SCHEDULE No. T-1

AUS TELEPHONE PLANT INDEX
NORTH ATLANTIC REGION 1973=100

LINE NO	COST INDEX NUMBER																								LINE NO
	1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999		
	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	
1	150	153	158	165	164	165	167	165	165	165	167	168	169	170	174	178	182	182	184	185	186	184	184	181	1
2																									2
3																									3
4	221	222	231	229	236	232	244	241	254	251	258	261	267	271	275	270	279	276	277	271	270	263	273	266	4
5	234	234	234	240	246	254	261	271	274	284	285	291	297	300	304	312	318	322	326	328	327	328	329	330	5
6	289	293	298	309	312	319	325	328	333	337	343	348	348	351	353	360	362	368	370	374	377	382	383	388	6
7	273	279	286	294	298	305	309	316	318	322	324	328	332	336	338	345	349	354	356	359	361	364	366	368	7
8	206	210	215	218	221	228	230	234	235	240	240	243	244	250	250	254	254	258	258	260	260	262	263	265	8
9																									9
10																									10
11	242	254	257	268	268	272	272	274	270	279	283	290	295	306	310	310	311	312	323	329	331	338	341	343	11
12	255	263	269	274	278	284	287	290	291	294	296	299	302	309	309	315	320	322	326	328	330	330	330	333	12
13	147	149	151	153	154	154	152	153	153	156	154	155	155	155	154	156	155	156	155	157	156	157	156	157	13
14	45	43	37	31	30	29	26	24	23	21	21	21	21	21	21	20	17	15	14	14	14	14	13	13	14
15																									15
16																									16
17	204	207	210	212	214	211	212	214	213	213	213	216	215	216	213	212	211	204	204	200	196	194	193	192	17
18	52	50	45	40	39	38	36	33	32	31	31	31	32	32	32	31	28	27	26	26	26	26	25	25	18
19																									19
20																									20
21	278	284	289	291	291	292	296	302	303	304	309	317	316	324	329	327	334	333	336	339	331	336	338	342	21
22																									22
23	213	216	217	218	218	218	220	223	224	224	227	231	231	236	238	236	239	240	239	239	234	237	237	239	23
24																									24
25																									25
26																									26
27	80	80	81	81	81	82	81	82	84	85	86	87	87	87	89	89	91	91	91	93	94	95	95	96	27
28	117	117	117	118	118	118	116	116	117	118	119	120	119	120	120	121	121	122	123	125	125	123	123	124	28
29	140	141	142	144	145	144	145	146	147	147	147	149	150	150	152	149	149	146	146	145	143	143	142	143	29
30	36	35	35	35	35	34	34	34	37	38	39	39	39	39	37	37	37	38	35	36	36	36	36	35	30
31																									31
32	205	209	212	214	216	213	213	215	214	214	213	216	215	216	213	212	211	204	204	200	196	195	194	192	32
33																									33
34																									34
35	278	285	291	295	300	304	310	315	319	327	331	338	352	365	368	369	379	385	400	402	406	413	418	421	35
36	226	237	257	275	273	277	282	277	279	275	281	282	283	282	294	310	319	323	325	328	333	324	322	314	36
37	94	87	85	89	89	89	90	90	89	90	89	89	88	87	88	89	90	91	91	92	93	94	94	95	37
38	210	221	244	265	261	265	270	261	263	256	262	260	260	257	270	289	299	304	305	308	312	299	297	285	38
39	84	75	73	77	76	76	77	77	76	76	75	74	73	72	72	73	74	75	75	76	76	77	77	77	39
40	204	215	240	262	257	261	265	256	257	249	256	253	252	249	262	283	293	298	298	301	306	291	288	275	40
41	82	73	71	75	74	74	75	75	74	74	73	72	71	69	70	71	72	73	73	73	74	74	75	75	41
42	235	244	260	274	274	277	283	278	282	279	285	286	287	288	298	310	319	323	324	327	332	325	325	319	42
43	114	107	106	111	111	111	113	113	113	114	113	114	113	113	114	115	118	119	119	120	121	122	123	123	43
44	227	238	257	275	273	277	282	277	279	275	281	282	282	282	293	309	318	323	324	328	333	324	322	314	44
45	95	87	85	90	89	89	90	91	90	90	89	89	88	87	88	89	91	92	92	93	94	94	95	95	45
46	249	261	270	278	279	283	290	291	293	298	302	305	307	312	320	324	329	332	334	337	341	344	342	342	46
47	269	277	301	309	311	309	316	308	307	310	314	320	325	331	336	340	345	347	350	353	355	358	362	366	47
48																									48
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53
54																									54

