APPENDIX XI

Kingston Sewage Transmission System and Cost Estimate Development (Final)

XI. KINGSTON SEWAGE TRANSMISSION SYSTEM AND COST ESTIMATE DEVELOPMENT (REVISED)

XI.1 INTRODUCTION

This appendix presents the revised versions of Appendix III "Sewerage System Design" and Appendix IV "Sewerage Collection System Costs" as previously presented in Phase 1 Working Document 2.

These revisions are as a result of a reduction of industrial flow contribution to the sewer system, from the original rate of 8300 igd/acre to 3043 igd/acre.

The reason for the reduction is due to the fact that a large volume of industrial cooling water was originally identified as sewage and included in the sewage flow estimates. This has now been revised, as such flows will not go to the sanitary sewer system in the future.

Except for the change in industrial flows, all "sewerage design basis and criteria" as set out in Section 2.0 of Phase 1 Working Document 2, remains the same.

Revisions occurred to sizing of only the following trunk sewers, however, the total design and costing section has been replaced to ensure no confusion arises in future implementation.

- Trunk No. 1
- Trunk No. 4
- Trunk No. 5B
- Trunk No. 13
- Trunk No. 14
- Trunk No. 17
- Trunk No. 22
- Trunk No. 23B
- Trunk No. 24

TABLE XI.2.1

KINGSTON HARBOUR ENVIRONMENTAL PROJECT
PROJECTED EQUIVALENT POPULATION YEAR - 2015

Zone	Residential Population	Industrial Area (Acres)	Industrial Flow (igpd)	Commercial Area (Acres)	Commercial Flow (igpd)	Institutional (igpd)	Equivalent Population
A	59017	13	39600	11	27500		60174
B1	23830			0	0		23830
B2	1504			0	0		1504
C	54779	250	760750	6	15000		68154
D	4474	117	356000	10	25000		11043
D1	4075	20	60860	0	0		5124
G	64398			78	195000		67760
AF	2453			0	0		2453
AG	1285			0	0		1285
F	31346			11	27500		31820
LG	4071			100	250000		8381
L	50722			52	130000		52963
M	27372			185	472100	126400	37691
MN	12058			67	167500	104000	16739
N	15610			164	429950	12850	23244
O	11050	50	152150	94	334750	250	19449
P	27987	50	152150	84	210000		34231
Q	26397			0	0		26397
R	9788			43	107500	15600	11910
S	47970			23	57500	58400	49968
T	15852			6	15000	13200	16338
U	6780			0	0		6780
V	11418			17	42500		12151
W	17690			23	57500		18681
X	5104	133	404750	0	0		12082
Y	4638			0	0	96000	6293
Z	8951			380	980000	320000	31365
J	4297	379	1675580	0	0		33186
H	64734			37	92500		66329
NO	1660			0	0		1660
E	2051	136	1263684	0	0		23839
K	10560	252	766836	0	0		23781
I	52560	150	456450	0	0		60430
TOTAL	686481	1550	6088810	1391	3477500	746700	867035

Average Domestic Sewage Generation = 58 imp. gal./Capita/day
Industrial Sewage Generation = 3043 imp. gal./acre minimum
Commercial Sewage Generation = 2500 imp. gal./acre excluding hotels
Hospital Sewage Generation = 200 imp. gal./day/bed
Hotel Sewage Generation = 150 imp. gal./day/room
Institutional Flow consists of Hospital Sewage Generation only

B:POPUL2.WQ1

REVISED 06/01/93

TABLE XI.2.2

KINGSTON HARBOUR ENVIRONMENTAL PROJECT
HOTEL SEWAGE GENERATION ESTIMATES

NAME OF HOTEL	ADDRESS	STUDY AREA	NO. ROOMS	AVE. FLOW (igpd) *
COURTLEIGH	TRAFALGAR ROAD	N	40	6000
COURTLEIGH HOUSE	TRAFALGAR ROAD	N	40	6000
FOUR SEASONS	RUTHVEN ROAD	N	39	5850
INDIES	HOLBORN ROAD	N	14	2100
JAMAICA PEGASUS	KNUTSFORD BLVD	O	350	52500
MAYFAIR	WEST KINGS HOUSE	M	32	4800
OCEANA	KINGS STREET	Z	200	30000
TERRA NOVA	WATERLOO ROAD	M	32	4800
WYNDHAM	KNUTSFORD BLVD	O	315	47250

* AVE. FLOW CALCULATED BY MULTIPLYING NUMBER OF ROOMS BY ASSUMED SEWAGE GENERATION RATE OF 150 igpd.

