

SECTION 02700

STORM DRAIN AND SANITARY SEWER SYSTEMS

1. General

A. Description

This section includes all work necessary to provide storm drain and sanitary sewer systems complete in place to the limits indicated in accordance with the Contract Documents.

B. Quality Assurance

Tests to be performed as outlined in this section shall not be performed until all other utilities shown on the approved plans are completed.

1. Sanitary Sewer Manhole Field Tests

Manholes and other structures shall be vacuum tested for water tightness after all connections have been made, and before backfilling. Final tests must be performed after the manholes and other structures have been backfilled.

After backfilling, manholes and other structures shall be visually inspected by the Engineer for leakage. Any visible leak shall be sealed or resealed until all leakage into the unit is satisfactorily eliminated. Final vacuum testing of the manholes or other structures shall be conducted only after the sewers attached to the structures have been air tested, and after final adjustments to finished grade have been made, and prior to final inch of paving. Air testing shall be in accordance with the following subsection: Sanitary Sewer Field Tests.

Manholes to be vacuum tested shall have ten (10) inches of mercury applied to the manhole and the time measured for the vacuum to drop from ten (10) inches to nine (9) inches of mercury. Vacuum equipment shall be approved by the Engineer prior to its use. Following are minimum allowable test times for manhole acceptance at the specified vacuum drop:

<u>Depth of Manhole</u>	<u>Time (sec)</u>		
	<u>Manhole Diameter (inches)</u>		
	<u>48"</u>	<u>60"</u>	<u>72"</u>
4'	7	9	12
8'	14	18	23
10'	17	23	28
12'	21	28	34
14'	25	32	40

<u>Depth of Manhole</u>	<u>Time (sec)</u>		
	<u>Manhole Diameter (inches)</u>		
	<u>48"</u>	<u>60"</u>	<u>72"</u>
16'	28	37	45
18'	32	41	51
20'	35	46	57
22'	39	51	62
24'	42	55	68
26'	46	60	74
28'	49	64	80
30'	53	69	85

Test times for structures other than manholes will be based on the times for manholes of the nearest equivalent volume or as directed by the Engineer.

AIR TEST TABLES **6" & 8"**
MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG

LENGTH OF LATERAL IN FEET	LENGTH OF MAIN LINE IN FEET										6" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	14	24	34	44	54	64	74	84	94	103	113	123	163	168	
50	19	29	39	48	58	68	78	88	98	108	118	128	166	167	
75	23	33	43	53	63	73	83	92	102	112	122	132	164	165	
100	28	37	47	57	67	77	87	97	107	117	127	136	162	163	
125	32	42	52	62	72	81	91	101	111	121	131	141	160	162	
150	36	46	56	66	76	86	96	106	116	125	135	145	159	161	
175	41	51	61	70	80	90	100	110	120	130	140	150	157	159	
200	45	55	65	75	85	95	105	114	124	134	144	153	156	158	
225	50	59	69	79	89	99	109	119	129	139	149	151	154	157	
250	54	64	74	84	94	103	113	123	133	143	149	150	153	156	
275	58	68	78	88	98	108	118	128	138	146	147	149	152	155	
300	63	73	83	92	102	112	122	132	142	145	146	147	151	154	
350	72	81	91	101	111	121	131	140	141	143	144	145	149	152	
400	80	90	100	110	120	130	136	138	139	141	142	143	147	150	
450	89	99	109	119	129	132	134	136	138	139	141	142	145	149	
500	98	108	118	126	129	131	133	135	136	138	139	140	144	147	

LENGTH OF LATERAL IN FEET	LENGTH OF MAIN LINE IN FEET										8" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	22	40	57	75	92	110	128	145	163	180	198	216	223	224	
50	26	44	62	79	97	114	132	150	167	185	202	218	220	221	
75	31	48	66	84	101	119	136	154	172	189	207	214	217	219	
100	35	53	70	88	106	123	141	158	176	194	209	211	214	216	
125	40	57	75	92	110	128	145	163	180	198	206	207	211	214	
150	44	62	79	97	114	132	150	167	185	201	202	204	209	212	
175	48	66	84	101	119	136	154	172	189	197	199	201	206	210	
200	53	70	88	106	123	141	158	176	192	194	197	199	204	208	
225	57	75	92	110	128	145	163	180	189	192	194	196	202	206	
250	62	79	97	114	132	150	167	183	186	189	191	193	200	204	
275	66	84	101	119	136	154	172	181	186	187	189	191	198	202	
300	70	88	106	123	141	158	174	178	181	184	187	189	196	200	
350	79	97	114	132	150	166	170	174	177	180	183	185	192	197	
400	88	106	123	141	157	162	166	170	174	176	179	181	189	194	
450	97	114	132	148	154	139	163	167	170	173	176	178	186	191	
500	106	123	140	146	151	156	160	164	167	170	173	175	183	189	

LENGTH OF LATERAL IN FEET	LENGTH OF MAIN LINE IN FEET										8" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	28	45	63	80	98	116	133	151	168	186	204	221	226	225	
50	37	55	73	90	108	126	143	161	178	196	214	220	222	223	
75	47	65	83	100	118	135	153	171	188	206	217	217	220	221	
100	57	75	93	110	128	145	163	181	198	214	214	215	218	220	
125	67	85	102	120	138	155	173	190	208	211	212	213	216	218	
150	77	95	112	130	148	165	182	200	207	209	210	211	214	217	
175	87	105	122	140	157	175	192	204	206	207	208	209	213	215	
200	97	114	132	150	147	185	201	202	204	205	206	207	211	214	
225	107	124	142	160	177	195	199	201	203	204	205	206	210	213	
250	117	134	152	169	187	195	198	199	201	202	203	204	209	212	
275	127	144	162	179	192	194	196	198	200	201	202	204	208	210	
300	136	154	172	187	190	192	195	196	198	200	201	202	207	209	
350	156	174	181	185	187	190	193	194	196	198	199	200	205	208	
400	173	178	181	184	186	189	191	192	194	196	197	198	230	206	
450	173	177	180	183	185	187	189	190	192	194	195	196	201	204	
500	173	177	180	182	184	186	188	189	191	192	193	194	200	203	

AIR TEST TABLES
MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG

10"

LENGTH OF LATERAL IN FEET 4" DIAMETER	LENGTH OF MAIN LINE IN FEET													10" DIAMETER	
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	32	59	87	114	142	169	197	224	252	277	277	278	279	280	
50	36	64	91	119	146	174	201	229	256	271	272	273	275	277	
75	41	68	96	123	151	178	206	233	261	265	267	268	272	274	
100	45	73	100	128	155	183	210	238	258	260	262	264	268	271	
125	50	77	105	132	160	187	214	242	253	255	257	259	264	268	
150	54	81	109	136	164	191	219	244	248	251	253	255	261	265	
175	58	86	113	141	168	196	223	239	243	246	249	251	258	262	
200	63	90	118	145	173	200	228	235	239	242	245	248	255	260	
225	67	95	122	150	177	205	226	231	235	239	242	244	252	257	
250	72	99	127	154	182	209	222	227	231	235	238	241	249	255	
275	76	103	131	158	186	211	218	223	228	231	235	238	247	253	
300	80	108	135	163	190	208	214	220	224	228	232	235	244	250	
350	89	117	144	172	194	201	208	213	218	222	226	229	239	246	
400	98	125	153	179	188	196	202	208	213	217	221	224	235	242	
450	107	134	162	174	183	191	197	303	208	212	216	220	230	238	
500	116	143	160	170	179	186	193	198	203	208	212	215	226	235	

LENGTH OF LATERAL IN FEET 6" DIAMETER	LENGTH OF MAIN LINE IN FEET													10" DIAMETER	
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	37	65	92	120	147	175	202	230	257	277	278	278	279	280	
50	47	75	102	130	157	185	212	240	267	271	272	273	276	277	
75	57	85	112	140	167	195	222	250	265	266	267	269	272	274	
100	67	95	122	150	177	205	232	257	260	262	263	265	269	271	
125	77	105	132	160	187	215	242	253	255	257	259	261	266	269	
150	87	114	142	169	197	224	245	248	251	254	256	257	263	266	
175	97	124	152	179	207	234	241	245	248	250	252	254	260	264	
200	107	134	162	189	217	233	237	241	244	247	249	251	258	262	
225	117	144	172	199	225	230	234	238	241	244	246	248	255	260	
250	127	154	182	209	222	227	231	235	238	241	243	246	253	258	
275	136	164	191	213	219	224	229	232	236	238	241	243	251	256	
300	146	174	201	211	217	222	226	230	233	236	239	241	249	254	
350	166	192	200	207	212	217	222	226	229	232	235	237	245	250	
400	181	190	197	203	209	214	218	222	225	228	231	233	241	247	
450	180	188	193	201	206	211	215	218	222	225	227	230	238	244	
500	179	186	193	198	203	208	212	215	219	222	224	227	235	241	

