7A BARBADOS AVENUE
KINGSTON 5
JAMAICA
TEL: 876.754.2154 -5
876.754.2158
FAX: 876.754.2156
MAIL@FCSCONSULTANTS.COM
WWW.FCSCONSULTANTS.COM
FCS CONSULTANTS LTD

PROPOSED RESIDENTIAL DEVELOPMENT,

CORAL SPRINGS TRELAWNY

FCS #: 1124/76/C

ENGINEERING REPORT
WATER SUPPLY

PREPARED FOR
Gore Developments Limited
2c Braemar Ave,
Kingston 10

FEBRUARY 2012

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Overview

Gore Developments Limited proposes to develop part of Coral Springs lands for housing. This particular parcel of land is north of the North Coast highway between White Bay and Duncans in Trelawny as shown in the figure below.

Figure 1 : Location of project site

The 169 acre parcel of land will be developed into 400 two bedroom homes and 142 larger service lots with the required open spaces, commercial area, and basic school. FCS Consultants Limited is responsible for the infrastructure designs within the project boundaries; this includes roadways, water distribution, sewage and storm water collection as well as constructed wetlands for tertiary sewage treatment.

The basis for design is guided by the local requirements for permitting and international standards with regards to similar developments. The subdivision layout as shown below will be used to develop designs and drawings for construction.

Figure 2: Coral Springs Subdivision Layout

Water Distribution

Water Quantity and Quality

The water quantity and quality is the responsibility of the National Water Commission (NWC). FCS Consultants has requested that water be provided for the project by the National Water Commission. They have indicated their willingness to provide water for the development.

Estimate of the Developments potable water use

The present average number of persons per household based on the 2001 census is 3.6, however 4.5 is used in our design to give a current and conservative population and estimate the water demand.

The peak factors are taken from the Jamaica Institution of Engineers recommended guidelines for design and construction of housing infrastructure volume 3 water supply systems.

Gore Coral springs Water Demand Estimate			
Item	**Description**	**Qty**	**Unit**
1	**Number of residential lots**	524	No
2	Estimate of the number of persons per lot	4.50	No
3	Population Estimate	2,358	No
4	Average per capita consumption per househole resident	227	Liters
5	Estimate of domestic water use	535,266	Liters
6			
7	**Commercial and Light Industry**		
8	Commercial and shopping area	9,225.00	m^2
9	Usage per unit area commercial space	14.68	L/m^2
10	% Area used for commercial floor space	20%	
11	Estimate of floor space	1,845.00	m^2
12	Water for commercial and light Industry	27,085	L
13			
14	**Basic School**		
15	Student Population	100	No
16	Staff Population	10	No
17	Total Basic School population	110	No
18			
19	Per Capita demand for each head of school population	57	Liters/day
20	Estimate of Basic School demand	6,270	Liters/day
21			
22			
23	**Other water use** (5% domestic use)	26,763.30	Liters
24			
25	**Average day demand**	**595,384.12**	**Liters**
26		**595**	**m^3/d**
27	Peak day in peak month factor	1.40	
28	Peak hour factor	1.50	
29	Peak factor	2.10	
30	Leak factor	20%	
31	Average day including leaks	**714**	**m^3/d**
32			
33	**Peak day water demand**	**11.60**	lps
34			
35			

Figure 3~~34~~: Estimate of water demand

Water Distribution Design

Approach to the Distribution Network Analysis

To size the water distribution pipelines EPANET 2, a water distribution network analysis programme developed by the Water Supply and Water Resources Division (formerly the Drinking Water Research Division) of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory, was used. The method used in EPANET to solve the flow continuity and head loss equations that characterize the hydraulic state of the pipe network at a given point in time can be termed a hybrid node-loop approach. The method of Hydraulic analysis is explained in Appendix D of the EPANET Users Manual.

The Hazen-Williams method of determining head loss by water flowing in a pipe due to friction with the pipe walls was used and the corresponding coefficients used in the analysis.

The user's manual for EPANET that describes the methods of analysis is available free online at http://www.epa.gov/nrmrl/wswrd/dw/epanet.html and can be referenced there.

The layout of the water distribution network was developed by identifying the areas throughout the development that are likely to demonstrate the upper and lower limits of demand, pressure and flow. Pipe junctions also called nodes are located at the various points of interest throughout the development and a network of pipes used to connect them. As the NWC pressure main is the source of water for the development a reservoir was used to model the source works. The demand node represents a group of users. **Figure 3** shows the overall network layout.