B:HOTELDAT.WQ1

TABLE XI.2.3

KINGSTON HARBOUR ENVIRONMENTAL PROJECT
HOSPITAL SEWAGE GENERATION ESTIMATES

NAME OF HOSPITAL	ADDRESS	STUDY AREA	NO. BEDS	AVE.FLOW (igpd) *
KINGSTON PUBLIC	NORTH STREET	Y	480	96000
ANDREW MEMORIAL	27 HOPE ROAD	M	32	6400
BELLVUE	WINDWARD ROAD	Z	1600	320000
BUSTAMANTE CHILDREN	ARTHUR WINT DRIVE	S	292	58400
NATIONAL CHEST	LIGUANEA	M	100	20000
MEDICAL ASSOCIATES	1B TANGERINE PLACE	N	64	12800
NUTALL MEMORIAL	6 CALEDONIA AVE	R	78	15600
ST. JOSEPH	22 DEANERY ROAD	T	66	13200
UNIV /WEST INDIES	MONA	MN	520	104000

* AVE. FLOW CALCULATED BY MULTIPLYING NUMBER OF BEDS BY ASSUMED SEWAGE GENERATION RATE OF 200 igpd.

b:hospdata

Sewer Hydraulic Requirements

The trunk sewer design is based on ultimately sewering of 100% of the design year population for the study area. All sewers are designed to provide a minimum cleansing velocity of 2.5 fps during peak flow. Since these velocities are based on collecting sewage from the entire study area it will be necessary to assess the flows more carefully in large trunks during staging of the service connections as discussed in the staging section.

Pipe flow calculations are based on the use of the Mannings Flow Formulas for gravity sewer pipes using a value for Mannings "n" of 0.013.

Sewer Physical Requirements

The physical requirements used in this preliminary design regarding sewer pipe types, sizes, location and depth of bury are generally as set forth by the National Water Commission in "phase 1 - Kingston & St. Andrew Sewerage Scheme Sewer Design Manual and Vol. 2 Guideline for Design & Construction of Housing Infrastructure 1984" sewerage systems.

Trunk Sewer Design

The following design tables and profiles summarize the calculations performed to size each of the trunk sewers. The "Trunk No." corresponds with the numbered trunks on Figure 5.1 in this Report. The profiles of the trunks were developed by extracting and plotting the original ground from the 1970 sewer design maps. These maps only show a contour interval of 20 feet and are somewhat outdated, however for preliminary design purposes these profiles were considered adequate. it will be necessary to confirm the original ground profiles during detailed design using updated orthographic drawings and field surveys.

Equivalent populations were attributed to various sections of the trunk system. These progressively cumulative equivalent populations, proceeding down the trunk sewers, were used to calculate a peaking factor based on the Harmon Formula. Peak flows were increased by 5 - 15%, related to elevation, to allow for infiltration. Pipe diameters

were selected that would convey the peak flow at the grades established on the preliminary profiles. No additional factor of safety above the peak flow capacity has been provided. The overall trunk system and corresponding pipe diameters are shown on Figure 5.1. Each trunk system is designed to convey flow from it's tributary drainage area as denoted on the drawing.

All flow except from Riverton and Hunts Bay would be collected at either the Nanse Pen or Greenwich Station. As noted in the Working Document 1 the Greenwich treatment facility is proposed to be abandoned and two syphons constructed from Greenwich to Soapberry. The two syphons from Greenwich to Soapberry have been increased in diameter from 2 - 48" diameter to 2 - 48" diameter lines and 1 - 30" diameter, to accommodate the final projected population.

The Riverton and Hunts Bay stations will pump directly into the Greenwich syphons near Hunts Bay rather than to Nanse Pen as indicated in Working Document 1.

A new Spanish Town Road Trunk will need to be constructed from Greenwich to Nanse Pen. It will act as an overflow to receive approximately 7 cfs from Greenwich during peak flow and provide a means of partially bypassing the Greenwich syphons if syphon blockages were to occur in the future.

Flow received at nanse Pen from the Lower West and Upper West Districts would be transmitted to the Soapberry Lagoons through 1 - 30" and 1 - 42" forcemains. The 30" forcemain would be constructed by extending the existing forcemain between Nanse Pen and Greenwich to the Soapberry area. it is anticipated that both forcemains will be required in the first phase of construction.

The existing 21" line from Darling Street to Western would be extended with a 24" main to Greenwich and the Western Treatment Plant would be abandoned early in the first stage of construction. An additional 24" main would be required later in the second phase of construction to accommodate additional flow from the Eastern Trunk.