LENGTH OF LATERAL IN FEET 8" DIAMETER	LENGTH OF MAIN LINE IN FEET													10" DIAMETER	
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	45	73	100	128	155	183	210	238	265	279	280	280	281	281	
50	63	90	118	145	173	200	228	255	275	275	276	277	278	279	
75	80	108	135	163	190	213	245	270	272	272	273	274	276	277	
100	98	125	153	180	208	235	263	267	268	269	270	271	274	275	
125	116	143	171	198	226	253	263	265	266	267	268	269	272	274	
150	133	161	188	216	243	258	260	262	264	265	265	267	270	272	
175	151	178	206	233	254	256	258	260	262	263	264	265	268	271	
200	168	196	223	249	252	254	256	258	260	261	262	263	267	269	
225	186	213	241	247	250	253	255	257	258	259	261	262	265	268	
250	204	231	242	246	249	251	253	255	256	258	259	260	264	267	
275	221	237	241	244	247	250	252	254	255	256	258	259	263	266	
300	232	237	240	243	246	249	251	253	254	255	256	258	262	265	
350	232	235	239	242	244	247	249	251	252	253	254	256	260	263	
400	231	234	238	240	243	245	247	249	250	251	253	254	258	261	
450	230	234	237	239	241	243	245	247	248	250	251	252	256	259	
500	230	233	236	238	240	242	244	246	247	249	250	251	255	258	

AIR TEST TABLES

12"

**MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG**

LENGTH OF LATERAL IN FEET 4" DIAMETER	LENGTH OF MAIN LINE IN FEET										12" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	44	84	123	163	202	242	282	321	332	333	334	334	336	336	
50	48	88	128	167	207	246	286	323	324	326	327	328	331	333	
75	53	92	132	172	211	251	290	316	317	319	321	323	327	329	
100	57	97	136	176	216	255	295	308	311	313	316	317	323	326	
125	62	101	141	180	220	260	297	301	304	308	310	312	319	323	
150	66	106	145	189	229	268	283	289	293	297	300	303	311	316	
175	70	110	150	194	233	271	277	283	288	292	296	299	308	313	
200	75	114	154	199	238	276	282	288	293	297	301	304	313	318	
225	79	119	158	202	242	280	286	291	296	300	304	307	316	321	
250	84	123	163	207	246	284	290	295	299	303	307	310	319	324	
275	88	128	167	211	251	289	295	300	304	308	311	314	323	328	
300	92	132	172	216	255	293	299	304	308	312	315	318	327	332	
350	101	141	180	213	231	241	249	256	262	268	272	276	289	297	
400	110	150	189	210	223	233	242	249	255	261	266	270	283	292	
450	119	158	189	204	216	227	235	243	249	255	260	264	278	288	
500	128	166	184	198	210	221	229	237	243	249	254	259	273	283	

LENGTH OF LATERAL IN FEET 6" DIAMETER	LENGTH OF MAIN LINE IN FEET										12" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	50	37	89	129	168	208	248	287	327	331	332	333	333	335	335
50	59	99	139	178	218	257	297	321	323	325	326	327	330	332	
75	69	109	149	188	223	267	307	314	316	318	320	321	326	328	
100	79	119	158	198	238	277	302	306	309	312	314	316	321	325	
125	89	129	168	208	248	287	295	300	303	306	309	311	317	321	
150	99	139	173	218	257	284	289	294	298	301	304	306	314	318	
175	109	149	188	228	257	278	284	289	293	296	299	302	310	315	
200	119	158	198	238	265	272	278	284	288	292	295	298	306	312	
225	129	168	208	248	260	268	274	279	284	288	291	294	303	309	
250	139	178	218	246	255	263	269	275	280	284	287	290	300	306	
275	149	188	228	242	251	259	266	271	276	280	284	287	297	304	
300	158	198	227	238	248	255	262	268	272	277	281	284	294	301	
350	178	208	221	232	241	249	255	261	266	271	274	278	289	296	
400	189	204	217	227	236	243	250	256	261	265	269	273	284	292	
450	187	201	213	223	231	239	245	251	256	260	264	268	279	288	
500	186	199	210	219	227	234	240	246	251	256	260	263	275	284	

LENGTH OF LATERAL IN FEET 8" DIAMETER	LENGTH OF MAIN LINE IN FEET										12" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	57	97	136	176	216	255	295	331	332	333	334	334	336	336	
50	75	114	154	194	233	273	312	324	325	327	328	329	331	333	
75	92	132	172	211	251	290	315	317	319	321	323	324	327	330	
100	110	150	189	229	268	306	309	312	314	316	318	319	324	327	
125	128	167	207	246	286	300	303	306	309	311	314	315	320	324	
150	145	185	224	264	290	295	299	302	305	307	310	311	317	321	
175	163	202	242	279	285	290	294	298	301	304	306	308	314	318	
200	180	220	260	275	281	287	291	294	297	300	303	305	312	316	
225	198	238	265	272	278	283	287	291	294	297	300	302	309	314	
250	216	253	262	269	275	280	284	288	291	294	297	299	306	311	
275	233	251	260	266	272	277	282	285	289	292	294	297	304	309	
300	240	249	258	264	270	275	279	283	286	289	292	294	302	307	
350	238	247	254	260	266	271	275	279	282	285	288	290	298	304	
400	237	245	252	257	263	267	271	275	278	281	284	286	294	300	
450	236	243	249	255	260	264	268	272	275	278	281	283	291	297	
500	235	242	248	253	257	262	265	269	272	275	278	280	288	295	

AIR TEST TABLES

15"

**MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG**

LENGTH OF LATERAL IN FEET 4" DIAMETER	LENGTH OF MAIN LINE IN FEET										15" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	66	128	190	252	314	376	414	415	416	417	418	418	420	421	
50	71	133	194	256	318	380	403	406	408	409	411	412	415	417	
75	75	137	199	261	323	385	393	397	400	402	404	406	410	413	
100	80	141	203	265	327	378	384	388	392	395	397	400	406	409	
125	84	146	208	270	331	369	375	380	385	388	391	394	401	406	
150	88	150	212	274	336	360	367	373	378	382	385	388	397	402	
175	93	155	216	278	340	351	359	366	371	376	380	383	392	398	
200	97	159	221	283	332	343	352	359	365	370	374	378	388	395	
225	102	163	225	287	324	336	345	353	359	365	369	373	384	392	
250	106	168	230	292	317	329	339	347	353	359	364	368	380	388	
275	110	172	234	293	310	323	333	341	348	354	359	364	377	385	
300	115	177	238	287	303	316	327	336	343	349	354	359	373	382	
350	124	135	247	275	292	305	316	325	333	340	346	351	366	376	
400	132	194	242	264	281	295	306	316	324	332	338	343	359	370	
450	141	203	233	255	272	285	298	308	316	324	330	336	353	365	
500	150	199	225	247	264	278	290	300	309	316	323	329	347	359	

LENGTH OF LATERAL IN FEET 6" DIAMETER	LENGTH OF MAIN LINE IN FEET										15" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	72	134	196	257	319	381	411	413	414	416	416	417	419	420	
50	82	144	205	267	329	391	399	402	404	406	408	409	413	415	
75	92	154	215	277	339	383	388	392	395	398	400	402	408	411	
100	102	163	225	287	349	372	378	383	387	390	393	395	402	406	
125	111	173	235	297	352	362	369	374	379	383	386	389	397	402	
150	121	183	245	307	342	352	360	367	372	376	380	383	392	398	
175	131	193	255	317	334	344	353	360	365	370	374	377	387	394	
200	141	203	265	312	325	337	346	353	359	364	368	372	383	390	
225	151	213	275	304	319	330	339	346	353	358	363	367	379	387	
250	161	223	279	298	312	323	333	341	347	353	358	362	374	383	
275	171	233	273	292	306	317	327	335	342	348	353	357	370	379	
300	181	243	268	286	300	312	322	330	337	343	349	353	367	376	
350	201	237	259	277	291	302	312	321	328	334	339	344	359	370	
400	204	231	252	258	282	294	304	312	320	326	332	337	353	364	
450	201	226	245	261	275	286	296	305	312	319	325	330	346	358	
500	199	221	240	255	269	280	290	298	306	312	318	324	341	353	

