FOREMAN
CHUNG
& SYKES

CIVIL & STRUCTURAL ENGINEERING CONSULTANTS
Suite 27, 6 Saint Lucia Avenue, Kingston 5
Tel 876 – 754-2154/5 Fax 754-2156 Email mail@fcsconsultants.com

GORE FLORENCE HALL DEVELOPMENT

FCS # 0827/76/C

INTERIM ENGINEERING REPORT

WATER SUPPLY DESIGN

PREPARED FOR
Gore Developments Limited
2c Braemar Ave
Kingston 10

NOVEMBER 2008

GORE FLORENCE HALL DEVELOPMENT
WATER SUPPLY DESIGN REPORT

1.0 OVERVIEW

Gore Limited proposes to develop lands north east of the Greenfield stadium and South of the North Coast Highway 2000 as a Housing Estate. The development will include a basic school, a commercial complex and several “green areas” which includes parks playfields and nature reverses.

The quantity of potable water required to sustain the proposed development is estimated to be 956m^3/day. The estimate of water use required for the proposed development included quantities for domestic, commercial, basic school and for other social needs. As is advertised by the National Water Commission (NWC) municipal water is not intended for irrigation and this is excluded from the estimate of water use and is available from nearby infrastructure and service provider.

The proposed source of water for the development will be from NWC’s Marthae brae station via a distribution pipe which runs parallel to the North Coast High. The documentation for the application for service will be provided by the Client.

Water Distribution

Water Quantity and Quality

The source of water to provide the required quantity and quality for the development is being handled by the Client who interacts directly with the WRA and Ministry of Health on this matter.

Estimate of the development’s potable water use

The present average number of persons per household based on the 2001 census is 3.6 however 4.5 is used to give a conservative population and estimate of water demand for the proposed development.

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

Water losses on the distribution network were taken as 20% of the estimated average day water demand as recommended by the NWC.

Table 1 Estimate of the Water Quantity required for the proposed Development

Florence Hall Development			
Estimate of Development's Water Demand			
Item	**Description**	**Qty**	**Unit**
1	Number of residential Units	866	No
2	Persons per lot	4.50	No
3	Population Estimate	3,897.00	No
4	Average per capita consumption	227	Liters
5	Domestic water use	884,619.00	Liters
6	Other water use (5% domestic use)	44,230.95	Liters
7	Average day demand	928,849.95	Liters
8		928.85	m^3/d
9			
10	**Commercial and Light Industry**		
11	Commercial and shopping area	3,846.43	m^2
12	Usage per unit area commercial space	14.68	L/m^2
13	% Area used for commercial floor space	20%	
14	Estimate of floor space	769.286	m^2
15	Water for commercial and light Industry	11,293.12	L
16			
17	**Basic School**		
18	Student Population	250.00	No.
19	Staff Population	25.00	No.
20	Total Basic School population	275.00	No.
21	Per Capita dem and for each head of school population	57.00	Liters/day
22	Estimate of Basic School demand	15,675.00	Liters/day
23			
24			
25	Average day demand	955,818.07	Liters
26		955.82	m^3/d
27			
28	Peak day in peak month factor	1.40	
29	Peak hour factor	1.50	
30	Peak factor	2.10	
31	Leak factor	20%	
32	Average day including leaks	1,146.98	m^3/d
33		252,300.64	UK gpd
34		303,000.56	US gpd
35	**Peak day water demand**	**1,605.77**	**m^3/d**
36		294.58	US gpm
37		245.29	UK gpm
38		18.59	Lps
39			
40	Demand per lot with Commercial & School	0.0215	Lps
41		0.3402	gpm US
42			
43	Demand per lot without Commercial nor School	0.0209	Lps
44		0.3306	gpm US

Table 2 Basis of Water quantity estimate for unplanned areas

Unit demands for areas without detailed plans				
41	Commercial Demand JIE	30	UK gal/100ft^2 day	
42		136	l/100ft^2 day	
43		15	L/m^2	
44				
45	Employee/ Teacher/Student water demand	15	US gal/day	
46		57	L/d	

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 in accordance with the latest National Water Commission Developer's Manual requirements and water distribution models conform to AWWA M-31 Distribution system requirements for fire protection except for the pressure requirements which will be guided by the JIE guideline.