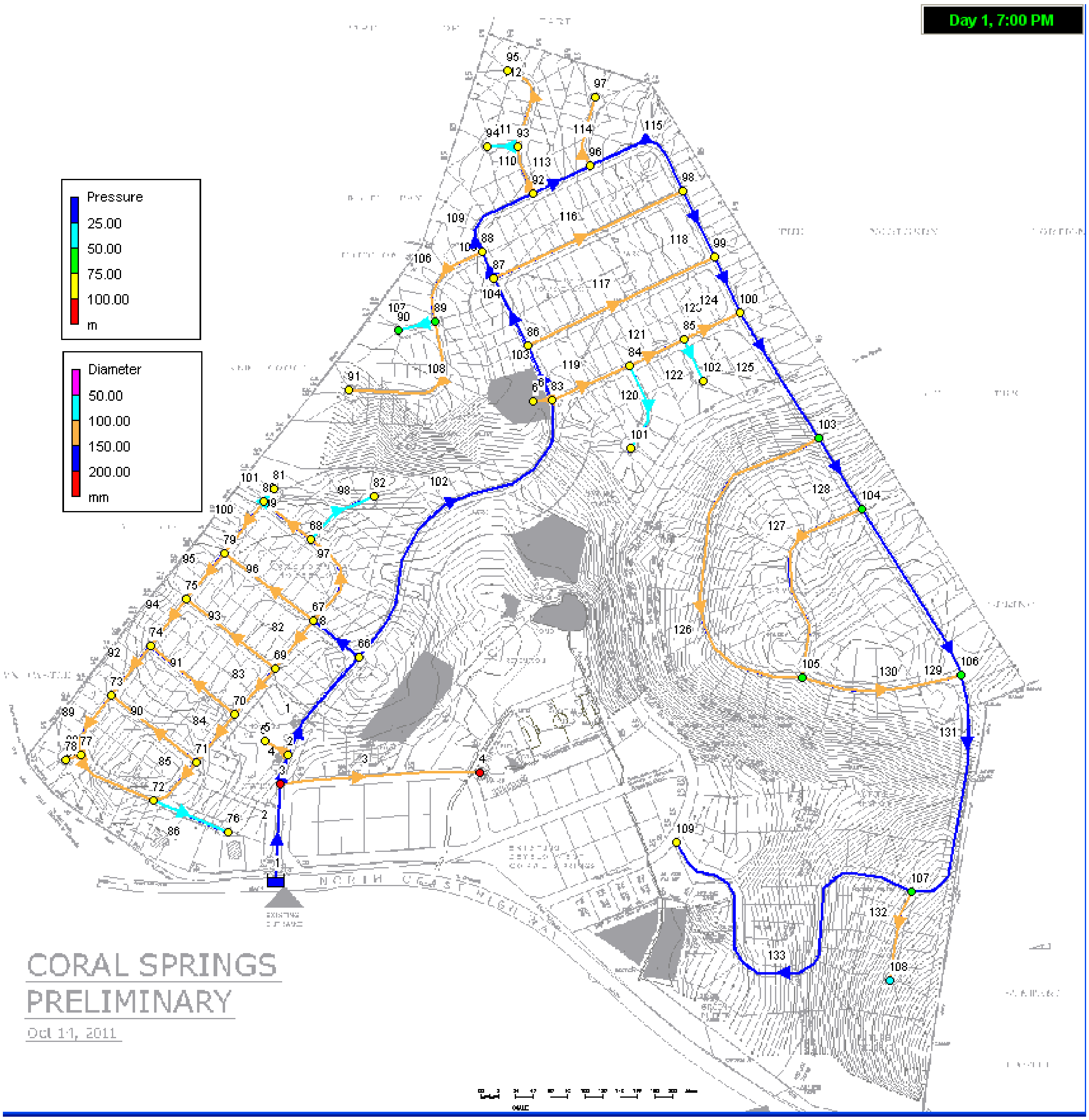

Figure 3 Water distribution model for the proposed Coral Springs Development

The nodes were assigned a base demand equal to the average water demand for a group of users that are located in a sub area of the development. The boundaries of the subareas are generally midway between nodes.

The EPANET programme allows for the variation of demand at nodes by use of time patterns that apply a multiplier to the base demand to simulate the demand at hour long time steps throughout the day. The time steps and multipliers are shown in Tables 3 and 4.

The programme is operated to analyse the network and the resulting maximum and minimum parameters are compared to the design criteria to ensure that the network meets the limits. The size and configuration of the various components of the network are varied until an economic and acceptable network is achieved.

Water distribution network criteria

The service delivery standards for water distribution systems in Jamaica are set by the Office of Utilities Regulation. The recommended minimum pressure at the service connection during peak demand is 20psi (14m of water or 138kPa). The Jamaica Institution of Engineers (JIE) Guidelines for Design and Construction of Housing Infrastructure recommend that the residual pressure at the hydrant during fire events be 5psi (3.52m of water or 34.47kPa). The water scheme was designed by taking into account the guidelines of the latest National Water Commission Developer's Manual requirements, the AWWA M-31 Distribution system requirements for fire protection and JIE guidelines. The pressure requirements during fire events and the maximum pressure of 689kPa (100psi) as stated in the JIE guideline were used in the evaluation of the system acceptability.

The NWC Developers manual recommends that "Pipelines should be sized to carry flows capable of servicing the maximum demand flow plus fire flows based on individual or group hydrant requirements."

It further states that "In urban sub-divisions street mains should be at least 100 mm (4") diameter except for short dead ends where 51 mm (2") diameter pipe running not longer than 45 m (150') are allowed at the discretion of the NWC. Velocities in pipes should not exceed 1.2 m/s (4 f.p.s) under normal circumstances and at no time should exceed 3.0 m/s (10 f.p.s)."

The rule of thumb of not using 50mm diameter pipes beyond 45m may have been exceeded in the development as the model would demonstrate that the flow and pressure criteria can be achieved in the configurations used and modeled in the network.

Water distribution Network

The subdivision was designed with varying sizes of PVC pipe ranging from 150mm to 50mm diameter with the latter size serving a maximum of 16 lots. The network was modelled to ensure that the minimum pressure was 14m of water (20psi) during peak demand (without fire flows). The network was also checked to ensure that a minimum pressure of 5psi (34kPa or 3.5m of water) is maintained at hydrants when fire flows are drawn off the system while peak day demand flows are drawn off the system. The hydrant spacing and pressure flow is based on the Jamaica Institution of Engineers (JIE) Guidelines for Design and Construction of Housing Infrastructure document.

Figure 3 shows the layout of the water distribution model superimposed on the proposed Coral Springs Development layout. The model includes a reservoir, pipes and nodes (which are pipe junctions). The model is prepared as an open network. The network without background showing more clearly the pipes and components is shown in **Figure 4.**

The water demand for each node was determined by estimating water demand for the houses or other intended land use, for example, commercial use within that area.