LENGTH OF LATERAL IN FEET 8" DIAMETER	LENGTH OF MAIN LINE IN FEET										15" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	80	141	203	265	327	389	411	413	414	418	416	417	419	420	
50	97	159	221	283	345	395	399	402	404	408	407	409	413	415	
75	115	177	228	300	362	383	383	392	395	400	400	402	407	410	
100	132	194	256	318	366	373	378	383	387	392	393	395	402	406	
125	150	212	274	336	356	364	370	375	379	385	386	389	397	402	
150	168	229	291	337	348	356	362	368	373	379	380	383	392	398	
175	185	247	309	329	340	349	355	362	366	373	374	378	387	394	
200	203	265	309	323	334	342	349	356	361	367	368	373	383	390	
225	220	282	303	317	328	337	344	350	356	362	364	368	379	386	
250	238	281	292	311	322	331	339	345	351	357	360	364	375	383	
275	256	277	293	307	318	327	334	341	346	353	356	359	372	380	
300	254	274	290	303	313	322	330	336	342	349	352	356	368	377	
350	250	269	283	296	306	315	322	329	335	341	344	349	362	371	
400	248	264	278	290	300	308	316	322	328	335	338	342	356	366	
450	246	261	274	285	294	303	310	316	322	329	332	337	351	361	
500	244	258	270	281	290	298	305	311	317	323	327	331	346	356	

AIR TEST TABLES

18"

**MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG**

LENGTH OF LATERAL IN FEET 4" DIAMETER	LENGTH OF MAIN LINE IN FEET										18" DIAMETER			
	25	50	75	100	125	150	175	200	225	250	275	300	400	500
25	94	183	272	361	450	496	498	499	501	502	502	503	505	506
50	98	187	276	365	454	483	487	489	492	493	495	496	499	502
75	102	191	281	370	459	470	476	480	483	485	488	489	494	497
100	107	196	285	374	450	459	465	470	475	478	481	483	489	493
125	111	200	289	378	438	448	456	462	467	470	474	477	484	489
150	116	205	294	383	427	438	446	453	459	463	467	471	480	481
175	120	209	298	387	416	428	438	445	452	457	461	465	475	481
200	124	213	303	388	406	419	430	438	445	450	455	459	470	478
225	129	218	307	378	397	410	422	431	438	444	449	453	466	474
250	133	222	311	369	388	402	414	426	431	438	443	448	462	470
275	138	227	316	360	380	395	407	417	425	432	438	443	457	467
300	142	231	320	352	372	387	400	411	419	426	433	438	453	463
350	151	240	308	337	358	374	388	399	408	416	422	428	445	457
400	160	249	295	323	345	362	376	388	397	406	413	419	438	450
450	168	246	283	312	333	351	365	378	388	396	404	411	430	444
500	177	237	273	301	323	341	355	368	379	388	396	403	423	438

LENGTH OF LATERAL IN FEET 6" DIAMETER	LENGTH OF MAIN LINE IN FEET										18" DIAMETER			
	25	50	75	100	125	150	175	200	225	250	275	300	400	500
25	99	188	277	366	455	492	495	497	498	499	500	501	503	505
50	109	198	287	376	465	476	481	484	487	489	491	493	497	499
75	119	205	297	386	453	462	468	473	477	480	482	484	490	494
100	129	218	307	396	439	449	456	462	467	470	474	476	484	489
125	139	228	317	406	425	437	445	452	457	462	466	469	478	484
150	149	228	327	397	413	426	435	443	449	454	458	462	473	480
175	158	248	337	385	402	415	425	434	441	446	451	455	467	475
200	168	257	347	375	392	406	417	426	433	439	444	449	462	470
225	178	267	340	365	383	397	409	418	426	432	438	443	457	466
250	188	277	331	356	374	389	401	411	419	426	431	437	452	462
275	198	237	323	348	367	382	394	404	412	419	426	431	447	458
300	208	284	316	341	359	375	387	397	406	414	420	426	443	454
350	228	272	303	328	346	362	375	385	395	403	409	415	434	446
400	224	263	293	316	335	351	364	375	384	392	400	406	426	439
450	219	255	284	307	325	341	354	365	375	383	391	397	418	432
500	215	246	276	298	316	332	345	356	366	375	382	389	411	426

LENGTH OF LATERAL IN FEET 8" DIAMETER	LENGTH OF MAIN LINE IN FEET										18" DIAMETER			
	25	50	75	100	125	150	175	200	225	250	275	300	400	500
25	107	196	235	374	463	490	493	495	497	498	499	500	503	504
50	124	213	303	392	468	473	478	482	483	487	489	491	495	498
75	142	231	320	409	451	458	465	469	474	477	479	482	488	492
100	160	249	338	423	436	445	452	453	463	467	470	473	482	487
125	177	266	355	409	423	433	442	448	454	458	462	466	475	482
150	195	284	373	397	411	422	432	439	445	450	454	458	469	477
175	212	301	366	386	401	413	422	430	437	442	447	451	464	472
200	230	319	356	377	391	404	414	422	429	433	440	445	458	467
225	248	321	348	368	384	396	406	415	422	429	434	439	453	463
250	265	325	341	361	376	389	399	403	416	423	423	433	448	458
275	275	309	334	354	369	382	393	402	410	417	422	428	443	454
300	271	304	325	348	363	376	387	396	404	411	417	422	439	450
350	266	296	319	337	352	365	375	385	394	401	407	413	430	443
400	252	259	311	329	343	356	367	376	384	392	398	404	422	436
450	258	284	304	321	335	348	359	363	376	384	390	396	415	429
500	255	279	298	315	328	340	351	361	369	376	383	389	409	423

AIR TEST TABLES

21"

**MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG**

LENGTH OF LATERAL IN FEET 4" DIAMETER	LENGTH OF MAIN LINE IN FEET											21" DIAMETER		
	25	50	75	100	125	150	175	200	225	250	275	300	400	500
25	126	247	368	490	577	581	582	584	585	586	587	588	590	591
50	130	251	373	494	561	567	570	573	576	578	579	581	584	586
75	135	256	377	498	545	553	559	563	567	569	571	574	579	582
100	139	260	381	503	531	541	548	553	558	561	564	567	573	578
125	143	265	386	503	518	529	537	544	549	553	557	560	568	573
150	148	269	390	488	505	518	527	535	541	546	550	553	563	569
175	152	273	395	475	493	507	518	526	533	538	543	547	558	565
200	157	278	399	462	482	497	509	518	526	531	536	541	553	561
225	161	282	403	450	472	488	500	510	518	524	530	535	548	557
250	165	287	408	439	462	479	492	502	511	518	524	529	544	553
275	170	291	397	429	452	470	484	495	504	511	518	523	539	549
300	174	295	387	420	443	462	476	488	498	505	512	518	535	546
350	183	304	368	402	427	446	462	474	485	493	501	507	526	538
400	192	304	352	386	412	432	448	462	473	482	490	497	518	531
450	201	291	338	372	398	419	436	450	462	472	480	488	510	524
500	209	279	325	360	386	407	425	439	452	462	471	479	502	518

LENGTH OF LATERAL IN FEET 6" DIAMETER	LENGTH OF MAIN LINE IN FEET											21" DIAMETER		
	25	50	75	100	125	150	175	200	225	250	275	300	400	500
25	131	253	374	495	572	576	579	581	582	584	585	586	588	589
50	141	262	384	505	552	559	563	567	570	573	574	575	581	584
75	131	272	394	515	533	543	549	554	559	562	565	567	574	578
100	161	282	403	501	516	528	536	542	548	552	555	559	567	572
125	171	292	413	483	501	514	524	531	537	542	547	550	561	567
150	181	302	423	468	487	501	512	521	528	533	538	543	554	562
175	191	312	425	454	474	490	501	511	518	525	530	535	548	557
200	201	322	412	441	462	479	491	501	510	517	522	528	542	552
225	210	332	399	429	451	468	482	492	501	509	515	521	537	547
250	220	342	388	418	441	459	473	484	493	501	508	514	531	542
275	230	336	378	409	432	450	464	476	486	494	501	508	526	538
300	240	327	369	399	423	441	456	468	479	487	495	501	521	533
350	255	312	353	383	407	426	441	454	465	474	482	490	511	525
400	246	300	339	369	393	412	428	441	453	462	471	479	501	517
450	239	290	327	357	380	400	416	429	441	451	460	468	492	509
500	234	281	317	346	369	389	405	419	431	441	450	439	484	501