Water distribution Network

The subdivision will be designed with varying sizes of PVC pipe ranging from of 250mm to 50mm diameter with the latter size serving a maximum of 16 lots. The network will be modelled to ensure that the minimum pressure will be 14m of water (20psi) during peak demand (without fire flows).The network will be 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.

EPANET, 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 to size the distribution system. The Hazen-Williams method was used to determine the flows and pressures in the pipe network.

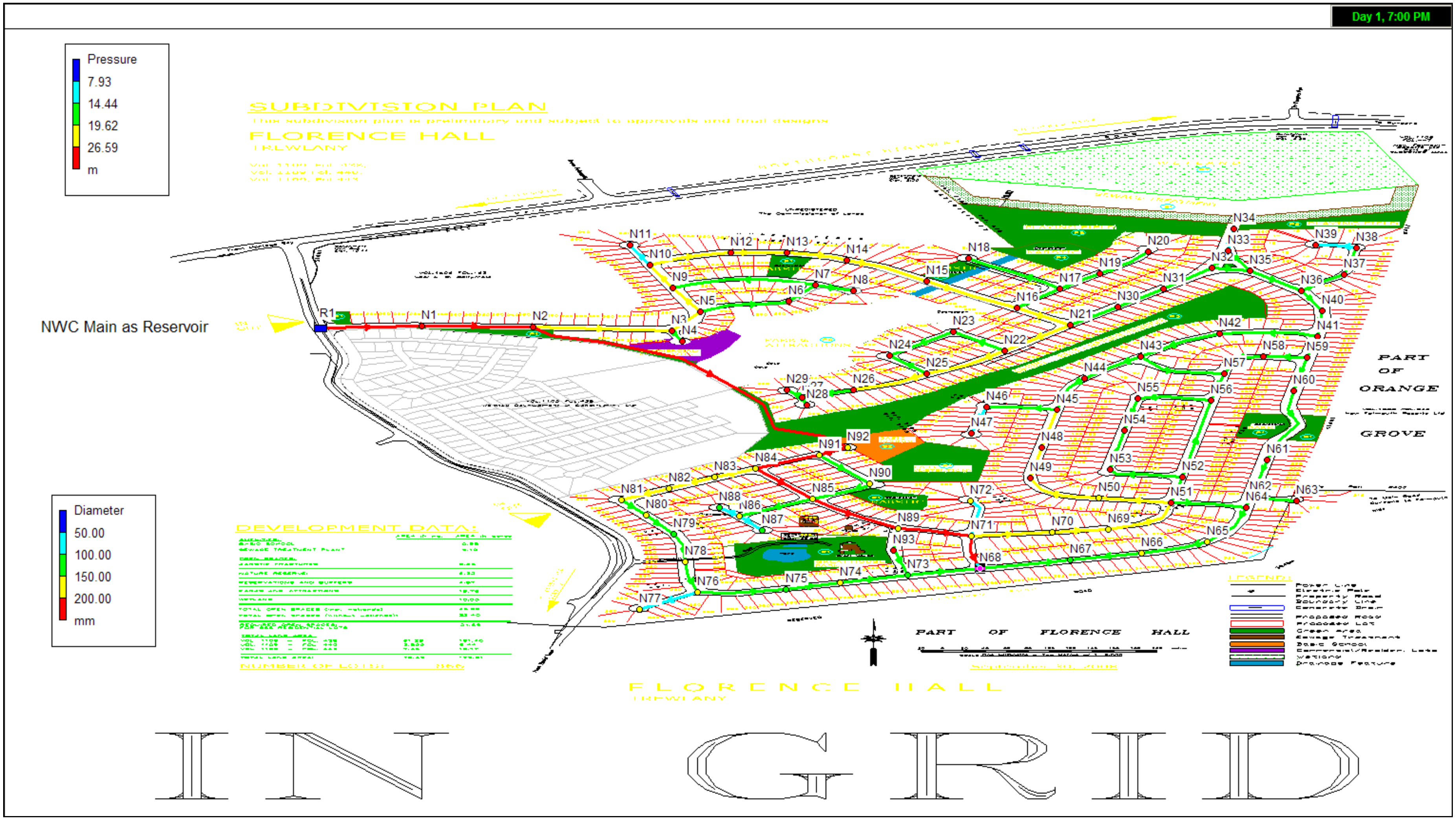

Figure 1 Water distribution model for the proposed Florence Hall Development showing node labels

Figure 1 shows the pipeline network layout and pressure at nodes during the peak hour flow and fire demand at node 68. This node was chosen as it is at the highest elevation and would represent the most critical location for fire flow. The Martha Brae system reservoir has a total head of 141.82m and is able to deliver water to the Florence Hall area at pressures up to 100m of water. The NWC supply line has been modelled as a reservoir set with total head of 70m.

