Hospital 02 / ( ZZAverage HLOS / 2)

Units: People/Day

(097) Severe Cases Hospital 01 = INTEG( IHS02 - SCH01 , 0)

Units: People

(098) Severe Cases Hospital 02 = INTEG( SCH01 - SCH02 , 0)

Units: People

(099) Severe Cases ICU 01 = INTEG( IHS01 - ICU01 , 0)

Units: People

(100) Severe Cases ICU 02 = INTEG( ICU01 - ICU02 , 0)

Units: People

(101) SII01 = Symptomatic Immediate Isolation 01 / ( Net Infectious Period for Infection Compartments

/ 2)

Units: People/Day

(102) SII02 = Symptomatic Immediate Isolation 02 / ( Net Infectious Period for Infection Compartments

/ 2)

Units: People/Day

(103) Susceptible = INTEG( - IR , ZZTotal Population - ZZNumber Seeds )

Units: People

Model Equation (1)

(104) Symptomatic Immediate Isolation 01 = INTEG( IP02b - SII01 , 0)

Units: People

Model Equation (5) - Compartment 1

(105) Symptomatic Immediate Isolation 02 = INTEG( SII01 - SII02 , 0)

Units: People

Model Equation (5) - Compartment 2

(106) Test = 0 + Step ( 1, 20)

Units: \*\*undefined\*\*

(107) TIME STEP = 0.125

Units: Day

The time step for the simulation.

(108) Total Exiting AR02 = Awaiting Results 02 / ( max ( 1, Net Infectious Period for Infection Compartments

- ZZAverage Wait for Results ) )

Units: People/Day

(109) Total Exiting Hospital 01 = In Hospital 01 / ( ZZAverage HLOS / 3)

Units: People/Day

(110) Total Exiting Hospital Severe = In Hospital Severe / ZZRTime Severe

Units: People/Day

(111) Total Exiting IP02 = Infected Presymptomatic 02 / ( Asymptomatic Infectious Period

/ 2)

Units: People/Day

Total exit rate from Infected Presymptomatic 02

(112) Total Exposed = Exposed 01 + Exposed 02

Units: People

(113) Total Hospitalised = In Hospital 01 + In Hospital 02 + In Hospital 03

Units: People

(114) Total in Hospital = Total in Hospital Non Severe + Total Severe in NonICU Hospital

+ Total Severe in ICU + In Hospital Severe

Units: People

(115) Total in Hospital Non Severe = In Hospital 01 + In Hospital 02 + In Hospital 03

Units: People

(116) Total Infectious = C01 Total Infected Presymptomatic + C02 Total Asymptomatic Infected

+ C03 Total Symptomatic Immediate Isolation Infectious + C04 Total Awaiting Results Infectious

+ C05 Total Isolated After Test Infected + C06 Total Not Quarantining Infected

Units: People

(117) Total Removed = Removed Asymptomatic + Removed Awaiting Results + Removed Hospital

+ Removed Not Quarantine + Removed Severe Cases Hospital + Removed Severe Cases ICU

+ Removed Symptomatic Immediate Isolation

Units: People

(118) Total Severe in Hospital = Total Severe in ICU + Total Severe in NonICU Hospital

Units: People

(119) Total Severe in ICU = Severe Cases ICU 01 + Severe Cases ICU 02

Units: People

(120) Total Severe in NonICU Hospital = Severe Cases Hospital 01 + Severe Cases Hospital 02

Units: People

(121) ZZAT = 1

Units: Day

(122) ZZAverage HLOS = 15

Units: Day

(123) ZZAverage Wait for Results = 3.16

Units: Day

(124) ZZBeta Calibrated = 0.91

Units: 1/Day

Beta value calibrated to Irish data

(125) ZZBeta Multiplier h = 0.11

Units: Dmnl

Multiplicative factor for reduction in infectiousness of

asymptomatic infected compartment

(126) ZZBeta Multiplier i = 0.07

Units: Dmnl

Multiplier on isolation compartment

(127) ZZBeta Multiplier j = 0.0612326

Units: Dmnl

(128) ZZBeta Multiplier k = 1

Units: Dmnl

(129) ZZDistancing Flag = ( 0 + Step ( 1, ZZDistancing Start Time ) - Step (

1, ZZSwitch Time ) ) \* ZZDistancing Switch

Units: Dmnl

Whether or not physical distancing is being implemented

(130) ZZDistancing Start Time = 20

Units: Day

Start time for physical distancing

(131) ZZDistancing Switch = 1

Units: Dmnl

A switch that activates physical distancing

(132) ZZFraction In Hospital Severe = 0

Units: Dmnl

(133) ZZFraction in Risk Group = 0

Units: Dmnl

(134) ZZICU Available Capacity = 250

Units: People

(135) ZZICU Residency Time = 10

Units: Day

(136) ZZIncubation Period C = 5.79

Units: Day

Duration of time at incubation stage

(137) ZZLag Time = 1

Units: 1/Day

(138) ZZLatent Period L = 3.58

Units: Day

Duration of time in incubation stage

(139) ZZNumber Seeds = 1

Units: People

Number of seeds initially importing the virus

(140) ZZPDAT = 4

Units: Day

(141) ZZPercentage Reduction of Physical Distancing = 0.6

Units: Dmnl

(142) ZZProportion Asymptomatic f = 0.25

Units: Dmnl

Proportion of infected who show symptoms

(143) ZZProportion Hospitalised = 0

Units: Dmnl

(144) ZZProportion Quarantined q = 0.21

Units: Dmnl

Proportion quarantined

(145) ZZProportion Tested t = 0.55

Units: Dmnl

(146) ZZPulse Duration = 21

Units: Day

The duration of the pulsed social distancing

(147) ZZPulse End = 300

Units: Day

(148) ZZPulse Off Duration = 10

Units: \*\*undefined\*\*

The duration when the policy is off (i.e. social distancing is

relaxed)

(149) ZZPulse Start Time = ZZSwitch Time + ZZPulse Off Duration

Units: Day

The start time for the pulse strategy

(150) ZZPulse Strategy Flag = ( 0 + Step ( 1, ZZSwitch Time + ZZPulse Off Duration

) ) \* ZZPulse Switch

Units: Dmnl

Whether or not the pulse startegy is enabled. It will start

after the physical distancing has ended (following an initial

lag)

(151) ZZPulse Switch = 0

Units: Dmnl

A switch to activate the pulse policy

(152) ZZR0 Fixed Flag = 0

Units: \*\*undefined\*\*

(153) ZZR0 Input = 2.8

Units: \*\*undefined\*\*

(154) ZZRTime Severe = 1

Units: Day

(155) ZZSwitch Time = 200

Units: Day

The time that continuous physical distancing ends

(156) ZZTotal Infectious Period D = 5.46

Units: Day

Duration of infectiousness

(157) ZZTotal Population = 4.99997e+06

Units: People

Total Population at outset of epidemic