In order to achieve the required pressures during peak demand times the source was modeled with varying pressures. When the source was modeled as a reservoir with total head 120m the system performed optimally when fire flows were included. The total head is equivalent to ground elevation 19m plus pressure head 101m.The existing ground elevation was taken from the topographical survey produced by the client for the proposed site.

The upper most ground elevation among the housing lots is to the south western side of the property and the elevation is 72m (node 108).

In the subdivision node 108 is located at the highest elevation. That location is likely to experience the lowest pressure in the system during peak flows or if ever there is need for fire flows in that location. If the quantity demand during fire flow and the minimum allowable pressure is met, then the network will satisfy the acceptable criteria for service during a fire in that area. It is likely that all other points in that subdivision will be similarly acceptable.

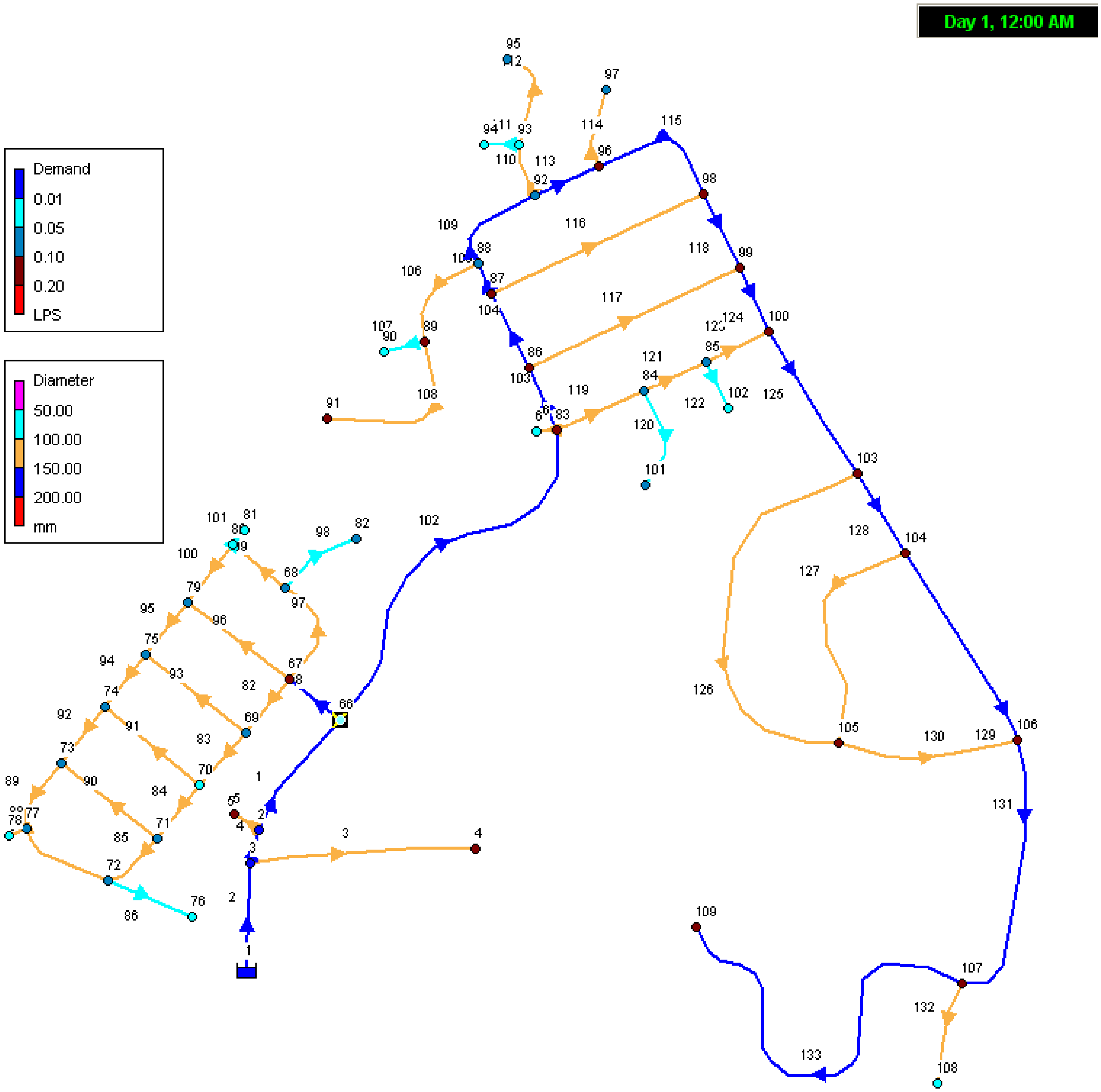

Figure 4 Pipe sizes used to analyse the proposed distribution system for The Coral Springs Development

The pipe layout showing the sizes used in the network analyses is shown in **Figure 4**.

Extended period simulations of 72 hours were run on the model. The 24 hour diurnal variation is repeated in 24 hour periods throughout the simulations.

Table 3

Diurnal variation in average day water demand	
Time Period	Multiplier
Midnight to 1:00 A.M.	0.60
1:00 - 2:00	0.50
2:00 - 3:00	0.50
3:00 - 4:00	0.50
4:00 - 5:00	0.60
5:00 - 6:00	0.80
6:00 - 7:00	1.00
7:00 - 8:00	1.10
8:00 - 9:00	1.25
9:00 - 10:00	1.28
10:00 - 11:00	1.20
11:00 - 12:00	1.18
12:00 - 1:00	1.16
1:00 - 2:00	1.10
2:00 - 3:00	1.00
3:00 - 4:00	1.08
4:00 - 5:00	1.15
5:00 - 6:00	1.30
6:00 - 7:00	1.50
7:00 - 8:00	1.40
8:00 - 9:00	1.25
9:00 - 10:00	0.90
10:00 - 11:00	0.85
11:00 - Midnight	0.70