The water source is connected to the proposed development by a 200mm diameter pipeline at the entrance of the development. That water transmission main connects to 200mm, 150mm and 100mm pipelines that loop through the proposed development.

The network was analysed to ensure that that the diurnal demands and minimum and maximum pressure requirements can be met throughout the life of the development and that the fire flow can be delivered throughout the proposed development. Fire flows were assigned to various nodes in the network at the highest and lowest elevations and other areas where it is likely to yield the limiting condition.

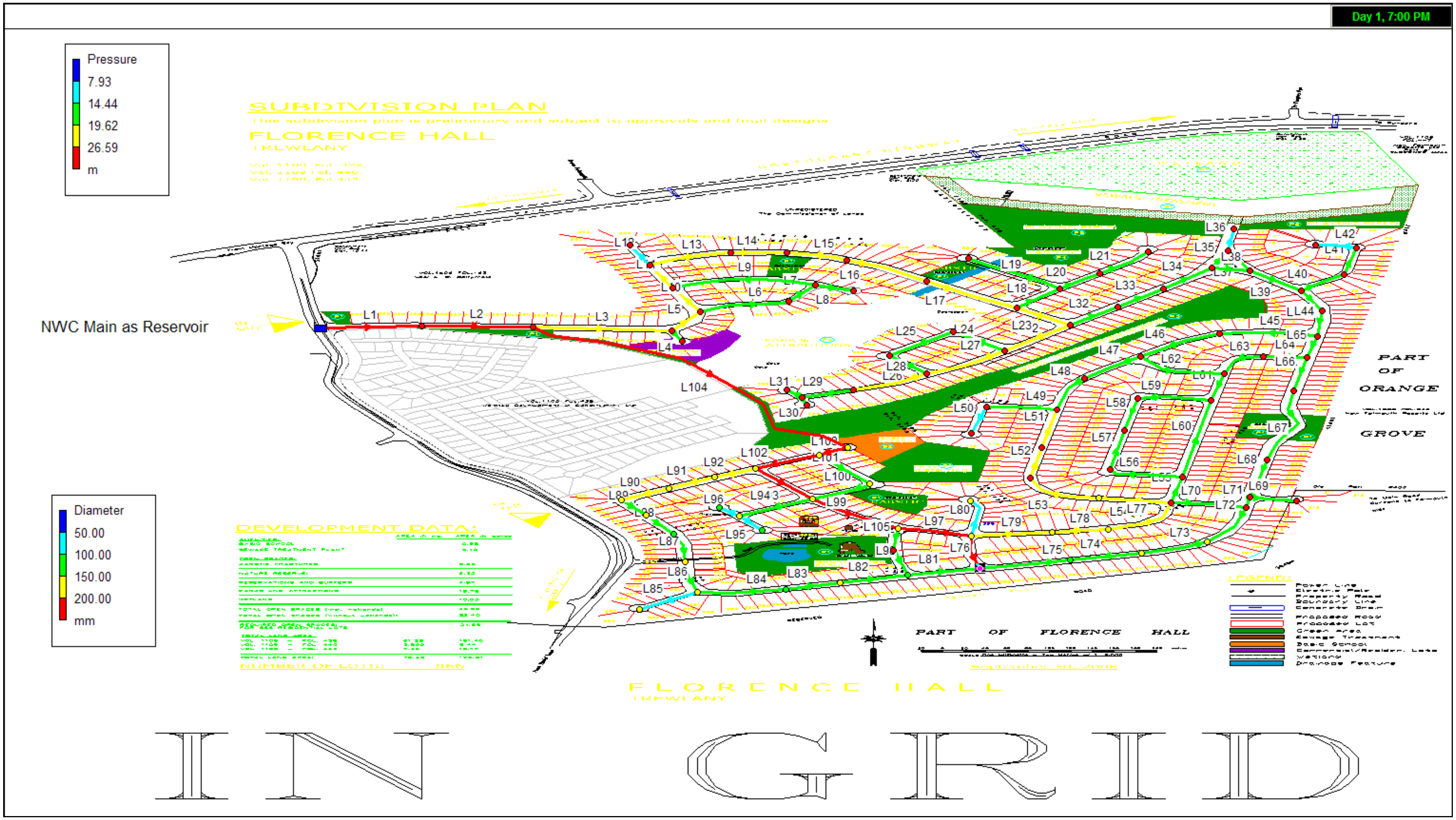

Figure 2 Water distribution model for the proposed Florence Hall Development showing pipe labels

Table 3 Results of the pressure variation in the water distribution model at peak flow with fire flow at node 68.

Network Table - Nodes at 19:00 Hrs											
	Elevation	Base Dem	Demand	Head	Pressure		Elevation	Base Dem	Demand	Head	Pressure
Node ID	m	LPS	LPS	m	m	Node ID	m	LPS	LPS	m	m
Junc N1	17	0.22	0.31	69.08	52.08	Junc N49	31	0.22	0.31	60.01	29.01
Junc N2	17	0.22	0.31	68.09	51.09	Junc N50	34	0.22	0.31	60.01	26.01
Junc N3	11.5	0.22	0.31	66.84	55.34	Junc N51	32.4	0.22	0.31	60.02	27.62
Junc N4	12	0.261	0.37	66.84	54.84	Junc N52	30.6	0.22	0.31	60.01	29.41
Junc N5	12.73	0.22	0.31	66.56	53.83	Junc N53	28.32	0.22	0.31	60.01	31.69
Junc N6	10.16	0.22	0.31	66.43	56.27	Junc N54	22	0.22	0.31	60.01	38.01
Junc N7	12.18	0.22	0.31	66.4	54.22	Junc N55	22	0.22	0.31	60.01	38.01
Junc N8	11.64	0.22	0.31	66.39	54.75	Junc N56	19.2	0.22	0.31	60.01	40.81
Junc N9	12.97	0.22	0.31	66.33	53.36	Junc N57	21	0.22	0.31	60.02	39.02
Junc N10	12.97	0.22	0.31	66.12	53.15	Junc N58	17	0.22	0.31	60.03	43.03
Junc N11	12.5	0.22	0.31	66.08	53.58	Junc N59	15.44	0.22	0.31	60.06	44.62
Junc N12	14.72	0.22	0.31	65.61	50.89	Junc N60	16.13	0.22	0.31	60.03	43.9
Junc N13	12	0.22	0.31	65.27	53.27	Junc N61	28.09	0.22	0.31	60	31.91
Junc N14	12.2	0.22	0.31	64.93	52.73	Junc N62	30.5	0.22	0.31	59.99	29.49
Junc N15	11	0.22	0.31	64.49	53.49	Junc N63	30.5	0.22	0.31	59.99	29.49
Junc N16	16.8	0.22	0.31	64	47.2	Junc N64	30.5	0.22	0.31	59.99	29.49