Mid Level Trunk

The existing 24" mid-level trunk sewer aligned along Laws, South Parade and Beckford Street contains a cast iron syphon section from the intersection of West Street and Beckford Street to the Western Treatment Plant. Since 1975 the mid-level trunk syphon has experienced blockages and sewage flows have been diverted from time to time to the Darling Street Pump Station through the low level trunk connection sewers. This situation is unacceptable as the low level trunk is overloaded and sewage frequently backs up and overflows from manholes.

In the future, flow conditions in the syphon section are expected to worsen due to flow relief provided by the proposed Eastern trunk. It has been proposed to cut the syphon section at the low point and extend to the Darling Street pump station through a 24" gravity sewer section. This modification would allow the mid-level trunk to accommodate both average and peak future flows. In order to abandon the Western Treatment Plant at an early date this modification must be completed in first stage of the construction.

High Level Trunk #20

The existing gravity High Level Trunk sewer ranging in size from 18" to 42" transmits sewage from its tributary area in the Central Eastern District to the Greenwich Treatment Plant along the route of Cumberland Avenue, Glenmore Road North, Bond, Percy, Regent, Nelson, Greenwich, Trench Town Streets and Spanish Town Road. The sewer is constructed of vitrified clay up to 18" diameter and cast in place concrete for over 18" diameter. It was originally predicted that the capacity of the existing line is such that future anticipated flows could not be accommodated, especially through the syphon sections. The current limiting capacity factor is the Tivoli Gully syphon. Reid Crowther estimated its capacity at 10 migpd in 1970. The current population forecast indicate that the flow in the High Level Trunk should not exceed 9.5 migpd due to negative growth in the service area, indicating the existing capacity of the High Level Trunk is satisfactory.

It is proposed that the high level trunk maintain its present function while removing a portion of the tributary flow from the Central East District by constructing relief sewers

along Southcamp, Wilde and Portland Roads. These relief sewers would transfer sewage to the Eastern Trunk.

Approximately 1700 ft. of the 42" section of the High Level trunk between its junction with the Upper Central Trunk and Greenwich will require duplication with an additional 42" trunk, to accommodate ultimate future flows conveyed by the Upper Central Trunk.

The Tivoli Gully syphon consisting of a 22", 18" and 16" three pipe steel syphon has invert pipes constructed at elevations that permit minimum flow to be carried in all three pipes resulting in frequent settling out of solids and partial blockage. it will be necessary to investigate this syphon further during the detailed design to determine if flow conditions can be improved.

Spanish Town Road Trunk #24

This sewer would require replacement with a main varying from 12" to 48" diameter. it would be graded in the opposite direction along Spanish town Road from Greenwich to Nanse Pen. The trunk would collect flow from the Lower West and Upper West areas and relieve some peak flows from the Greenwich syphons through the overflow connection.

Low Level Trunk

The existing cast iron Low Level trunk along Harbour Street was constructed in 1893 and at the time of this report in 1992 was being reconstructed. As was indicated the new construction and design meets the requirements of the original master plan and will be compatible with the current Flow West Scheme.