Table 4

Diurnal variation in peak day water demand based on average day demand	
Time Period	Multiplier
Midnight to 1:00 A.M.	0.84
1:00 - 2:00	0.70
2:00 - 3:00	0.70
3:00 - 4:00	0.70
4:00 - 5:00	0.84
5:00 - 6:00	1.12
6:00 - 7:00	1.40
7:00 - 8:00	2.10
8:00 - 9:00	1.75
9:00 - 10:00	1.79
10:00 - 11:00	1.68
11:00 - 12:00	1.65
12:00 - 1:00	1.62
1:00 - 2:00	1.54
2:00 - 3:00	1.40
3:00 - 4:00	1.51
4:00 - 5:00	1.61
5:00 - 6:00	1.82
6:00 - 7:00	2.10
7:00 - 8:00	1.96
8:00 - 9:00	1.75
9:00 - 10:00	1.26
10:00 - 11:00	1.19
11:00 - Midnight	0.98

The diurnal variation of demand at nodes throughout the average day is shown in **Table 3**. However the distribution system must support the peak day demands. The average demand during the peak day is estimated to be 1.4 times the average day demand as recommended by the JIE guidelines. The diurnal variation for that condition is shown in **Table 4**. The peak hour of the peak day is 2.1 times the average day demand and that is set for 7:00 to 8:00 A.M.

Analysis of Network for average day flows

Two simulations are presented in this report. The first is a simulation of average day flows repeated over three days. It is unlikely that three consecutive days of peak flow will occur but this check shows the robustness of the system designed. The second is a simulation of fire flows set at various nodes during the average day demands.

The diurnal variation in **Table 4** shows the multiplier applied to average flow demand for each node at each time step used in the first simulation. The results from nodes at the highest (Node 108, Elv. 72m) and lowest elevations (Node 4, Elv. 14m) in the subdivision and a node at an intermediate elevation (Node 83, Elv. 36m) are shown in this report to demonstrate the variation in pressure throughout the network.

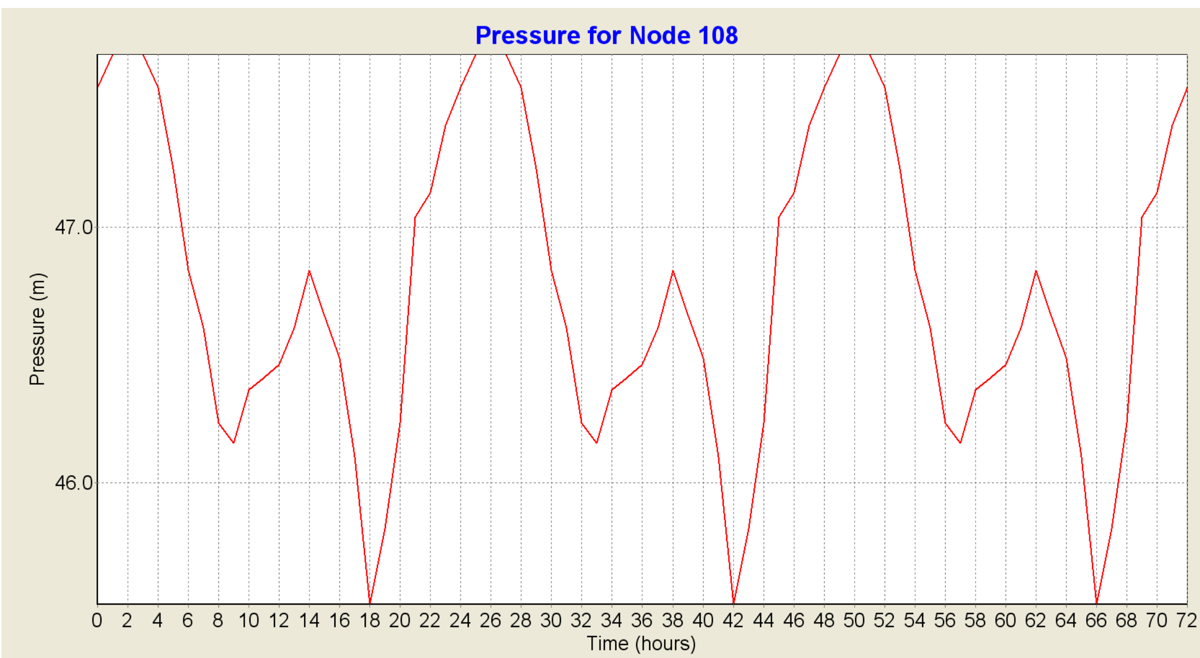

Figure 5 Pressure variations at node 108 the node at the highest elevation among the housing lots.