Junc N17	12.53	0.22	0.31	63.97	51.44	Junc N65	40	0.22	0.31	59.98	19.98
Junc N18	7.94	0.22	0.31	63.97	56.03	Junc N66	40	0.22	0.31	59.98	19.98
Junc N19	8	0.22	0.31	63.97	55.97	Junc N67	42	0.22	0.31	59.98	17.98
Junc N20	5.23	0.22	0.31	63.96	58.73	Junc N68	42.8	31.22	31.22	59.98	17.18
Junc N21	13.16	0.22	0.31	63.78	50.62	Junc N69	36	0.22	0.31	60.07	24.07
Junc N22	12.95	0.22	0.31	63.77	50.82	Junc N70	38	0.22	0.31	60.11	22.11
Junc N23	15.86	0.22	0.31	63.76	47.9	Junc N71	40.5	0.22	0.31	60.18	19.68
Junc N24	15.04	0.22	0.31	63.76	48.72	Junc N72	39	0.258	0.36	60.11	21.11
Junc N25	16.48	0.22	0.31	63.76	47.28	Junc N73	41.33	0.22	0.31	60.62	19.29
Junc N26	17.54	0.22	0.31	63.76	46.22	Junc N74	41	0.22	0.31	60.8	19.8
Junc N27	18.83	0	0	63.76	44.93	Junc N75	41.55	0.22	0.22	60.96	19.41
Junc N28	20.29	0.11	0.15	63.76	43.47	Junc N76	40.5	0.22	0.31	61.27	20.77
Junc N29	17.5	0.11	0.15	63.76	46.26	Junc N77	41	0.22	0.31	61.19	20.19
Junc N30	11.03	0.22	0.31	62.88	51.85	Junc N78	41	0.22	0.31	61.43	20.43
Junc N31	8	0.22	0.31	62.05	54.05	Junc N79	43	0.22	0.31	61.6	18.6
Junc N32	3.37	0.22	0.31	61.24	57.87	Junc N80	42	0.22	0.31	61.82	19.82
Junc N33	2.24	0.22	0.31	61.15	58.91	Junc N81	40	0.22	0.31	62.03	22.03
Junc N34	2	0.22	0.31	61.12	59.12	Junc N82	40	0.22	0.31	62.09	22.09
Junc N35	4.3	0.22	0.31	61.07	56.77	Junc N83	38	0.22	0.31	62.15	24.15
Junc N36	10.33	0.22	0.31	60.48	50.15	Junc N84	37	0.22	0.31	62.18	25.18
Junc N37	10.22	0.22	0.31	60.46	50.24	Junc N85	37	0.22	0.31	61.67	24.67
Junc N38	8	0.22	0.31	60.46	52.46	Junc N86	42	0	0	61.67	19.67
Junc N39	7	0.22	0.31	60.4	53.4	Junc N87	43	0.1	0.14	61.66	18.66
Junc N40	13.7	0.22	0.31	60.28	46.58	Junc N88	43	0.1	0.14	61.66	18.66
Junc N41	13.81	0.22	0.31	60.12	46.31	Junc N89	40	0.22	0.31	60.78	20.78
Junc N42	22.12	0.22	0.31	60.05	37.93	Junc N90	38	0.22	0.31	62.07	24.07
Junc N43	24	0.22	0.31	60.02	36.02	Junc N91	37	0.22	0.31	62.51	25.51
Junc N44	19.51	0.22	0.31	60.01	40.5	Junc N92	38	1	1.4	62.91	24.91
Junc N45	26.6	0.22	0.31	60.01	33.41	Junc N93	0	0.1	0.14	60.71	60.71
Junc N46	26.59	0.22	0.31	59.99	33.4	Resvr R1	70	#N/A	-59.24	70	0
Junc N47	31	0.22	0.31	59.95	28.95	Tank T1	46	#N/A	0	53	7
Junc N48	24	0.22	0.31	60.01	36.01						

