**Nomenclatures**

- $C_1$: Cognitive parameter, the weight of a particle's own experience in PSO
- $C_2$: Social parameter, the weight of the combined experience of the swarm in PSO
- $C$: Pipe roughness (Hazen-Williams)
- $C_{ij}$: Substance concentration (mg/l) at position $x$ and time $t$ in the link between nodes $i$ and $j$
- $C_{ij}@x=0$: Concentration at the start of the link connecting node $i$ to node $j$ in mg/L (where $x=0$)
- $C_{kj}@x=L$: Concentration at the end of a link in mg/L
- $C_j$: Chlorine concentration at junction node, mg/L.
- $C_{ks}$: Concentration of contaminant in link $k$ to $s$, mg/m$^3$
- $C_s$: Concentration for the tanks, mg/L
- $C_t$: Concentration of chlorine the water, throughout the transportation time, $t$
- $C_o$: Chlorine concentration at the beginning of transportation
- $d$: Diameter of pipe, m
- $dS$: Change in storage, m$^3$/s
- $dT$: Change in time, seconds
- $F$: Friction factor
- $g$: Acceleration due to gravity, m/s$^2$
- $h_p$: Pumping head gain, m
- $h_L$: Head loss in pipes, m
- $h_m$: Head loss due to minor losses, m
- $I$: Injection Nodes
- $J$: Critical Nodes
- $k_b$: Bulk decay coefficient, d$^{-1}$
- $k_{ij}$: Rate at which the substance reacts within the link (s$^{-1}$)
- $K_{i,j}$: Impulse response coefficients corresponding to injection nodes
- $k_w$: Wall reaction constant with units of length over time, m/d
- $L$: Length of pipe, m
- $M$: Total numbers of critical nodes
M_i Mass rate injected at injection node (i) at Source or Booster Stations, mg/min
N Total number of Injection nodes
Pid Parameter value of i\textsuperscript{th} particle corresponding to the best solution ever
personally visited by the given particle in PSO
pgd Parameter value corresponding to the best solution ever visited by any
particle (the current global best) in PSO.
P_1 and P_2 Pressure at points 1 and 2 respectively, N/m\textsuperscript{2}
Q_i Inflow to node in i\textsuperscript{th} pipe, m\textsuperscript{3}/s
Q_{ki} Flow from k to i, m\textsuperscript{3}/sec
Q_{ks} Flow from node k to s, m\textsuperscript{3}/s
Q_{sj} Flow from node s to j, m\textsuperscript{3}/s
r_1, r_2 Independent and uniformly distributed random numbers in PSO
Re Reynolds number
U_i Water used or leaving at the i\textsuperscript{th} node, m\textsuperscript{3}/s
V Velocity of water in pipe, m/sec
V_id Velocity of parameter d of ith particle in PSO
v_{ij} Flow velocity in the link, m/s
v_1\textsuperscript{2} and v_2\textsuperscript{2} Velocity at points 1 and 2 respectively, m/s
V Volume of tank at nodes, m\textsuperscript{3}
W Inertia weight in PSO
xid Value of parameter d of i\textsuperscript{th} particle in PSO
Z_1 and Z_2 Elevation at points 1 and 2 respectively, m
\Gamma Fluid (water) specific weight, N/m\textsuperscript{3}
\varepsilon Pipe roughness (Darcy-Weisbach)
\eta Kinematic viscosity of water (resistance to flow).
\chi Constriction factor