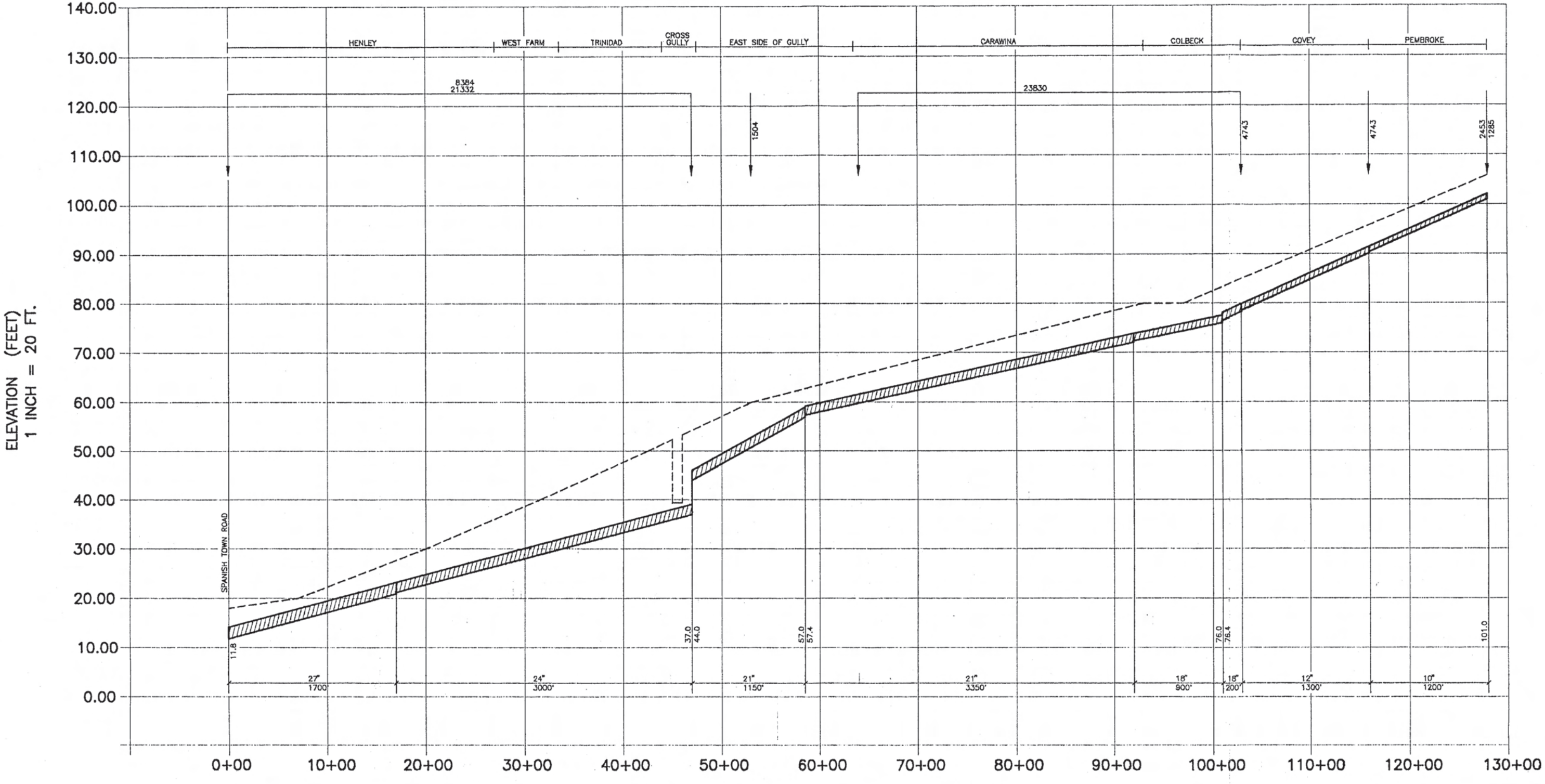
The new construction consists of a new pump station at Hanover Street and Harbour Street. The new pump station will accept gravity flow along Harbour Street west to Markland and east to Michael Lane and pump this flow to the new gravity sewer at Church Street which would in turn flow to the Darling Street pump station. Sewage east of Markland would flow by gravity sewer east to the Rae Town pumping station where it would be pumped to the Hanover Street pumping station.

Eastern Trunk #19

The proposed Eastern trunk is required to serve the east Kingston area and to relieve flow from more easterly sections of the High Level Trunk. The trunk route proceeds along Windward Road, Victoria Avenue, East Queen Street, Victoria Park, West Queen Street, Spanish Town Road, Scott Land, Brooks Street, Salt Lane and Darling Street to the Darling Street pump station. A syphon or bridged gravity crossing at the Franklin Town gully will be required.

Upper Central Trunk #23

The Upper Central Trunk is an existing trunk that drains the Upper Central District and follows a route adjacent to the west boundary of the district connecting to the high level trunk at Spanish Town Road. It is anticipated that the existing 8", 18" and 21" upper section of the trunk between West Kings House Road and Mannings Hill Road along Constant Spring Road will require replacement with a 12", 15" and 24" and 27" section to accommodate future flows in Stage 2 of construction.