LENGTH OF LATERAL IN FEET 8" DIAMETER	LENGTH OF MAIN LINE IN FEET											21" DIAMETER		
	25	50	75	100	125	150	175	200	225	250	275	300	400	500
25	139	260	381	503	569	573	576	578	580	582	583	584	587	588
50	157	278	399	520	546	554	559	563	566	569	571	573	579	582
75	176	295	417	513	526	536	543	549	554	557	560	563	571	575
100	192	313	434	493	508	520	529	536	542	546	550	554	563	569
125	209	331	452	476	493	506	516	524	531	536	540	545	556	563
150	227	348	436	461	479	493	504	513	520	526	531	536	549	557
175	245	366	422	447	466	481	493	502	511	517	523	528	542	552
200	262	375	409	435	455	470	483	493	502	509	515	520	536	546
225	280	364	398	424	444	461	473	484	493	501	507	513	530	541
250	297	355	389	415	435	451	465	476	485	493	500	506	524	536
275	298	347	380	406	425	443	456	468	478	486	493	499	518	531
300	293	340	372	398	412	435	449	460	470	479	486	493	513	525
350	285	328	359	384	404	421	435	447	458	466	474	481	503	517
400	279	319	348	372	392	409	423	435	446	455	463	471	493	509
450	274	311	338	362	381	398	413	425	435	445	453	481	484	501
500	270	304	330	353	372	389	403	415	426	436	444	452	476	493

AIR TEST TABLES

24"

**MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE
TO DROP FROM 3-1/2 TO 2-1/2 PSIG**

LENGTH OF LATERAL IN FEET 4" DIAMETER	LENGTH OF MAIN LINE IN FEET										24" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	163	321	480	638	662	665	667	669	670	671	672	673	674	676	
50	167	326	484	637	645	650	654	658	660	662	664	665	669	671	
75	172	330	488	617	629	636	642	647	650	653	656	658	663	666	
100	176	334	493	599	613	623	631	637	641	645	648	650	658	662	
125	180	339	497	582	599	611	620	627	632	637	640	643	652	658	
150	185	343	502	567	585	599	609	617	623	629	633	636	647	653	
175	189	348	506	552	573	588	599	608	615	621	626	630	642	649	
200	194	352	506	538	560	577	589	599	607	613	619	623	637	645	
225	198	356	492	525	549	566	580	591	599	606	612	617	632	641	
250	202	361	478	513	538	556	571	582	591	599	605	611	627	637	
275	207	365	465	501	528	547	562	574	584	592	599	606	622	633	
300	211	370	454	491	518	538	554	567	577	585	593	599	617	629	
350	220	375	432	471	499	521	538	552	563	573	581	588	608	621	
400	229	356	413	433	482	505	523	538	550	560	569	577	599	613	
450	238	340	397	436	467	491	509	525	538	549	558	566	590	606	
500	244	326	382	422	453	477	497	513	526	538	548	556	582	599	

LENGTH OF LATERAL IN FEET 6" DIAMETER	LENGTH OF MAIN LINE IN FEET										24" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	126	327	485	644	656	660	663	665	667	668	669	670	673	674	
50	178	337	495	624	634	641	646	651	654	656	658	660	665	668	
75	188	347	505	600	614	624	631	637	641	645	648	650	658	662	
100	198	356	515	579	596	608	617	624	630	634	638	641	650	656	
125	208	366	525	559	579	593	603	612	618	624	629	632	644	651	
150	218	376	511	542	563	579	591	600	608	614	619	624	637	645	
175	228	386	493	526	548	566	579	589	598	605	611	616	630	640	
200	238	396	477	511	535	553	567	579	588	596	602	608	624	634	
225	248	406	462	497	522	542	557	569	579	587	594	600	618	629	
250	257	397	449	485	511	531	547	559	570	579	586	593	612	624	
275	267	385	437	473	500	521	537	550	561	571	579	586	606	619	
300	277	374	426	462	490	511	528	542	553	563	571	579	600	614	
350	283	356	406	443	471	493	511	526	538	549	558	566	589	605	
400	272	340	389	426	454	477	495	511	524	535	545	553	579	596	
263	263	327	375	411	439	462	481	497	511	523	533	542	569	587	
500	255	316	362	398	426	449	468	485	499	511	521	531	559	579	

LENGTH OF LATERAL IN FEET 8" DIAMETER	LENGTH OF MAIN LINE IN FEET										24" DIAMETER				
	25	50	75	100	125	150	175	200	225	250	275	300	400	500	
25	176	334	493	645	652	656	659	662	664	666	667	668	671	673	
50	194	352	510	615	627	633	641	645	649	652	654	636	662	666	
75	211	370	528	589	604	615	623	630	635	639	642	645	653	659	
100	229	387	541	566	584	597	607	615	622	627	631	635	645	652	
125	246	405	519	546	566	581	592	602	609	615	620	625	637	645	
150	264	422	499	528	550	566	579	589	597	604	610	615	630	639	
175	282	436	482	512	535	553	566	577	586	594	600	606	622	633	
200	299	421	467	498	522	540	554	566	576	584	591	597	615	627	
225	317	408	453	485	509	528	543	556	566	575	583	589	608	621	
250	331	396	441	473	498	517	533	546	557	566	574	581	602	615	
275	324	386	430	462	487	507	523	537	548	558	566	573	595	610	
300	317	377	421	452	478	498	514	528	540	550	559	566	589	604	
350	307	362	404	435	460	481	498	513	525	535	544	553	577	594	
400	298	350	390	420	445	466	483	498	511	522	532	540	566	584	
450	292	340	378	407	432	453	470	485	498	510	520	529	536	575	
500	286	331	367	396	471	441	459	474	487	498	509	518	547	567	

AIR TEST TABLES 27"-30"-33"
MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR
PRESSURE TO DROP FROM 3-1/2 TO 2-1/2 PSIG

		PIPE DIAMETER											
		4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"
LENGTH OF LINE IN FEET	25	4	10	18	28	40	62	89	121	158	200	248	299
	50	9	20	35	55	79	124	17	243	317	401	495	599
	75	13	30	53	83	119	186	267	364	475	601	743	898
	100	18	40	70	110	158	248	356	485	634	765	851	935
	125	22	50	88	138	198	309	446	595	680			
	150	26	59	106	165	238	371	510					
	175	31	69	123	193	277	425						
	200	35	79	141	220	317							
	225	40	89	158	248	340							
	250	44	99	176	275								
	275	48	109	194	283								
	300	53	119	211									
	350	62	139	227									
	400	70	158										
	450	79	170										
	500	88											
	550	97											
	600	106											
	650	113	170	227	283	340	425	510	595	680	765	851	935

NOTE: TO BE USED WHEN TESTING ONE DIAMETER ONLY

AIR TEST TABLES
MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR
PRESSURE TO DROP FROM 3-1/2 TO 2-1/2 PSIG

		PIPE DIAMETER													
		4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"
LENGTH OF LINE IN FEET	25	40	10	18	28	40	62	89	121	158	200	248	299	356	
	50	90	20	35	55	79	124	178	243	317	401	495	599	713	
	75	13	30	53	83	119	186	267	364	475	601	743	898	1020	
	100	18	40	70	110	158	248	356	485	634	765	851	935		
	125	22	50	88	138	198	309	446	595	680					
	150	26	59	106	165	238	371	510							
	175	31	69	123	193	277	425								
	200	35	79	141	220	317									
	225	40	89	158	248	340									
	250	44	99	179	275										
	275	48	109	194	283										
	300	53	119	211											
	350	62	139	227											
	400	70	158												
	450	79	170												
	500	88													
	550	97													
	600	106													
	650	113	170	227	283	340	425	510	595	680	765	851	935	1020	

NOTE: TO BE USED WHEN TESTING ONE DIAMETER ONLY

AIR TEST TABLES **36" – 108"**
MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR
PRESSURE TO DROP FROM 3-1/2 TO 2-1/2 PISG

LENGTH OF LINE IN FEET	36"	39"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"
	25	356	418	485	634	802	990	1198	1425	1673	1940	2228
50	713	837	970	1268	1528	1698	1868	2038	2207	2372	2547	2717
75	1020	1105	1189	1358								
100												
125												
150												
175												
200												
225												
250												
275												
300												
350												
400												
450												
500												
550												
600												
650	1020	1105	1189	1358	1528	1698	1868	2038	2207	2372	2547	2717

NOTE: TO BE USED WHEN TESTING ONE DIAMETER ONLY

LENGTH OF LINE IN FEET	102"	108"
	25	2861
50	2887	
650	2887	3056

2. Sanitary Sewer Field Tests

Sanitary sewers shall be tested under low air pressures listed on the following tables after completion of backfill and approval of the compaction. Inspect sewers and manholes prior to testing and eliminate discernible water leaks and debris. The Contractor may perform preliminary tests at his own discretion for his information, without the presence of the Engineer, at no cost to the City. The Contractor shall schedule the proposed tests with the Engineer at least 48 hours in advance. Tests shall be performed in the presence of the Engineer or his duly authorized representative. Pressure gauges and stop watches will be furnished by the Engineer. All other material, equipment and labor required shall be provided by the Contractor. Test sewers from manhole to manhole or from manhole to terminus.

