Establishing the feasibility of alleviating water shortages in Cape Town using decentralised wastewater treatment plants

CALCULATIONS

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OM Storage Tanks = \( \text{INTEG}(\text{Borehole Water Entering} + \text{Treated WW Entering} - \text{OM Potable Water Consumed} - \text{Over Capacity}) + 0 \) (Unit: m\(^3\))

Borehole Water Entering = \( \text{MIN}(\text{OM Borehole Water}, \text{OM Borehole Water Capacity}) \) (Unit: m\(^3\)/Year)

OM Potable Water Consumed = OM Storage Tanks (Unit: m\(^3\)/Year)

Over Capacity = IF THEN ELSE(OM Storage Tanks > OM Storage Tank Capacity, ((OM Storage Tanks - OM Storage Tank Capacity) / Year), 0) (Unit: m\(^3\)/Year)

Treated WW Entering = \( \text{MIN}((\text{OM CoCT Treated Effluent} + \text{OM Wastewater Produced} - \text{OM Process Losses}), (\text{OM Treatment Plant Capacity} / \text{Year}) \) (Unit: m\(^3\)/Year)

OM Treatment Plant Capacity = 1 + \( \text{INTEG}(\text{Increase OM WWTW Capacity}) \) (Unit: m\(^3\))

Increase OM WWTW Capacity = OM WWTW Capacity Added (Unit: m\(^3\)/Year)

OM WWTW Capacity Added = Lookup OM WWTW Capacity (Unit: m\(^3\)/Year)

Lookup OM WWTW Capacity Added = WITH LOOKUP(Time) (Unit: m\(^3\)/Year)

Look up OM WWTW = \([(2001,0)-(2040,300000)], (2001,0), (2002,0), (2003,0), (2004,0), (2005,0), (2006,0), (2007,0), (2008,0), (2009,0), (2010,0), (2011,0), (2012,0), (2013,0), (2014,0), (2015,0), (2016,0), (2017,0), (2018,237250), (2019,0), (2020,0), (2021,0), (2022,0), (2023,0), (2024,0), (2025,0), (2026,0), (2027,0), (2028,0), (2029,0), (2030,0), (2031,0), (2032,0), (2033,0), (2034,0), (2035,0), (2036,0), (2037,0), (2038,0), (2039,0), (2040,0) \)
WWT Throughput = Treated WW Entering/("1/Year"*OM Treatment Plant Capacity) (Unit: Dimensionless)

OM Process Losses = Fraction Process Losses*OM Storage Tanks (Unit: m3/Year)

Fraction Process Losses = 0.05 (Unit: Dimensionless)

OM Borehole Water = Fraction OM Borehole Water*OM Annual Consumption (Unit: m3/Year)

Fraction OM Borehole Water = 0 (Unit: Dimensionless)

OM Annual Consumption = OM Demand*(1-OM Water Saving Intervention) (Unit: m3/Year)

OM Borehole Water Capacity = 91250 (Unit: m3/Year)

Over Capacity = IF THEN ELSE(OM Storage Tanks>OM Storage Tank Capacity, ((OM Storage Tanks-OM Storage Tank Capacity)*"1/Year"), 0) (Unit: m3/Year)

OM Storage Tank Capacity = 167900 (Unit: m3)

Water Entering OM System = OM CoCT Potable+OM Potable Water Consumed (Unit: m3/Year)

OM Water Requirement = OM Annual Consumption-OM Potable Water Consumed (Unit: m3/Year)

Fraction from Municipal = OM CoCT Potable/OM Annual Consumption (Unit: Dimensionless)

OM Annual Consumption = OM Demand*(1-OM Water Saving Intervention) (Unit: m3/Year)

OM Water Saving Intervention = 0*OM Water Saving Intervention LOOKUP + Intervention (Unit: Dimensionless)

OM Water Saving Intervention LOOKUP = WITH LOOKUP(Time) (Unit: Dimensionless)

Look up OM Water Saving Intervention = ([(2001,0)-(2040,0.5)],(2001,0), (2002,0), (2003,0),(2004,0), (2005,0),(2006,0),(2007,0), (2008,0),(2009,0),(2010,0), (2011,0),(2012,0) ,(2013,0), (2014,0), (2015,0),(2016,0.3),(2017,0.3),(2018,0.3), (2019,0.35),(2020,0.3), (2021,0.3),(2022,0.3),(2023,0.3), (2024,0.3),(2025,0.3),(2026,0.4), (2027,0.3),(2028,0.3), (2029,0.3), (2030,0.3),(2031,0.3),(2032,0.3), (2033,0.3),(2034,0.3),(2035,0.3),(2036,0.3), (2037,0.3),(2038,0.3),(2039,0.35),(2040,0.3) ) (Unit: Dimensionless)

Intervention = 0.3 (Unit: Dimensionless)
OM Demand = 180000 (Unit: m3/Year)

OM Losses = Fraction Consumption Losses*OM Annual Consumption (Unit: m3/Year)
Fraction Consumption Losses = 0.07 (Unit: Dimensionless)

OM Irrigation = Fraction OM Irrigation*OM Annual Consumption (Unit: m3/Year)
Fraction OM Irrigation = 0.3 (Unit: Dimensionless)

OM Evaporation = OM Annual Consumption*Fraction Evaporation (Unit: m3/Year)
Fraction Evaporation = 0.1 (Unit: Dimensionless)

OM Consumption = Fraction Consumption*OM Annual Consumption (Unit: m3/Year)

OM Wastewater Produced = OM Consumption*Fraction of OM WW+WW from CoCT (Unit: m3/Year)
WW from CoCT = 0 (Unit: m3/Year)
Fraction of OM WW = 0.97 (Unit: Dimensionless)

OM CoCT Treated Effluent = Fraction of Treated Effluent*OM Annual Consumption (Unit: m3/Year)
Fraction of Treated Effluent = 0.25 (Unit: Dimensionless)