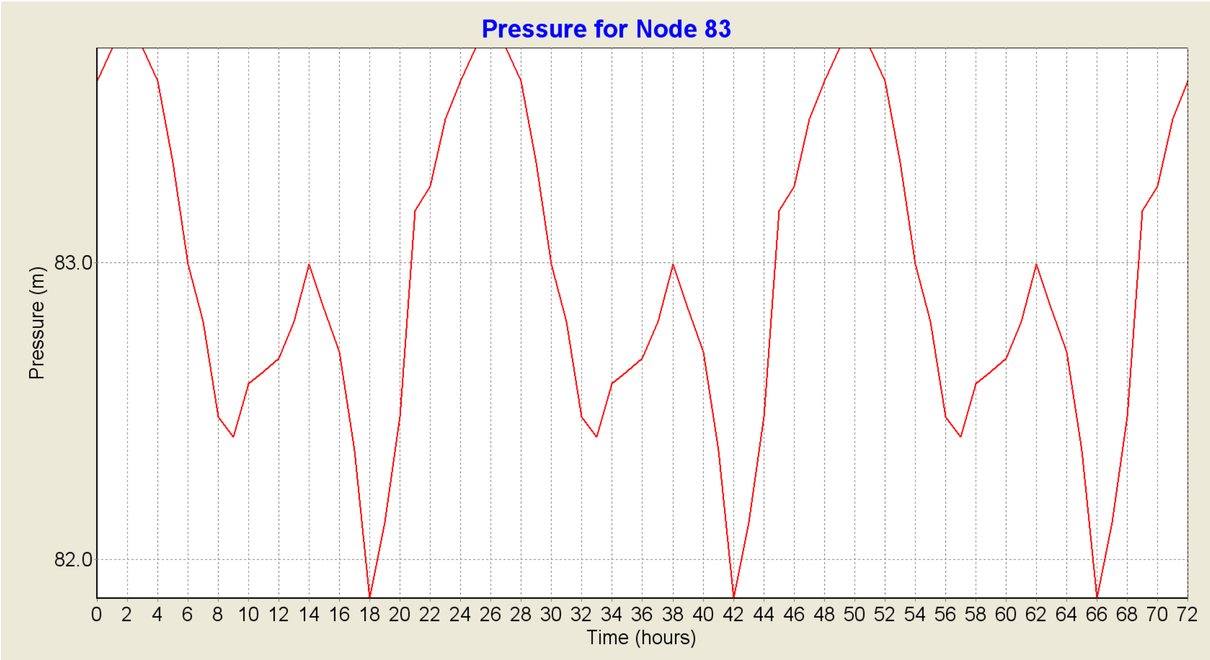

Figure 6 Pressure variations for node 83 a node at an intermediate elevation among the housing lots.

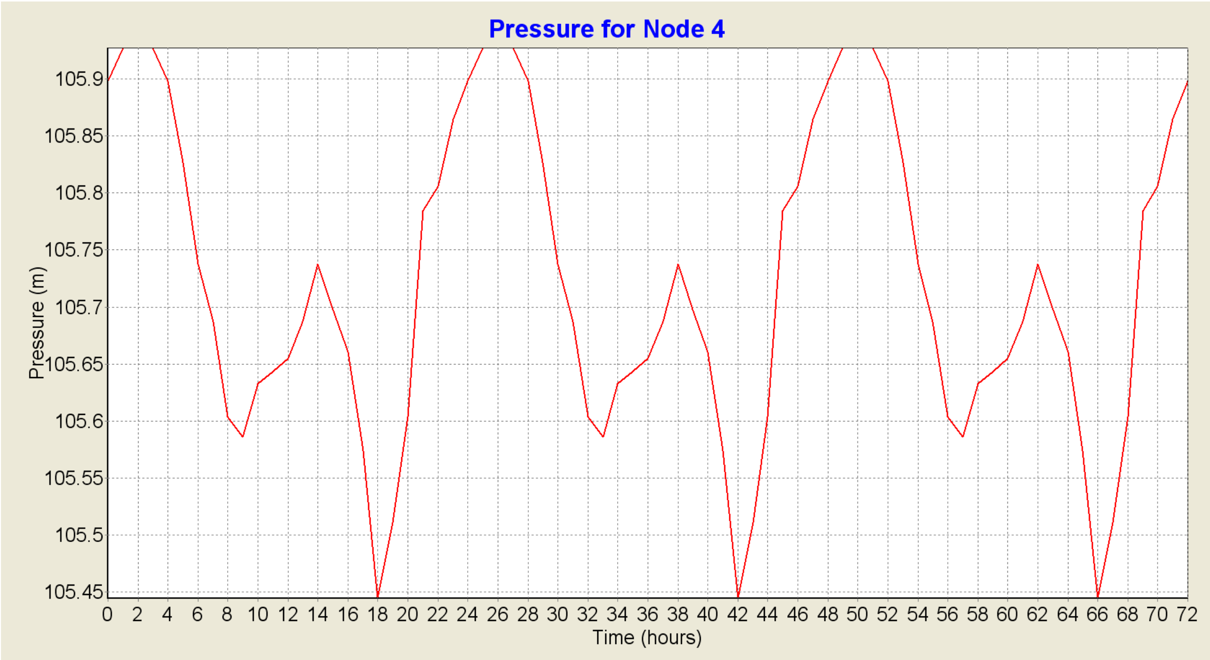

Figure 7 Pressure variations for node 4 the node at the lowest elevation in the housing subdivision.

Table 5 Node results at peak hour on average day demand.