Table 4 Results of the pipeline parameters for the water distribution model at peak flow with fire flow at node 68.

Network Table - Links at 19:00 Hrs													
	Length	Diameter	Flow	Velocity	Friction Facto	Status		Length	Diameter	Flow	Velocity	Friction F	Status
Link ID	m	mm	LPS	m/s			Link ID	m	mm	LPS	m/s		
Pipe L1	95.14	250	59.24	1.21	0.032	Open	Pipe L54	67.55	150	-1.54	0.09	0.052	Open
Pipe L2	103.72	250	58.93	1.2	0.032	Open	Pipe L55	26.23	100	0.92	0.12	0.053	Open
Pipe L3	129.52	150	15.5	0.88	0.037	Open	Pipe L56	68.02	100	0.47	0.06	0.059	Open
Pipe L4	13.95	100	0.37	0.05	0.061	Open	Pipe L57	38.65	100	0.17	0.02	0.069	Open
Pipe L5	32.11	150	14.82	0.84	0.037	Open	Pipe L58	33.05	100	-0.14	0.02	0.071	Open
Pipe L6	83.65	100	1.96	0.25	0.048	Open	Pipe L59	68.81	100	-0.45	0.06	0.059	Open
Pipe L7	29.14	100	1.66	0.21	0.049	Open	Pipe L60	76.93	100	0.14	0.02	0.071	Open
Pipe L8	35.99	100	0.31	0.04	0.063	Open	Pipe L61	27.6	100	-0.62	0.08	0.057	Open
Pipe L9	133.96	100	1.04	0.13	0.052	Open	Pipe L62	81.1	100	0.07	0.01	0.078	Open
Pipe L10	33.98	150	12.55	0.71	0.038	Open	Pipe L63	42.47	100	-0.85	0.11	0.054	Open
Pipe L11	29.99	150	13.28	0.75	0.038	Open	Pipe L64	40.73	100	-1.16	0.15	0.052	Open
Pipe L12	26.71	50	0.31	0.16	0.057	Open	Pipe L65	22.2	100	2.73	0.35	0.045	Open
Pipe L13	75.97	150	12.67	0.72	0.038	Open	Pipe L66	33.44	100	1.26	0.16	0.051	Open
Pipe L14	52.82	150	12.36	0.7	0.038	Open	Pipe L67	79.64	100	0.96	0.12	0.053	Open
Pipe L15	55.95	150	12.05	0.68	0.038	Open	Pipe L68	38.22	100	0.65	0.08	0.056	Open
Pipe L16	77.59	150	11.74	0.66	0.039	Open	Pipe L69	43.51	100	0.31	0.04	0.063	Open
Pipe L17	87.6	150	11.43	0.65	0.039	Open	Pipe L70	70.17	100	0.99	0.13	0.053	Open
Pipe L18	43.87	100	1.23	0.16	0.051	Open	Pipe L71	10.28	100	0.03	0	0.056	Open
Pipe L19	90.42	100	0.31	0.04	0.063	Open	Pipe L72	49.89	100	0.72	0.09	0.055	Open
Pipe L20	39.47	100	0.62	0.08	0.057	Open	Pipe L73	62.14	100	0.41	0.05	0.06	Open
Pipe L21	49.71	100	0.31	0.04	0.063	Open	Pipe L74	66.83	100	0.1	0.01	0.074	Open
Pipe L22	52.24	150	9.89	0.56	0.04	Open	Pipe L75	85.32	100	-0.21	0.03	0.067	Open
Pipe L23	65.73	150	1.85	0.1	0.051	Open	Pipe L76	32.85	200	-26.13	0.83	0.036	Open
Pipe L24	50.94	100	0.45	0.06	0.059	Open	Pipe L77	68.39	150	-3.76	0.21	0.046	Open