Conduct tests as follows: Provide tests plugs at each manhole, securely braced. Provide suitable means of determining depth of groundwater level above the inverts immediately before testing. The engineer will increase gauge pressures accordingly. Add air slowly to the portion of the pipe being tested until internal air pressure is at a test pressure of 4 psi above the invert or above the groundwater table, whichever is greater, or pressure equal to the hydraulic gradient, whichever is greater. Do not allow personnel in manholes after increasing air pressure. If, in the engineer's opinion, there is any indication of leakage at the test plug, relieve the pressure before taking steps to eliminate the leak. Maintain test pressure for a minimum of two minutes, then disconnect hose and compressor. If pressure decreases to 3.5 psi, record the time required for the pressure to drop one psi from 3.5 to 2.5 psi. Pipes failing to maintain minimum acceptable holding times set forth in the tables included herein will not be accepted. Make repairs or replacement as required at no cost to the City and retest as specified herein.

TV inspections to identify deficiencies including blockages, sags, cracks, incorrect fittings, etc. will be conducted by the City for all public sewer during the following phases of construction;

- **Inspection of the sewer main lines and all laterals prior to the placement of base paving (Base Phase)**
- **Inspection of the sewer laterals from the clean-out to the main line, including dumping water into the lateral to check for sags, prior to issuance of certificate of occupancy (C/O Phase)**
- **Inspection of the sewer main lines prior to placement of top coat of paving and final acceptance. This phase will inspect for blockages and major defects in the main including cracks, busted pipe, blockages, or sags holding greater than ½ inch of water.**

The aforementioned inspections (1 per Phase) are included under the Grading/Public Improvements Permit inspection fees. The contractor will be required to correct any and all defects at the contractor's expense and subsequent reinspections will be required until all defects have been corrected.

Sewer lines and manholes are required to be clean (jet sprayed by the contractor, if necessary) prior to TV inspection. Any sewer line found to be dirty (mud, gravel, obstructions, etc.) during the TV inspection process must be cleaned by the contractor prior to re-inspection by the City.

Any reinspections shall require the payment of a reinspection fee at the current rate as adopted by the Mayor and Board of Aldermen. For City contracts, the cost of additional tests and reinspections will be deducted from the monies owed the Contractor.

3. Pressure Tests for Force Mains

The Contractor shall provide equipment for and conduct pressure tests under pressures indicated on the plans. Pressure recorder, charts and water meter for testing will be furnished by the City. Set up testing equipment in accordance with the Standard Detail for testing watermains. Tests conducted on ductile iron pipe shall meet requirements of AWWA C-600. Tests conducted on concrete pipe shall meet requirements of AWWA C-600, modified as per AWWA Manual M II.

Test pipe after completion of backfill operations in lengths directed by the engineer. Close ends of test sections with valves or plugs, where possible, or provide test plugs.

Fill the length of the force main under test with water and subject it to the maximum sustained internal pressure plus water hammer at the low point as indicated in the Contract Documents. Maintain pressure for a minimum of two hours. City personnel will operate all valves in the test section during this portion of the test.

Should test results show any visible leakage, displacement or damage, the Contractor shall repair the leakage, displacement or damage and retest until specified conditions are met, to the satisfaction of the engineer, at no cost to the City.

The maximum allowable leakage shall be determined from the following formula:

$$L = \frac{NDP}{3700}$$

L = allowable leakage in gallons per hour

N = number of joints in length of pipe tested

D = nominal diameter of pipe in inches

P = average test pressure during the test in psi

4. Inspection and Testing of Pipe

The engineer may inspect and test all pipe, fittings and joint material upon delivery to the site or at the factory. The pipe manufacturer or supplier shall furnish materials to be tested and labor as required to assist the engineer with the tests.

Manufacturer or supplier shall provide ample space between rows of stockpiled pipe to facilitate adequate inspection.

The pipe manufacturer or supplier shall provide the City Materials Inspector, prior to commencing the inspection of pipe for an order with the complete City contract number, contractor's name, the pipe diameters, classes and designs and footage of pipe needed to fill the order.

The pipe manufacturer or supplier shall provide evidence to the City Materials Inspector, prior to inspection, that there is an adequate quantity of pipe available of the required diameters, classes and designs for inspection.

The pipe manufacturer or supplier shall provide facilities for conducting load-bearing test.

The pipe manufacturer or supplier shall provide competent personnel for the preparation and conducting of hydrostatic and load bearing tests. The City Materials Inspector has the right to be present during all phases of testing.

For reinforced concrete pipe furnished under this Section, provide test specimens, selected at random from production pipe, to the City Materials Inspector.

Provide up to 1/2 of one percent of the number of pipes to be furnished for each size, but no less than two test specimens for each size and class for the load bearing test. Where hydrostatic tests are required, conduct such tests concomitant with the load bearing tests, using two pieces of pipe jointed together, of the same size, class and production run, load bearing test specimens will not be accepted for incorporation into the work.

Precast concrete manhole requirements are specified in Section 02700.

5. Deflection Test, PVC Pipe:

At any time beyond thirty (30) days after final backfill of the trench and prior to the expiration of one (1) year the sewer lines shall be checked for deflection. Vertical deflection tests shall be performed on all of the PVC pipe installed. The Contractor shall conduct the tests under the observation of the Engineer and shall furnish all test equipment and labor for conducting the tests. Deflections of five percent (5%) or greater of the inside pipe diameter shall be considered unacceptable and such pipe shall be replaced by the Contractor at his expense. The deflection shall

be checked by pulling a cylinder, sphere, or measuring device through the pipe.

C. Submittals

Submit shop drawings labeled with the City Contract Number, Contractor's name, project name and location, title, drawing number, revision number and date of drawing and revisions for the following:

Nonreinforced concrete pipe; show strength, joint and gasket dimensions, and conformance to pertinent ASTM Specifications.

Reinforced concrete pipe; show strength, details of special fittings, reinforcing dimensions and details and joint and gasket dimensions.

For pipe designated in the Plans by D loads, furnish calculations signed by a Professional Engineer registered in the State of Maryland, or an officer, or a duly authorized representative of the pipe designs required by ASTM C655.

Furnish laying schedules for all curved and beveled pipe and where indicated.

Joint openings specified in the laying schedule for sanitary sewers shall not exceed one half inch.

Limit bevels to 4 –1/2 degrees for all beveled pipe.

Precast concrete manholes are specified in Section 02720.

Shop drawing requirements for concrete pipe and manholes will be materials furnished under this Section. Certifications shall include City contract number, job location, contractor's name, types, classes and strengths of pipe, and pipe manufacturer.

Submit certified tests reports before delivery of materials for all materials furnished under this Section. Certifications shall include City contract number, job location, contractor's name, types, classes and strengths of pipe, and pipe manufacturer.

At the option of the Engineer, the Contractor shall, in addition to or in lieu of the above specified certified tests reports, furnish certificates of compliance from the manufacturer.

A packing list or invoice shall accompany every shipment and shall contain the following information: City contract number, kind and class of pipe, length and other pertinent information.

Alternate precast concrete structures.

The Contractor may, at his option, provide precast concrete structures in lieu of the cast-in-place concrete or masonry structures shown on the Standard Details on the Plans. Precast manholes and inlets to be indicated on standard drawings.

Submit working drawings including calculations, design loads, materials, strengths and sizes and thicknesses.

D. Test Criteria

Cast iron soil pipe shall withstand pressures as set forth in the applicable referenced specifications referred to herein.

All other pipe for sewers shall withstand internal hydrostatic pressure of ten psi (10) for ten minutes with no leakage. Moisture appearing in the form of patches or beads which results in runs on pipe walls will not be considered as leakage, provided the pipe walls appear dry upon retesting at the prescribed test pressure after elapse of maximum 24 hours. Do not apply pressure during the period between the test and the retest. Provide hydrostatic tests for reinforced concrete pipe for sewers in accordance with ASTM C497.