CORAL SPRINGS DEVELOPMENT										
Network Table - Nodes at 19:00 Hrs (Peak hour of average day demand)										
Node ID	Elevation m	Base Demand LPS	Demand LPS	Pressure m		Node ID	Elevation m	Base Demand LPS	Demand LPS	Pressure m
Junc 66	28	0.3	0.42	90.87		Junc 100	33	0.18	0.25	84.9
Junc 67	24	0.18	0.25	94.85		Junc 101	39	0.13	0.18	79.03
Junc 68	24	0.11	0.15	94.83		Junc 102	36	0.06	0.08	81.94
Junc 69	25	0.11	0.15	93.82		Junc 103	47	0.3	0.42	70.86
Junc 70	22	0.07	0.1	96.81		Junc 104	59	0.26	0.36	58.84
Junc 71	28	0.09	0.13	90.8		Junc 105	66	0.28	0.39	51.84
Junc 72	28	0.11	0.15	90.8		Junc 106	65	0.18	0.25	52.83
Junc 73	27	0.15	0.21	91.8		Junc 107	64	0.31	0.43	53.82
Junc 74	23	0.14	0.2	95.81		Junc 108	72	0.08	0.11	45.82
Junc 75	23	0.15	0.21	95.82		Junc 109	21	0.17	0.24	96.82
Junc 76	21	0.08	0.11	97.77		Junc 2	21	0	0	98.37
Junc 77	26	0.13	0.18	92.8		Junc 3	19	0	0	100.53
Junc 78	26	0.04	0.06	92.8		Junc 4	14	0.31	0.43	105.51
Junc 79	25	0.13	0.18	93.83		Junc 5	22	0.32	0.45	97.36
Junc 80	24	0.08	0.11	94.83		Junc 6	37	0.073	0.1	81.12
Junc 81	22	0.04	0.06	96.82		Resvr 1	120	#N/A	-9.99	0
Junc 82	22	0.09	0.13	96.8						
Junc 83	36	0.18	0.25	82.12						
Junc 84	37	0.13	0.18	81.09						
Junc 85	36	0.11	0.15	81.95						
Junc 86	38	0.22	0.31	80.04						
Junc 87	39	0.18	0.25	78.98						
Junc 88	40	0.13	0.18	77.97						
Junc 89	43	0.19	0.27	74.95						
Junc 90	44	0.06	0.08	73.94						
Junc 91	40	0.19	0.27	77.94						
Junc 92	39.5	0.11	0.15	78.45						
Junc 93	41	0.08	0.11	76.94						
Junc 94	41.5	0.06	0.08	76.44						
Junc 95	40.5	0.14	0.2	77.44						
Junc 96	37	0.18	0.25	80.94						
Junc 97	38	0.09	0.13	79.94						
Junc 98	33	0.24	0.34	84.93						
Junc 99	33.6	0.19	0.27	84.32						

Table 6 Pipe results at peak hour on average day demand.

CORAL SPRINGS DEVELOPMENT																
Network Table - Links at 19:00 Hrs (Peak hour of average day demand)																
Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Friction Factor	Status		Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Friction Factor	Status
Pipe 1	138.3	150	100	-9.1	0.52	0.04	Open		Pipe 110	56	100	100	0.39	0.05	0.061	Open
Pipe 8	65	150	100	2.38	0.13	0.049	Open		Pipe 111	40	50	100	0.08	0.04	0.07	Open
Pipe 82	71	100	100	0.96	0.12	0.053	Open		Pipe 112	109	100	100	0.2	0.02	0.067	Open
Pipe 83	71	100	100	0.6	0.08	0.057	Open		Pipe 113	74	150	100	1.38	0.08	0.053	Open
Pipe 84	70	100	100	0.43	0.05	0.06	Open		Pipe 114	86	100	100	0.13	0.02	0.072	Open
Pipe 85	80	100	100	0.26	0.03	0.064	Open		Pipe 115	145	150	100	1	0.06	0.056	Open
Pipe 86	105	50	100	0.11	0.06	0.067	Open		Pipe 116	241	100	100	0.69	0.09	0.056	Open
Pipe 87	95	100	100	-0.01	0	0.189	Open		Pipe 117	241	100	100	1.07	0.14	0.052	Open
Pipe 88	19	100	100	0.06	0.01	0.076	Open		Pipe 118	86	150	100	1.36	0.08	0.053	Open
Pipe 89	82	100	100	-0.25	0.03	0.065	Open		Pipe 119	101	100	100	0.9	0.12	0.054	Open
Pipe 90	126	100	100	0.04	0.01	0.081	Open		Pipe 120	114	50	100	0.18	0.09	0.062	Open
Pipe 91	127	100	100	0.08	0.01	0.078	Open		Pipe 121	1000	100	100	0.54	0.07	0.058	Open
Pipe 92	72	100	100	-0.41	0.05	0.06	Open		Pipe 122	53	50	100	0.08	0.04	0.07	Open
Pipe 93	131	100	100	0.2	0.03	0.067	Open		Pipe 123	1000	100	100	0.3	0.04	0.063	Open
Pipe 94	71	100	100	-0.53	0.07	0.058	Open		Pipe 124	69	150	100	2.16	0.12	0.05	Open
Pipe 95	70	100	100	-0.54	0.07	0.058	Open		Pipe 125	173	150	100	2.21	0.13	0.049	Open
Pipe 96	132	100	100	0.6	0.08	0.057	Open		Pipe 126	428	100	100	0.3	0.04	0.063	Open
Pipe 97	118	100	100	0.57	0.07	0.057	Open		Pipe 127	251	100	100	0.25	0.03	0.065	Open
Pipe 98	91	50	100	0.13	0.06	0.066	Open		Pipe 128	95	150	100	1.49	0.08	0.052	Open
Pipe 99	74	100	100	0.29	0.04	0.063	Open		Pipe 129	225	150	100	0.88	0.05	0.057	Open
Pipe 100	71	100	100	-0.12	0.02	0.072	Open		Pipe 130	187	100	100	0.16	0.02	0.069	Open
Pipe 101	22	50	100	0.06	0.03	0.074	Open		Pipe 131	284	150	100	0.78	0.04	0.058	Open
Pipe 102	406	150	100	6.3	0.36	0.042	Open		Pipe 132	107	100	100	0.11	0.01	0.073	Open
Pipe 103	71	150	100	5.05	0.29	0.044	Open		Pipe 133	466	150	100	0.24	0.01	0.069	Open
Pipe 104	86	150	100	3.67	0.21	0.046	Open		Pipe 2	109	150	100	9.99	0.57	0.04	Open
Pipe 105	35	150	100	2.72	0.15	0.048	Open		Pipe 3	235	100	100	0.43	0.06	0.06	Open
Pipe 106	111	100	100	0.62	0.08	0.057	Open		Pipe 4	42	150	100	-9.55	0.54	0.04	Open
Pipe 107	43	50	100	0.08	0.04	0.07	Open		Pipe 5	44	100	100	0.45	0.06	0.059	Open
Pipe 108	184	100	100	0.27	0.03	0.064	Open		Pipe 6	29	100	100	0.1	0.01	0.074	Open
Pipe 109	110	150	100	1.93	0.11	0.05	Open									

The results shown in Figures 5 and 6 show that the minimum pressure anticipated in the subdivision is 45.82m of water (66psi). The maximum velocity in any pipe at peak hour of the average day is estimated to be 0.57m/s as shown in Table 6 which is less than the maximum 1.2m/s specified by NWC. Tables 5 and 6 show the demands and resulting pressures as well as the velocity of flow in the pipelines in the network during the peak hour of the average day demand.