TRUNK 1

NOVEMBER, 1993

Trunk No. 1 DESIGN FLOW (igpd) 58 n= 0.013

LOCATION	STREET/ROAD		POPULATION		DESIGN FLOW				SEWER DESIGN						PROFILE	
			INDIVIDUAL	CUMMULATIVE	PEAK	SEWAGE	INFILTR.	TOTAL	SLOPE	DIAM.	Q	V	LENGTH		UPPER	LOWER
	FROM	TO	P	P	FACTOR	CFS	% OF FLOW	Q CFS	%	INCHES	CFS	FPS	FT.		INVERT	INVERT
PEMBROKE			3738	3738	3.359528	1.352522	10	1.487775	0.911111	10	2.090294	3.834425	2700	*	101	76.4
COVEY			4743	8481	3.0254	2.763483	10	3.039831	0.911111	12	3.399049	4.329999	2700	*	101	76.4
COLBECK			4743	13224	2.833305	4.035367	10	4.438904	0.911111	15	6.162886	5.024519	2700	*	101	76.4
COLBECK			4776	18000	2.698485	5.231418	10	5.754559	0.437647	18	6.945611	3.932406	4250	**	76	57.4
CARAWINA			19054	37054	2.387898	9.529666	10	10.48263	0.437647	21	10.47696	4.358023	4250	**	76	57.4
EAST GULLY			1504	38558	2.371271	9.847422	10	10.83216	1.130435	18	11.16275	6.320029	1150		57	44
HENLEY			21332	59890	2.19262	14.1431	15	16.26456	0.53617	24	16.55655	5.272786	4700	***	37	11.8
HENLEY			8384	68274	2.141663	15.74829	15	18.11054	0.53617	27	22.66608	5.703505	4700	***	37	11.8
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					4.5	0	15	0	ERR		ERR	ERR				

NOTES:

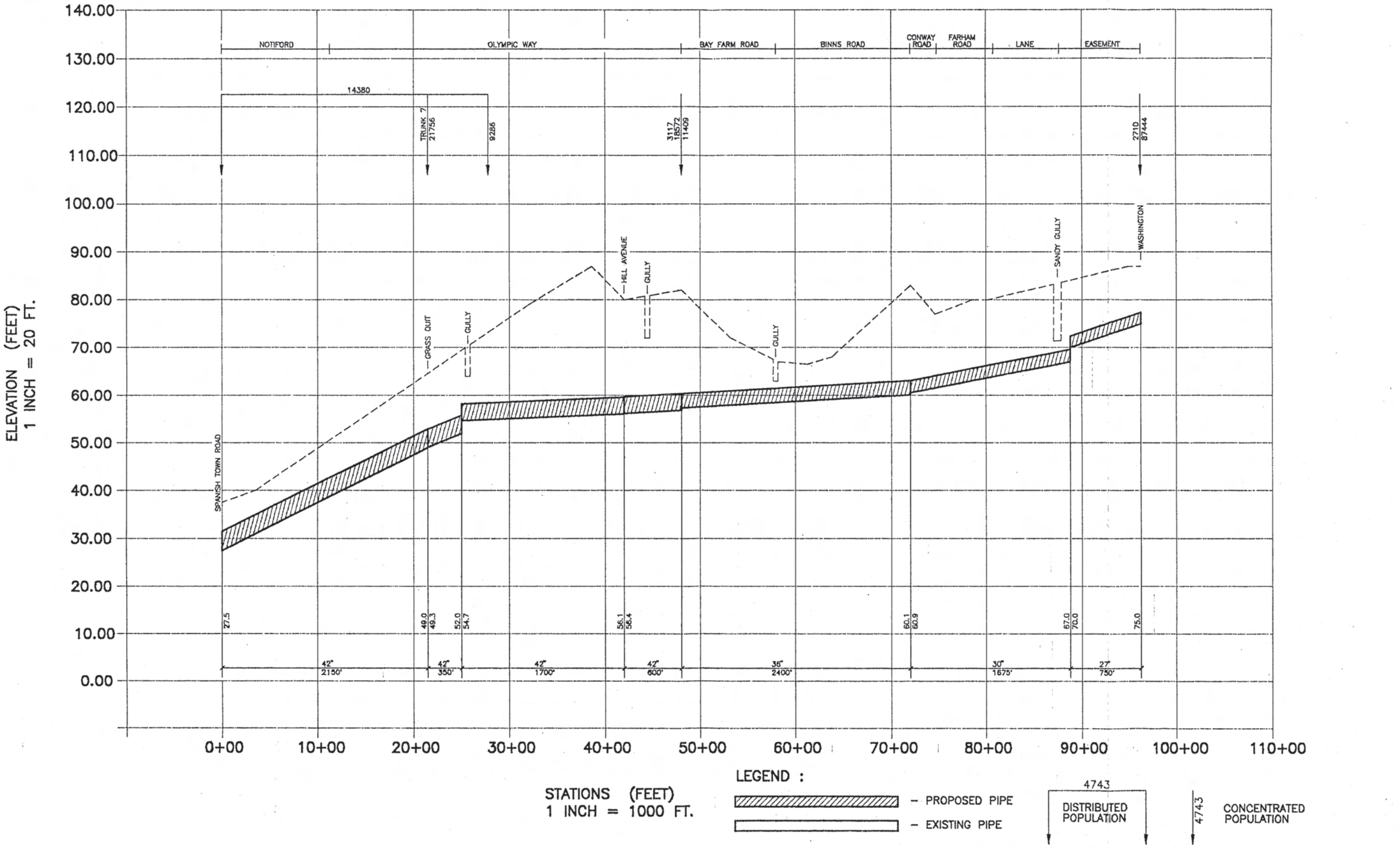
* 1200 feet - 10 inch dia., 1300 feet - 12 inch dia., and 200 feet - 15 inch dia.