Pipe L25	63.82	100	0.15	0.02	0.07	Open	Pipe L78	52.27	150	-4.07	0.23	0.045	Open
Pipe L26	38.99	100	-0.16	0.02	0.069	Open	Pipe L79	75.15	150	-4.38	0.25	0.045	Open
Pipe L27	75.9	150	1.09	0.06	0.055	Open	Pipe L80	38.23	50	0.36	0.18	0.056	Open
Pipe L28	70.55	150	0.62	0.03	0.06	Open	Pipe L81	67.75	100	-5.3	0.67	0.041	Open
Pipe L29	48.86	100	0.31	0.04	0.063	Open	Pipe L82	63.38	100	-2.67	0.34	0.046	Open
Pipe L30	8.65	100	0.15	0.02	0.069	Open	Pipe L83	50.59	100	-2.98	0.38	0.045	Open
Pipe L31	15.08	100	0.15	0.02	0.069	Open	Pipe L84	83.12	100	-3.2	0.41	0.044	Open
Pipe L32	46.88	100	7.74	0.99	0.039	Open	Pipe L85	56.47	50	0.31	0.16	0.057	Open
Pipe L33	46.32	100	7.43	0.95	0.039	Open	Pipe L86	30.29	100	-3.82	0.49	0.043	Open
Pipe L34	49.29	100	7.12	0.91	0.039	Open	Pipe L87	28.76	100	-4.12	0.53	0.043	Open
Pipe L35	22.26	100	3.27	0.42	0.044	Open	Pipe L88	31.51	100	-4.43	0.56	0.042	Open
Pipe L36	21.18	50	0.31	0.16	0.057	Open	Pipe L89	27.23	100	-4.74	0.6	0.042	Open
Pipe L37	28.36	100	2.66	0.34	0.046	Open	Pipe L90	45.86	150	-5.05	0.29	0.044	Open
Pipe L38	35.85	100	3.54	0.45	0.044	Open	Pipe L91	44.45	150	-5.36	0.3	0.043	Open
Pipe L39	51.15	100	5.89	0.75	0.041	Open	Pipe L92	38.81	150	-5.66	0.32	0.02	Open
Pipe L40	43.14	100	0.92	0.12	0.053	Open	Pipe L93	60.35	200	30.59	0.97	0.035	Open
Pipe L41	26.75	100	0.62	0.08	0.057	Open	Pipe L94	69.92	100	0.28	0.04	0.064	Open
Pipe L42	38.41	50	0.31	0.16	0.057	Open	Pipe L95	25.16	50	0.14	0.07	0.065	Open
Pipe L43	26.58	100	4.66	0.59	0.042	Open	Pipe L96	20.39	50	0.14	0.07	0.065	Open
Pipe L44	24.59	100	4.35	0.55	0.042	Open	Pipe L97	69.1	200	-31.18	0.99	0.035	Open
Pipe L45	92.01	100	1.31	0.17	0.051	Open	Pipe L98	27.76	100	-2.93	0.37	0.045	Open
Pipe L46	76.78	100	1	0.13	0.053	Open	Pipe L99	84.02	200	-34.56	1.1	0.034	Open
Pipe L47	56.63	100	0.62	0.08	0.057	Open	Pipe L100	55.85	100	-4.55	0.58	0.042	Open
Pipe L48	39.61	100	0.31	0.04	0.063	Open	Pipe L101	53.84	100	-4.86	0.62	0.042	Open
Pipe L49	68.17	100	0.62	0.08	0.057	Open	Pipe L102	60.78	200	-36.56	1.16	0.016	Open
Pipe L50	27.6	50	0.31	0.16	0.057	Open	Pipe L103	26.91	200	-41.73	1.33	0.033	Open
Pipe L51	39.11	150	-0.61	0.03	0.06	Open	Pipe L104	326.74	200	43.13	1.37	0.033	Open
Pipe L52	29.79	150	-0.92	0.05	0.056	Open	Pipe L105	20.49	100	3.07	0.39	0.045	Open
Pipe L53	69.14	150	-1.23	0.07	0.054	Open							