Analysis of Network for fire flows

The AWWA M31 manual outlines a number of methods to assess the Needed Fire Flow (NFF) and duration. The method used in this report is the Insurance Services Office method to determine the fire flow needed for a fire in an extended house in the proposed development.

The fire flow used for this project is two streams from a hydrant anywhere in the subdivision.

Needed Fire Flow (NFF) for a dwelling in proposed development

The Insurance Services Office Method defines the NFF as the rate of flow considered necessary to control a major fire in a specific building. The calculation of a NFF, in US gallons per minute considers the construction (C_i), occupancy (O_i), exposure (X_i) and communication (P_i) factors of that building.

$NFF = (C_i)\ (O_i)\ (X + P)_i$

$C_i = 18\ F\ (A_i)^{0.5}$

Where F = 1.0 for construction class 2 (jointed masonry)

A_i = effective area, where the effective area is the total square footage of the largest floor plus 50% of all other floors for class 2 construction

The effective area will be taken as 60% of a standard lot for a ground and a suspended floor. This is because the houses being sold can be expanded to this maximum.

A_i = 3,600 sq ft x 0.6 x 1.5 = 3,240 sq ft.

C_i = 18 x 1.0 x $(3{,}240)^{0.5}$ = 1,024 US gpm

O_i = 0.82 *(From table 1-2 AWWA M31 limited combustible C-2)*

X_i = 0.21 *(From table 1-3 AWWA M31)*

P_i = 0.3 *(From table 1-4 AWWA M31)*

Therefore NFF = 1,024 x 0.82 x (0.21 + 0.3) = 428.34 US gpm or 1,621Lpm of 27Lps

Two streams from a single hydrant can supply 30.4 Lps which will be adequate to suppress a fire from the building considered.

The fire flow used to check the distribution network is a minimum of 30 Lps at selected hydrants. Quantity of water for fire is estimated to be 32Lps for two hours that being a minimum of 230.4m^3.

Fire flow was set at node 92 in the housing development. The fire flow was set at time steps 7:00 – 8:00P.M., and 8:00 - 9:00P.M. for the node.

Table 7 Node results during Fire Flow with average day demand.

CORAL SPRINGS DEVELOPMENT										
Network Table - Nodes at 19:00 Hrs (Fire flow with average day demand)										
Node ID	Elevation m	Base Demand LPS	Demand LPS	Pressure m		Node ID	Elevation m	Base Demand LPS	Demand LPS	Pressure m
Junc 66	28	0.3	0.42	74.65		Junc 95	40.5	0.14	0.2	33.04
Junc 67	24	0.18	0.25	78.63		Junc 96	37	0.18	0.25	36.91
Junc 68	24	0.11	0.15	78.61		Junc 97	38	0.09	0.13	35.9
Junc 69	25	0.11	0.15	77.6		Junc 98	33	0.24	0.34	41.65
Junc 70	22	0.07	0.1	80.59		Junc 99	33.6	0.19	0.27	41.24
Junc 71	28	0.09	0.13	74.58		Junc 100	33	0.18	0.25	41.84
Junc 72	28	0.11	0.15	74.58		Junc 101	39	0.13	0.18	42.17
Junc 73	27	0.15	0.21	75.58		Junc 102	36	0.06	0.08	41.79
Junc 74	23	0.14	0.2	79.59		Junc 103	47	0.3	0.42	27.8
Junc 75	23	0.15	0.21	79.6		Junc 104	59	0.26	0.36	15.79
Junc 76	21	0.08	0.11	81.55		Junc 105	66	0.28	0.39	8.78
Junc 77	26	0.13	0.18	76.58		Junc 106	65	0.18	0.25	9.78
Junc 78	26	0.04	0.06	76.58		Junc 107	64	0.31	0.43	10.77
Junc 79	25	0.13	0.18	77.6		Junc 108	72	0.08	0.11	2.76
Junc 80	24	0.08	0.11	78.61		Junc 109	21	0.17	0.24	53.76
Junc 81	22	0.04	0.06	80.6		Junc 2	21	0	0	89.8
Junc 82	22	0.09	0.13	80.58		Junc 3	19	0	0	94.32
Junc 83	36	0.18	0.25	45.66		Junc 4	14	0.31	0.43	99.3
Junc 84	37	0.13	0.18	44.23		Junc 5	22	0.32	0.45	88.79
Junc 85	36	0.11	0.15	41.8		Junc 6	37	0.073	0.1	44.66
Junc 86	38	0.22	0.31	40.63		Resvr 1	120	#N/A	-41.99	0
Junc 87	39	0.18	0.25	37.25						
Junc 88	40	0.13	0.18	35.57						
Junc 89	43	0.19	0.27	32.55						
Junc 90	44	0.06	0.08	31.54						
Junc 91	40	0.19	0.27	35.54						
Junc 92	39.5	0.11	32.15	34.05						
Junc 93	41	0.08	0.11	32.54						
Junc 94	41.5	0.06	0.08	32.04						

Table 8 Pipe results during Fire Flow with average day demand.