** 900 feet - 18 inch dia., and 3350 feet - 21 inch dia.

*** 3000 feet - 24 inch dia., and 1700 feet - 27 inch dia.

TRUNK 1

NOVEMBER, 1993



TRUNK 2

NOVEMBER, 1993

						Trunk No. 2				DESIGN FLOW (igpd)			58		n=	0.013
LOCATION	STREET/ROAD		POPULATION		DESIGN FLOW				SEWER DESIGN				PROFILE			
			INDIVIDUAL	CUMMULATIVE	PEAK	SEWAGE	INFILTR.	TOTAL	SLOPE	DIAM.	Q	V	LENGTH		UPPER	LOWER
	FROM	TO	P/ACRE	P	FACTOR	CFS	% OF FLOW	Q CFS	%	INCHES	CFS	FPS	FT.		INVERT	INVERT
EASEMENT			90154	90154	2.037425	19.78307	10	21.76137	0.666667	27	25.27432	6.35982	750		75	70
LANE			0	90154	2.037425	19.78307	10	21.76137	0.367164	30	24.84136	5.063206	1675		67	60.85
BINNS			0	90154	2.037425	19.78307	10	21.76137	0.133333	36	24.34246	3.445501	3000	*	60.1	56.1
BAY FARM			33098	123252	1.927036	25.5806	10	28.13866	0.133333	42	36.71887	3.818419	3000	*	60.1	56.1
NORTH COCK			9286	132538	1.902497	27.1576	10	29.87336	0.082353	48	41.20071	3.280311	1700		56.1	54.7
NORTH COCK			21756	154294	1.85254	30.78531	10	33.86384	0.98	30	40.58431	8.271962	2500		52	27.5
NORTH COCK			14380	168674	1.824138	33.13848	10	36.45233	0.98	30	40.58431	8.271962	2500		52	27.5
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					4.5	0	15	0	ERR		ERR	ERR				
					4.5	0	15	0	ERR		ERR	ERR				
					4.5	0	15	0	ERR		ERR	ERR				

NOTES: * 2400 feet - 36 inch dia., and 600 feet - 42 inch dia.

ELEVATION (FEET)
1 INCH = 20 FT.

240.00
230.00
220.00
210.00
200.00
190.00
180.00
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00

WASHINGTON
TRUNK 4
47261
1220
TRUNK 3B
19244
4811
14908
SAVANAH
SANDY GULLY
MOLYNES
TRUNK 2 TIE-IN
80.0
105.0
105.6
113.0
121.0
150.0
150.4
154.0
165.0
221.0
27"
1700'
27"
1000'
24"
1750'
24"
850'
18"
300'
15"
300'
12"
2600'

0+00 10+00 20+00 30+00 40+00 50+00 60+00 70+00 80+00 90+00 100+00

STATIONS (FEET)
1 INCH = 1000 FT.

LEGEND :