Acceptance of reinforced concrete pipe will be based on the Plant Load-Bearing Tests, Materials Tests and Inspection of Manufactured Pipe for Visual Defects and Imperfections and stipulations as set forth in appropriate ASTM specification and modified herein.

Polyvinyl chloride (PVC) pipe 6 inches through 15 inches in diameter shall conform to the requirements of ASTM D3034 and referenced ASTM documents.

Delete all referenced to agreements between seller and purchaser on the referenced ASTM Standard.

Criteria for sampling, inspection shall be specified in Paragraph I.B.3. Criteria for retest and rejection shall be as specified below:

Retest and Rejection:

Upon failure of any specimen tested to meet requirements set forth herein and in the referenced ASTM documents, the City Materials Inspector will randomly select and test two additional samples from the same production run of the pipe originally tested.

Failure of either of these two additional samples to meet the referenced requirements shall be cause for rejection of the remainder of that production run.

2. Materials

A. Contractor's Options

For house connections, furnish either PVC pipe or cast iron soil pipe, service weight of the size indicated.

House connection renewals, including drop connections, shall be 4 or 6 inch PVC or cast iron soil pipe.

For main line sewers less than 15 inches in diameter, unless otherwise indicated, furnish either PVC pipe, thickness classification SDR-26 or concrete sewer pipes extra strength.

For main line sewers 15 inches in diameter and larger, furnish either PVC pipe meeting requirements of ASTM F 679 and Reference Standards or reinforced concrete pipe, class as indicated.

Prestressed concrete pipe and fittings may be supplied in lieu of reinforced concrete pipe provided it meets design, quality control and test requirements of ASTM C76 as modified and supplemented herein.

B. Materials Requirements

1. Pipe and Fittings

General – All pipe and fittings between structures or between structure and terminus shall be of the same size and material and shall be furnished by the same manufacturer. Each pipe length shall be clearly marked at intervals of five feet maximum with the manufacturer's name or trademark, pipe size, PVC cell classification, appropriate legend such as SDR-26 PVC Sewer Pipe, ASTM D3034, manufacturer's lot number, date of manufacture and point of origin. Pipe not marked as indicated herein may be rejected.

Polyvinyl chloride pipe and fittings shall meet ASTM Standard D3034 in sizes 4 inch through 15 inch and ASTM F679 in sizes 18 inch through 27 inch, except as modified herein. Joints for PVC pipe and fittings shall conform to ASTM D3212 and Reference Standards.

Fittings shall have SDR-26 minimum wall thickness for sewer main fittings and SDR-26 or SDR-35 for cleanout connection fittings as shown on Detail SS-2. Fittings in sizes 4 inch through 8 inch shall be molded in one piece with minimum socket depth as specified in Section 7.3.2 of ASTM D3034 and a gasket cross sectional area minimum of 0.20 square inches. Fittings 10 inches and larger shall conform to Section 7.22 of ASTM D3034.

Pipe with blisters, bubbles, cuts or scrapes on inside or outside surfaces, which appreciably damage the wall thickness, or other imperfections which impair the performance or life of the pipe, may be rejected.

Cast iron soil pipe and fittings shall meet requirements of ASTM A74, service weight, furnished in five and ten foot lengths, single or double hub as required. Hydrostatic tests will not be required. Joints shall be lead or neoprene compression gaskets, TySeal of Tyler Pipe, Dual-Tyte of Charlotte Foundry or equal. Provide plain beveled end with centering recess in the hub for use with gasket joint.

Circular reinforced concrete pipe and fittings shall meet requirements of ASTM C76 as modified herein.

Pipe shall be substantially free from surface roughness. The interior walls shall be substantially a smooth surface and be free from noticeable and harmful ridges, corrugations, elevations and depressions. The finished surface shall also be free of any material which is not an integral part of the compacted concrete, such as loose aggregate, cementitious slurry coats, silts, cement and non-required markings.

Pipe shall be tested to the 0.01-inch crack and to the specified ultimate load.

In pipes with belled ends, extend longitudinal steel so as to form supports for holding circumferential steel in place, and so form as to provide bell reinforcement with adequate concrete cover. Extend longitudinal reinforcement to within one inch from both terminal ends of pipe. Provide horizontal (circumferential) reinforcement at end reinforcement at maximum 1-1/4 inches on center.

Pipe for sanitary sewers shall have bell and spigot ends with rubber gaskets joints meeting requirements of ASTM C361. Lifting holes will not be permitted.

Pipe for storm drains shall have ends suitable for standard mortar or mastic joints. Lifting holes will be permitted.

Non-float concrete pipe shall meet the requirements specified above and the following:

Outside diameter shall be increased so that the pipe contains sufficient concrete to resist flotation with the pipe empty and uncovered. Increased thickness shall be homogeneous or heterogeneous of same concrete f'c as contiguous pipe and reinforced as required to prevent shrinkage and temperature cracks.

Joints shall be interchangeable with those of the contiguous sewer pipe.

Reinforced concrete elliptical pipe and fittings for storm drains shall meet requirements of the ASTM C507 as modified herein.

Pipe shall be substantially free of surface roughness. The interior walls shall be substantially a smooth surface and be free from noticeable and harmful ridges, corrugations, elevations and depressions. The finished surface shall be free of any material which is not an integral part of the compacted concrete such as loose aggregate, cementitious slurry coats, silt, cement and non-required markings.

Pipe shall be tested to the 0.01-inch crack load and then to the specified ultimate strength.

Pipe shall have ends suitable for standard mortar or mastic joints. Lifting holes will be permitted.

Reinforced concrete pipe designated on the plans by D loads shall meet requirements of ASTM C655 as modified herein.

Pipe shall be tested to the 0.01 inch crack load and the to the ultimate load specified.

Perform absorption tests as specified in ASTM C76.

In addition to causes for rejection set forth in ASTM C655, pipe shall be subject to rejection for the following causes:

Surface defects indicated honeycombing.

Joints for sanitary sewers shall meet requirements specified elsewhere herein. Pipe for storm sewers shall have ends suitable for standard mortar or mastic joints.

At PVC house connection to main of another material, provide approved coupling or adapter as required for watertight seal as directed by the Engineer.

Provide watertight plug on PVC house connection at property line.

Pipe stronger than that designated may be furnished provided such pipe meets or exceeds in all other respects the requirements specified herein.

Ductile iron pipe for force mains shall meet requirements set forth in Section 02660 of these specifications.

Cast in place concrete shall be as specified in Section 03300 of these specifications, class as indicated in the Standard Details and the Plans.

Manhole Adapters:

PVC manhole adapters shall be Vassallo, or approved equal, as shown on Details SS-23a and SD-14a.

Stoppers:

Stoppers for concrete sewers from six to twelve inches shall be concrete with a spigot end for a rubber gasket for installation in the bell end of the stub or terminating line.

Stoppers for concrete sewers 15 inches and larger shall be concrete as described elsewhere herein or metal. Provide brick bulkheads when directed by the Engineer.

Stoppers for all other types of pipe shall be watertight and of an approved design as furnished by the pipe manufacturer.

Granular bedding material is specified in Section 02200 of these specifications.

Precast concrete manholes are specified in Section 03480 of these specifications.

Castings shall meet the following requirements:

Manhole steps shall be of the size and spacing shown on the Standard Detail and shall conform to the requirements of ASTM C478 as supplemented herein:

Exposed materials shall be resistant to corrosion and deterioration.

Cast iron steps shall meet requirements of ASTM A-48, Class 30-A.

Threads shall have a non-slip surface.

Manhole and lamp hold frames, covers, inlet frames and grates shall be grey iron as specified in Section 05500 of these specifications. All manholes located in 100-year floodplains or in stormwater spread areas in roadways shall be watertight.

Miscellaneous metal connectors and appurtenances shall be in accordance with requirements set forth in elsewhere in these specifications and the Standard Details and Plans.

Jointing mastic shall be an elastic, water resistant formulation of plastic bituminous materials and invert fillers so combined that when applied to a vertical metal surface and heated to 120° F, the jointing mastic will neither slump nor lose plasticity. When applied directly from the container without further fixing the jointing mastic can be applied in an even, adherent coat within the temperature range of 20° to 100° F.

Mortar for pipe joints shall consist of one part Portland cement and two and one-half parts of volume of mortar sand conforming to ASTM C144. Mortar shall be used within one hour after addition of the water.