CORAL SPRINGS DEVELOPMENT																
Network Table - Links at 19:00 Hrs (Fire flow with average day demand)																
Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Friction Factor	Status		Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Friction Factor	Status
Pipe 1	138.34	150	100	-41.1	2.33	0.032	Open		Pipe 112	109	100	100	0.2	0.02	0.067	Open
Pipe 8	65	150	100	2.38	0.13	0.049	Open		Pipe 113	74	150	100	-10.65	0.6	0.039	Open
Pipe 82	71	100	100	0.96	0.12	0.053	Open		Pipe 114	86	100	100	0.13	0.02	0.072	Open
Pipe 83	71	100	100	0.6	0.08	0.057	Open		Pipe 115	145	150	100	-11.03	0.62	0.039	Open
Pipe 84	70	100	100	0.43	0.05	0.06	Open		Pipe 116	241	100	100	4.35	0.55	0.042	Open
Pipe 85	80	100	100	0.26	0.03	0.064	Open		Pipe 117	241	100	100	6.93	0.88	0.04	Open
Pipe 86	105	50	100	0.11	0.06	0.067	Open		Pipe 118	86	150	100	-7.01	0.4	0.042	Open
Pipe 87	95	100	100	-0.01	0	0.189	Open		Pipe 119	101	100	100	3.41	0.43	0.044	Open
Pipe 88	19	100	100	0.06	0.01	0.076	Open		Pipe 120	114	50	100	0.18	0.09	0.062	Open
Pipe 89	82	100	100	-0.25	0.03	0.065	Open		Pipe 121	1000	100	100	3.05	0.39	0.045	Open
Pipe 90	126	100	100	0.04	0.01	0.081	Open		Pipe 122	53	50	100	0.08	0.04	0.07	Open
Pipe 91	127	100	100	0.08	0.01	0.078	Open		Pipe 123	1000	100	100	2.81	0.36	0.045	Open
Pipe 92	72	100	100	-0.41	0.05	0.06	Open		Pipe 124	69	150	100	-0.35	0.02	0.065	Open
Pipe 93	131	100	100	0.2	0.03	0.067	Open		Pipe 125	173	150	100	2.21	0.13	0.049	Open
Pipe 94	71	100	100	-0.53	0.07	0.058	Open		Pipe 126	428	100	100	0.3	0.04	0.063	Open
Pipe 95	70	100	100	-0.54	0.07	0.058	Open		Pipe 127	251	100	100	0.25	0.03	0.065	Open
Pipe 96	132	100	100	0.6	0.08	0.057	Open		Pipe 128	95	150	100	1.49	0.08	0.052	Open
Pipe 97	118	100	100	0.57	0.07	0.057	Open		Pipe 129	225	150	100	0.88	0.05	0.057	Open
Pipe 98	91	50	100	0.13	0.06	0.066	Open		Pipe 130	187	100	100	0.16	0.02	0.07	Open
Pipe 99	74	100	100	0.29	0.04	0.063	Open		Pipe 131	284	150	100	0.78	0.04	0.058	Open
Pipe 100	71	100	100	-0.12	0.02	0.072	Open		Pipe 132	107	100	100	0.11	0.01	0.073	Open
Pipe 101	22	50	100	0.06	0.03	0.074	Open		Pipe 133	466	150	100	0.24	0.01	0.069	Open
Pipe 102	406	150	100	38.3	2.17	0.032	Open		Pipe 2	109	150	100	41.99	2.38	0.032	Open
Pipe 103	71	150	100	34.5	1.95	0.033	Open		Pipe 3	235	100	100	0.43	0.06	0.06	Open
Pipe 104	86	150	100	27.3	1.54	0.034	Open		Pipe 4	42	150	100	-41.55	2.35	0.032	Open
Pipe 105	35	150	100	22.7	1.28	0.035	Open		Pipe 5	44	100	100	0.45	0.06	0.059	Open
Pipe 106	111	100	100	0.62	0.08	0.057	Open		Pipe 6	29	100	100	0.1	0.01	0.074	Open
Pipe 107	43	50	100	0.08	0.04	0.07	Open									
Pipe 108	184	100	100	0.27	0.03	0.064	Open									
Pipe 109	110	150	100	21.9	1.24	0.035	Open									
Pipe 110	56	100	100	0.39	0.05	0.061	Open									
Pipe 111	40	50	100	0.08	0.04	0.07	Open									

The pressure and demand (flow) variations for fire flows with average daily demand at node 92 is met while water is being supplied by the network.

Water piping

1. PVC pipe shall conform to JS 39: Part 2: 1987 **PVC plastic pipe SDR-PR. Part 2: Metric** criteria for classifying PVC plastic pipes and requirements and methods of test for material, workman-ship, dimensions and pressure ratings.

2. PVC pipe designs to conform to methods described in Uni-Bell Handbook of PVC Pipe: Design and Construction.

3. Installation of PVC pressure pipe to conform to AWWA Standard C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

4. Ductile iron pipe shall be designed in accordance with the latest revision of ANSI/AWWA C150/A21.50 for a minimum 150 psi (or project requirements, whichever is greater) rated working pressure plus a 100 psi surge allowance (if anticipated surge pressures are other than 100 psi, the actual anticipated pressure should be used); a 2 to 1 factor of safety on the sum of working pressure plus surge pressure; Type laying condition and a depth of cover of feet.

Recommendations and Conclusion

The Coral Springs Subdivision will require a pressure head between 70 and 100 m at the connection with the NWC main in order to satisfy regular and fire demands at the uppermost sections of the development. No water tank is proposed for this development as there is storage within the Martha Brae system. The NWC tank just east Duncans has a ground elevation of 130m and as such the pressures required by Coral Springs can be achieved. The water quantity requirements for the proposed development and network configuration proposed will adequately describe the sustainable infrastructure needs for the proposed development.

Prepared by:	**Checked by:**
Darrio Nepaul, B. Eng.	Lise Walter, PE
Civil Engineer	**Senior Civil Engineer**