Fire Flow Requirements

The fire flow requirements were guided by the AWWA Manual M31 Distribution system requirements for fire protection. The Jamaica Institution of Engineers recommended guidelines for design and construction of housing infrastructure volume 3 water supply systems allow the minimum pressure on the network during a fire to be 5psi (34.5kPa or 3.5m of water). The required fire flow as defined in the manual is the rate of water flow, at a residual pressure of and for a specified duration, that is necessary to control a major fire in a specific structure. The residual pressure used in this report is 5psi (34.5kPa or 3.5m of water) in the vicinity of the hydrant as allowed in the JIE guidelines.

The manual outlines a number of methods to assess the Needed Fire Flow (NFF) and duration. The values used in this report conform to the Insurance Services Office method.

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 Florence Housing 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.

$C_i = 18 \times 1.0 \times (3{,}240)^{0.5}$ = 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 31 Lps at selected hydrants.

Water storage

Distribution storage can be economically justified if it takes care of normal daily variation and provide needed reserve for fire protection and minor emergencies.

The National Water Commission advised that the Martha Brae system includes transmission storage as such water storage is not needed to ensure the development is supplied with water regularly. Storage would only be needed during emergencies.

Table 5 Sizing of water storage tank

Water Storage		
JIE recommended 30% Ave day + fire qty	571.22	m^3/d
	150,900.15	**US gallons**
One day's supply	1,146.98	m^3/d
	303,000.49	**US gallons**

The Florence Hall site is not conducive to the siting of a tank. As such no tank is proposed for the development. If a tank were to be included in the civil infrastructure it would be located at the south end of the development. The appropriate size would be 1,135.624m^3 or 300,000US gallons.

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, which ever 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.

5. Sewer pipe construction to conform to ASTM Standard D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.

Conclusion

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:

Lise M. Walter P.E.
Senior Civil Engineer
Foreman Chung and Sykes Consultants Limited

DATE: November 11, 2008