– PROPOSED PIPE

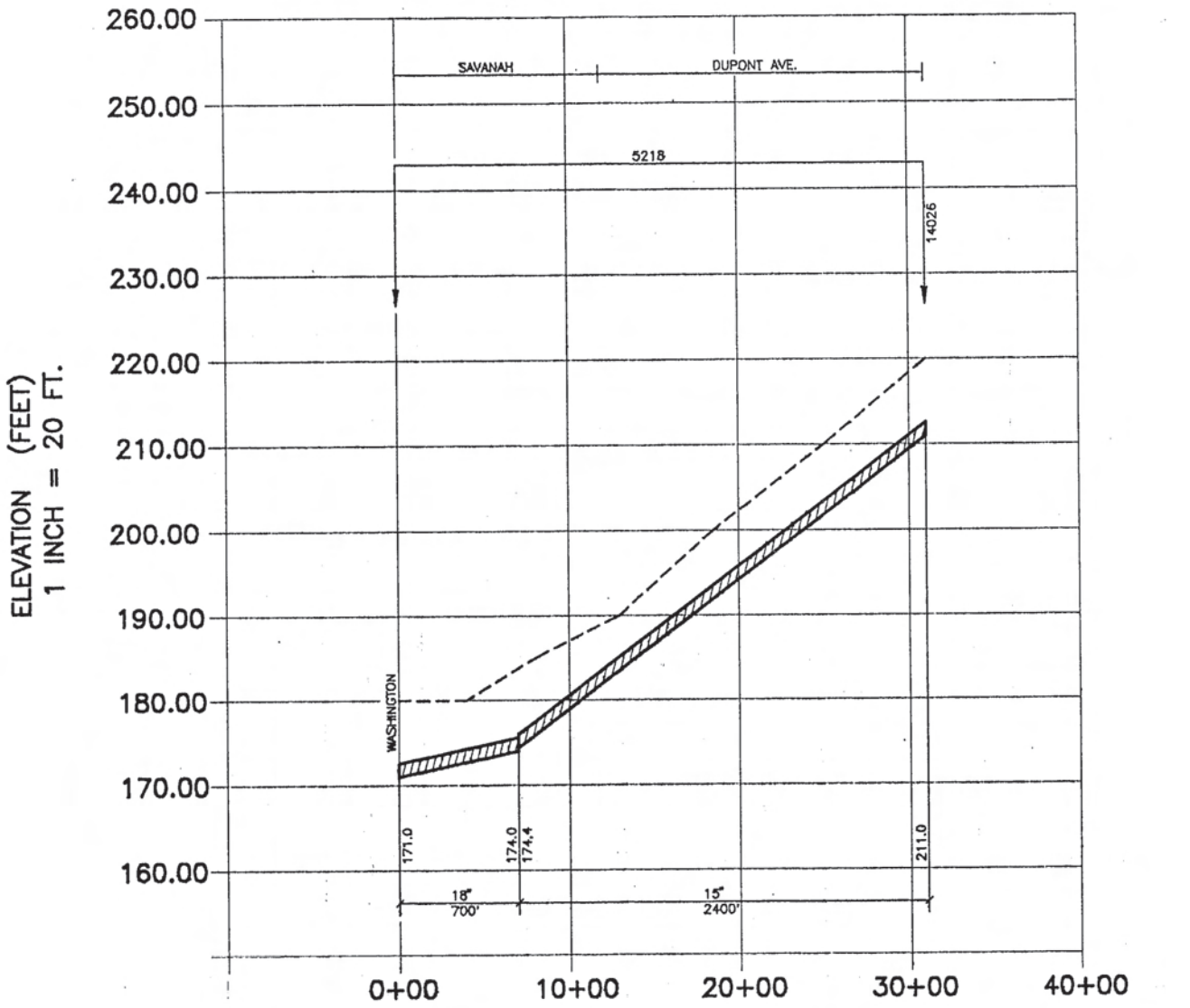
– EXISTING PIPE

4743
DISTRIBUTED POPULATION

4743
CONCENTRATED POPULATION

TRUNK 3A

NOVEMBER, 1993

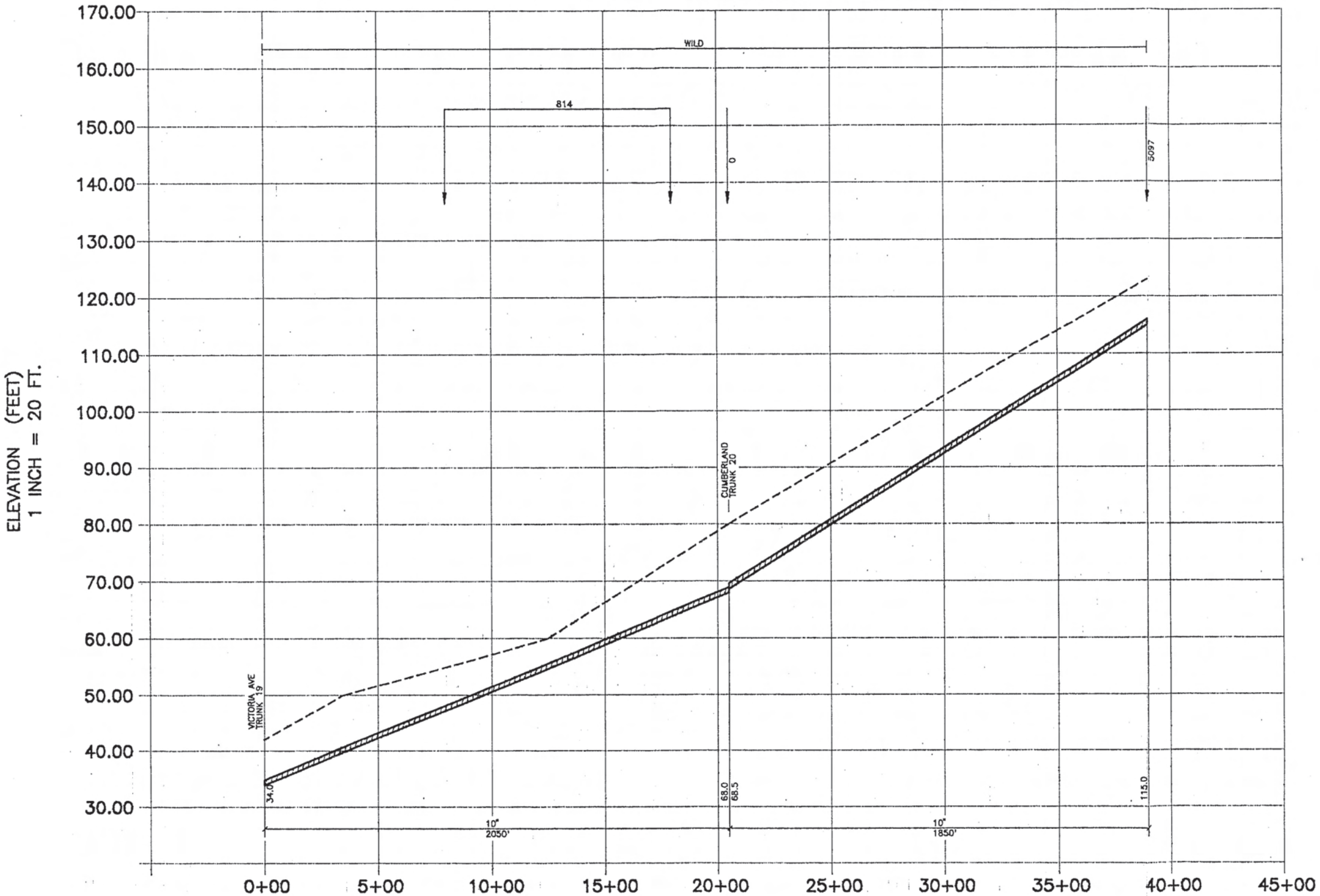


LEGEND :

- PROPOSED PIPE
- EXISTING PIPE
- 4743 DISTRIBUTED POPULATION
- 4743 CONCENTRATED POPULATION

TRUNK 3B

NOVEMBER, 1993



TRUNK 12

NOVEMBER, 1993

Trunk No. 11									DESIGN FLOW (igpd)				58	n=	0.013
LOCATION	STREET/ROAD		POLULATION		DESIGN FLOW				SEWER DESIGN				PROFILE		
			INDIVIDUAL	CUMMULATIVE	PEAK	SEWAGE	INFILTR.	TOTAL	SLOPE	DIAM.	Q	V	LENGTH	UPPER	LOWER
	FROM	TO	P	P	FACTOR	CFS	% OF FLOW	Q CFS	%	INCHES	CFS	FPS	FT.	INVERT	INVERT
SOUTHCAMP			18939	18939	2.6762661	5.4590018	5	5.7319518	2.94	12	6.10584	7.778141	500	130	115.3
SOUTHCAMP			0	18939	2.6762661	5.4590018	10	6.0049019	1.4275862	15	7.714356	6.289411	1450	115	94.3
SOUTHCAMP			4431	23370	2.5847407	6.5058283	10	7.1564112	1.4275862	15	7.714356	6.289411	1450	115	94.3
SOUTHCAMP			798	24168	2.5701939	6.6901139	10	7.3591253	4.1272727	15	13.11687	10.69401	550	94	71.3
SOUTHCAMP			0	24168	2.5701939	6.6901139	10	7.3591253	1.6363636	15	8.259208	6.733622	2200	71	35
					4.5	0	10	0	ERR	21	ERR	ERR			
					4.5	0	15	0	ERR	24	ERR	ERR			
					4.5	0	15	0	ERR	27	ERR	ERR			
					4.5	0		0	ERR		ERR	ERR			
					4.5	0	15	0	ERR		ERR	ERR			
					4.5	0	15	0	ERR		ERR	ERR			
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					4.5	0	15	0	ERR		ERR	ERR			
					4.5	0	15	0	ERR		ERR	ERR			
					4.5	0	15	0	ERR		ERR	ERR			

TRUNK 11

NOVEMBER, 1993