Masonry work shall be as specified in Section 04200 of these specifications.

Filter cloth for under drain system shall be woven or nonwoven polypropylene cloth, rot proof and resistant to chemical conditions.

Drainage stone for under drain system shall be well graded coarse aggregate MSHA SRC gradation 6.

Asphalt based waterproof coating for exterior of manholes shall be mineral filled solvent type meeting requirements of MIL-C-82052.

Quick setting non-shrink grout shall conform to requirements of Corps of Engineers CRD-588, octocrete, speedcrete or equal.

Flexible plastic gasket between manhole and manhole frame shall be extruded rope type B, in accordance with AASHTO M-198, butyle based, 3/4 inch diameter minimum.

Expansion joint filler shall be Type 1 in accordance with ASTM D-1752.

3. Execution

A. Preparation

Trench excavation and backfill shall be as specified in Section 02200 of these specifications. Before commencing excavation at each location, dig test pits as directed by the Engineer to determine the adequacy of the grade from the mainline sewer to the property line, thence to the house to be served. Should the grade be inadequate, notify the Engineer and do not proceed with that connection until resolution of the problem. Excavate tests pits as specified elsewhere in these specifications, sufficiently in advance of trench construction so that reasonable changes in line and grade can be made where the location of existing structures varies from that shown. Completely excavate sufficient trench to assure that no unforeseen obstructions exist before commencing pipe installation. Work occasioned by failure to take such precautions shall be performed at no cost to the City.

Provide Granular bedding material under all storm drain and sanitary sewer pipe in accordance with the Standard Details and as specified in Section 02200 of these specifications. Provide encasement and/or concrete cradle where indicated on the Plans. Insure that pipes are well bedded.

B. Laying Pipe

Lay pipe to a true uniform line and grade as indicated with continuous bearing of barrel on cradle or bedding material. Handle pipe and fittings with care so as to avoid damage. Where indicated, provide erosion checks or concrete anchors in accordance with the Standard Details.

Lay pipe up-grade with the bell or groove pointing in the direction of upstream. Lay each section of pipe in such a manner as to form a close concentric joint with the adjoining section and to prevent sudden offsets in the flow line. The spigot end of each pipe shall be fully inserted into the bell until it is fully home.

Construct mitered and curved bends where indicated in accordance with the Standard Details and the Plans. Curved bends shall have a uniform interior radius.

Construct curves for sanitary sewers by use of beveled pipe, short lengths and by opening of joints in accordance with the following table:

<u>Pipe Size</u>	<u>Maximum Joint Opening</u>
thru 36"	1/2"
42" thru 60"	3/4"
66" thru 102"	1"
108" thru 144"	1-1/4"

Construct curves for storm sewers by use of beveled pipe, short lengths, and joint openings not to exceed 1/3 the pipe joint depth.

For any pipe size less than or equal to 24", beveled pipe shall be used.

Place sufficient backfill on each section of pipe, as it is laid to hold firmly in place.

Place circular reinforced concrete pipe with elliptical reinforcement so that the mark which delineates the minor axis of the reinforcing is centered on the top of the pipe, and is easily visible from the top of the trench.

Clean out the interior of the pipe as the work progresses. Utilize a suitable swab or drag in small diameter pipe and pull forward past each joint immediately after the jointing has been complete.

Keep trenches and excavations free of water during construction and until final inspection. When the work is not in progress, securely close open ends of pipe and fittings to prevent trench water, earth or other substances from entering the pipes or fittings.

Provided a minimum of 42" of cover over polyvinyl chloride, ABS and concrete pipe.

C. Sewer House Connection

Provide sewer house connections and sewer drop house connections where indicated in accordance with the Standard Details.

Where possible, place house connections simultaneously with construction of new main line sewer before backfilling main line sewer.

Lay house connection pipe at a 2 % grade, unless otherwise indicated on plan. Excavate 5 to 10 feet beyond end of mains and sewer house connections on minimum percent grade to ensure that no rock is encountered.

Terminate house connection pipe at property line with bell end an approved plastic plug and a cleanout.

D. Joints

Mastic Joints for Concrete Storm Drain:

Bell and spigot joints – clean the interior surface of the bell thoroughly then fill the lower portion of the bell with sufficient thickness of mastic to make the inner surfaces of the abutting sections flush. Fit the spigot end of the adjoining pipe into the bell so that the sections are closely fitted and aligned. Apply sufficient jointing mastic to fill the remaining void in the joint. Clean off excess mastic from the interior of the pipe. Utilize a suitable swab or drag in small diameter pipe and pull forward part of each joint immediately after the jointing has been completed.

Tongue and groove joints – clean the groove thoroughly then apply mastic to the lower half of the groove. Clean the tongue of next pipe and apply a layer of mastic to the upper half. Fit the tongue into the groove until the pipes are

closely fitted and aligned and the mastic is squeezed out onto the inner and outer surfaces. Clean off excess mastic from the interior of pipe.

Mortared Joints for Concrete Storm Drain:

Bell and spigot joints – where pipe cradle is aggregate place a shallow bed of mortar under the joint. Thoroughly wet the bell and fill the lower half with mortar. Thoroughly wet the spigot and uniformly fit into the bell so that the sections are closely fitted and aligned. Fill the remaining annular space in the bell with mortar sufficient to form a bead around the outside of the spigot end of the pipe. Remove excess mortar from the interior of pipe and finish exterior and interior to smooth surfaces.

Tongue and groove joints – thoroughly wet the groove then apply mortar to the lower half of the groove. Thoroughly wet the tongue of the next pipe and apply a layer of mortar to the top half. Fit the tongue into the groove until the pipe are closely fitted and aligned and the mortar is squeezed onto the inner and outer surfaces of the joint. Clean off the inner surface of the pipes at the joint and point up the outside with a bead of mortar.

Joints for Concrete Sanitary Sewer:

Prior to joining pipe, liberally coat pipe joints with lubricant. Fit the bell or spigot with gasket according to manufacturer's instructions. Join the pipes with equipment designed for the purpose. Before the joint is completely home, check the position of the gasket using a suitable gauge. If the gasket is found to be dislocated, repeat the entire joining process using a new gasket. The rubber gasket shall be the sole element relied upon for water tightness.

For pipe with steel end ring joints, after the joining has been complete, completely fill the exterior joint spaces with mastic or mortar. Fill interior joint spaces of such pipes 30 inches and larger in diameter with mastic or mortar and remove excess material from the inside of the pipe.

Joints for Vitrified Clay Pipe:

Joints for polyvinyl chloride pipe shall be elastomeric gasket joint assembled with the manufacturer's recommendations. When installing pipe, push spigot end home in bell of receiving pipe.

Immediately before joining vitrified pipe, liberally coat the bell with lubricant for pipe joints and fit the spigot with a gasket.

Join pipes using equipment designed for the purpose.

Joints for cast iron pipe for main line sewers shall be as specified in Section 02660.

Joints for cast iron soil pipe for house connections shall be lead as specified in Section 02660, or neoprene compression gaskets as specified hereinbefore.

E. Connections with Existing Systems

Sanitary Systems:

Connect sewer house connections to main lines according to Standard Details.

Installation of saddles of tapping of existing mains shall be performed by City personnel only.

Storm Drain:

Provide field connections in accordance with the Standard Details and the Plans. Provide a smooth finish on the interior of the connections.

Abandoned storm drain systems, when encountered during the work, shall be bricked shut or otherwise closed in a manner acceptable to the Engineer.

Sewer Manholes:

Tightly mortar in pipe to manholes 48" and larger with quick setting non-shrink grout.

F. Brick Construction

Perform brick construction as specified in Section 04200 for Utility Structures, in accordance with Standard Details and the Plans.

G. Manholes.

Manholes shall be watertight. Coat exterior of brick manholes with one-half (1/2) inch coating to the limits indicated on the Standard Details.

Construct manholes of precast sections, cast in place concrete, or brick in accordance with Standard Details and the Plans. Place axis of manholes directly over the centerlines of the pipes unless otherwise shown.

Construct appropriate flow channels in the bottom of manholes, as shown on the Standard Details and the plans and specified herein below:

Sewer manhole – line channels in bottom with brick up to the crown of the pipes.

Storm drain manhole – line channels with brick up to the crown of the pipes.

Cut the pipe three inches from the inside face of the structures. When installing ABS or PVC pipe one of the adapters, as described herein above for connection to manholes, shall be provided and installed per the Standard Detail or in accordance to manufacturers procedure using quick setting non-shrink grout. All other pipe shall be directly mortared into the manhole opening with non-shrink grout.

In storm manholes, provide a mortar joint between the pipe and structure. Provide blank connections or stubs not less than 16 inches in length where indicated and provide a watertight stopper which shall be easily removable.

In manholes 48 inch or larger, tightly mortar in pipe with quick setting non-shrink grout.

Manhole Frames and Covers: All manhole frames and covers (sanitary and storm drain) shall be bolted to the top section of the structure using 5/8 inch all thread dowels and non-shrinking grout unless otherwise directed.

H. Storm Drain Inlets

Construct inlets of cast in place concrete or precast sections, concrete block or brick in accordance with the Standard Details and the Plans after grading has been substantially completed as determined by the engineer.

Inlet inverts may be of brick, cast-in-place concrete or air entrained Type II sloped towards outlet pipe on terminal inlets. Provide brick bottom channel in through inlets.

Cut the pipe flush with the inside wall of the structure. Provide a mortar joint between the pipe and structure. Provide blank connections or stubs with a minimum length of sixteen (16) inches, free of leakage, where indicated, and provide a watertight stopper, which shall be easily removable.

Install manhole steps, frame and grate or cover to proper grade.

I. Underdrain Systems

Construct under drain systems where indicated on the plans or where directed by the Engineer. Excavate trench to dimensions indicated and lay filter cloth so as to result in a one foot overlap on the top of the under drain system. Place gravel to the pipe invert where pipe is required. Lay pipe with joints not less than one fourth (1/4) inch and not more than one half (1/2) inch in width. Protect upper end of pipe against the entrance of foreign matter and close with a permeable membrane after completion of pipe laying. Place remaining gravel to the elevation indicated on the plans or designated by the Engineer. Lay filter cloth across top of gravel and complete backfilling operations.

J. Sewer House Connection Renewals

Utilize existing tap at main line unless otherwise directed by the Engineer. Otherwise, abandon existing tap and retap utilizing proper sized saddle or thimble or cut in a tee or wye branch; or remove the existing tamp and cut in an additional tee, as determined by the Engineer, resulting in a watertight joint without jointing collars.

Plug abandoned existing house connections and taps which have been replaced by utilizing approved watertight plugs.

Retap the main line as follows:

Tapping shall be performed by the Contractor.

Where indicated or directed by the Engineer, tap directly into manholes for sewer house connections. Cut through manhole wall and make connection as per Detail SS-23a. Seal sleeve in opening with quick setting concrete so as to make a watertight connection.

Provide cleanouts installed at the property line for all sewer connection renewals in accordance with the Standard Details.

K. Abandonment

Storm sewers under thirty six (36) inches in diameter:

Construct bulkheads of minimum nine (9) inches brick masonry or 2500 psi concrete at structures and at cut ends

Sanitary sewers under thirty six (36) inches in diameter:

Unearth main at manhole and disconnect pipe.

Brick shut pipe opening at manhole and bulkhead disconnected pipe with minimum nine (9) inches bulk masonry or 2500 psi concrete.

Sanitary sewers thirty six (36) inches and over in diameter, use one of the following:

Remove the sewer completely. Brick shut pipe opening at manholes with a minimum of eight (8) inches brick masonry. Waterproof masonry plug and immediate area outside manhole with cement mortar plastered one half (1/2) inch thick followed by two (2) coats of asphalt based coating.

Unearth sewer main at the manholes and remove the pipe for a minimum of ten (10) feet from the face of the manholes. Brick shut pipe opening at manholes with a minimum of eight (8) inches brick masonry. Waterproof masonry plug and immediate area outside manhole with cement mortar plastered one half (1/2) inch thick followed by two (2) coats of asphalt based coating. Bulkhead disconnected pipe with minimum twelve (12) inches bulk masonry or 2500 psi concrete.

Brick shut pipe opening at manholes with a minimum of eight (8) inches brick masonry. Waterproof masonry plug and immediate area outside manhole with cement mortar plastered one half (1/2) inch thick followed by two (2) coats of asphalt based coating. Pump the sewer full of non-shrink type grout or lean mixture of sand and cement.

Storm and sanitary manholes and structures:

Remove frame and cover and return to the City.

Remove structure to a minimum of two (2) feet below finished grade.

Break up base slab or bottom to provide drainage and backfill as specified in Section 02200. Abandon adjacent storm and sanitary sewers as necessary.

4. Measurement and Payment

A. Sewer Pipe

Furnishing and installing sewer pipe will be measured for payment by the linear foot of the various types and sizes provided, measured horizontally along the centerline of the pipe from center of structures. No deductions will be made for the lengths of fittings or connections.

Payment will be made for the quantities measured at the unit price per linear foot for the various sizes listed in the bid schedule. Pipe noted in the bid schedule as contractor's option shall be of materials specified hereinbefore.

Payment will include provision of fittings, connections to new and existing facilities and T and Y branches, and various sized drop connections at manholes.

Payment will include excavation, backfill and bedding as specified in Section 02200.

B. Storm Drain Pipe

Furnishing and installing storm drain pipe will be measured for payment by the linear foot of the various types and sizes provided, measured horizontally along the centerline of the pipe from center to center of manholes or structures. No deductions will be made for the lengths of fittings or connections.

Payment will be made for the quantities measured at the unit price per linear foot for the various sizes listed in the bid schedule.

Payment will include provision of fittings and connections to new and existing facilities.

Payment will include excavation, backfill and bedding as specified in Section 02200.

C. House Connections

Furnishing and installing house connections will be measured by the linear foot of the various types and sizes provided, measured horizontally along the centerline of the pipe from center of main line sewer for house connections placed simultaneously with sewer and for house connections placed after backfill of sewer. No deductions will be made for the lengths of fittings or connections.

Payment will be made for the quantities measured at the unit price listed for the various sizes and types in the bid schedule.

Payment includes provision of fittings, thimbles, drop house connections and connections to new and existing facilities, pipes and manholes and installation of saddles.

Payment includes excavation, backfill and bedding as specified in Section 02200.

D. Manholes

Furnishing and installing manholes will be measured for payment by the vertical foot measured from the invert to the bottom of the frame of the various types and sizes complete in place, including installation of the frames and covers.

Payment will be made for the quantities measured at the unit price per vertical foot for the various types and sizes listed in the bid schedule.

Payment will include excavation, backfill and bedding as specified in Section 02200 and provision of drop connections of the proper size and type required and concrete, where indicated.

E. Lampholes

Furnishing and installing lampholes will be measured for payment by each complete in place, including installation of frames and covers.

Payment will be made for the quantities measured at the unit price per each listed in the bid schedule.

Payment will include excavation, backfill and bedding as specified in Section 02200.

Payment will include the appropriate size Y branch.

F. Inlets, End Walls, Cut Off Walls and Entrance Structures

Furnishing and installing inlets, end walls, cut off walls and entrance structures will be measured for payment by each of the various types, complete in place, including installation of frames and covers.

Payment will be made for the quantities measured at the unit price per each of the various structures listed in the bid schedule.

Payment will include excavation and backfill as specified in Section 02200 and connection to new and existing pipes.

G. Underdrain System

Providing under drain system with and without pipe will be measured for payment by the cubic yard of drainage stone actually placed for underdrains with pipe and for underdrains without pipe.

Payment will be made for the quantities measured at the unit price per cubic yard listed for the various types in the bid schedule.

Payment will include excavation and backfill as specified in Section 02200, pipe (where applicable) and filter cloth.

H. Furnishing Pipe to be Installed in Tunnels

Furnishing and installing pipe in tunnels for storm or sanitary sewer systems shall be measured by the linear foot measured along the centerline of the tunnel from inside face to inside face of access shafts.

Payment will be made for the quantity measured of the various sizes of pipe at the unit prices listed in the bid schedule.

I. Concrete Encasement and Cradle

Constructing concrete encasement and cradle will be measured for payment by the cubic yard of concrete actually placed.

Payment will be made for the quantities measured at the unit prices per cubic yard listed in the bid schedule.

J. Non-Payment Items

The following items will not be measured for payment but the cost thereof will be considered as incidental to the contract:

Removal of existing facilities as necessary to complete the project.

Abandonment, plugging and disposal of existing facilities.

Restoration and restabilization of disturbed areas.

Stoppers, plugs and stubs.

Testing.

Timber-marking house connections.

Replacement of various appurtenant connections and devices required for watertight construction.

Concrete anchors and erosion checks.

Adjustment of manholes frames and covers, as indicated.