AUS TELEPHONE INDEX BULLETIN NO. 60

SCHEDULE No. T-1

AUS TELEPHONE PLANT INDEX

NORTH ATLANTIC REGION 1973=100

LINE NO	PLANT IN SERVICE DESCRIPTION	FCC Acct	COST INDEX NUMBER																LINE NO
			2000		2001		2002		2003		2004		2005		2006		2007		
			Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	Jan 1	July 1	
1	Total Plant		182	185	188	190	191	193	194	197	201	206	210	213	227	244	244	249	1
2																			2
3																			3
4	Motor Vehicles	2112	275	269	276	266	270	263	264	257	268	266	272	261	262	258	264	257	4
5	Aircraft	2113	334	343	351	359	362	364	369	377	387	393	408	417	424	438	447	450	5
6	Special Purpose Vehicles	2114	388	392	392	392	392	398	400	404	404	413	428	445	449	462	465	472	6
7	Garage Work Equipment	2115	369	372	373	377	376	376	377	378	379	387	393	403	408	416	422	430	7
8	Other Work Equipment	2116	266	267	268	273	271	272	271	273	273	275	276	278	278	275	278	279	8
9																			9
10																			10
11	Buildings	2121	353	359	364	374	377	384	385	385	407	412	425	431	441	443	457	472	11
12	Furniture	2122	335	337	338	341	341	341	344	346	346	350	360	368	372	376	380	386	12
13	Office Equipment	2123	156	157	157	158	159	158	158	157	159	160	158	162	161	161	160	161	13
14	General Purpose Computer	2124	12	11	9	9	7	7	6	4.8	3.4	3.4	3.3	3.3	3.0	2.8	2.6	2.7	14
15																			15
16																			16
17	Analog Electronic Switching	2211	193	193	193	190	189	190	189	190	189	190	190	189	187	193	196	186	17
18	Digital Electronic Switching	2212	25	24	22	23	23	23	21	22	22	22	22	22	22	23	23	23	18
19																			19
20																			20
21	Electro Mechanical Switching	2215	344	348	350	358	366	376	379	386	391	395	403	405	414	421	430	432	21
22																			22
23	Operator Systems	2220	241	242	243	247	251	257	258	261	264	266	271	272	276	282	287	287	23
24																			24
25																			25
26																			26
27	Radio System—Analog	22311	96	96	96	95	95	95	95	95	95	96	95	95	94	97	98	94	27
28	Radio Systems—Digital	22312	125	125	126	127	128	127	125	125	125	126	127	127	128	129	130	130	28
29	Circuit Equipment—Analog	22321	143	144	144	142	143	143	143	144	143	145	145	145	144	148	150	144	29
30	Circuit Equipment—Digital	22322	36	36	36	37	37	38	38	39	38	38	39	39	39	40	40	41	30
31																			31
32	Public Telephone Term Eq	2351	193	193	193	191	190	190	190	191	190	191	190	189	187	193	195	186	32
33																			33
34																			34
35	Poles	2411	421	429	434	446	451	459	463	472	477	490	495	503	502	521	526	529	35
36	Aerial Cable—Metallic	24211	313	322	328	333	335	338	340	349	357	371	379	386	430	486	477	492	36
37	Aerial Cable—Fiber	24212	96	98	100	102	104	105	105	108	110	112	114	116	118	119	121	122	37
38	Underground Cable—Metallic	24221	281	289	295	299	298	299	299	307	314	326	334	340	394	461	448	466	38
39	Underground Cable—Fiber	24222	78	80	82	83	84	86	85	87	89	91	92	94	95	96	98	98	39
40	Buried Cable—Metallic	24231	271	278	284	287	285	289	286	293	300	312	320	326	383	456	441	460	40
41	Buried Cable—Fiber	24232	76	77	79	80	81	83	82	84	85	87	89	90	91	92	93	94	41
42	Submarine Cable—Metallic	24241	320	327	334	338	341	343	346	353	362	372	379	384	417	459	454	466	42
43	Submarine Cable—Fiber	24242	125	127	130	132	134	136	136	138	141	144	146	148	149	150	153	154	43
44	Intra Building Cable—Metallic	24261	313	322	328	333	335	338	340	349	357	370	378	385	429	483	474	489	44
45	Intra Building Cable—Fiber	24262	97	99	101	103	104	106	106	108	110	113	115	117	118	120	121	122	45
46	Aerial Wire	2431	348	355	362	368	372	377	381	391	399	412	419	427	446	466	465	472	46
47	Conduit Systems	2441	375	380	391	395	403	412	418	422	432	442	453	458	474	478	495	493	47
48																			48
49	Aerial Cable-FTTP (Distribution)	24213	0	0	0	0	0	0	0	0	0	100	97	95	92	89	88	87	49
50	Underground Cable-FTTP (Dist.)	24223	0	0	0	0	0	0	0	0	0	100	99	98	98	97	96	96	50
51	Buried Cable-FTTP (Distribution)	24233	0	0	0	0	0	0	0	0	0	100	102	105	104	103	103	102	51
52	Submarine Cable-FTTP (Dist.)	24243	0	0	0	0	0	0	0	0	0	100	99	98	98	97	96	96	52
53	Intra Building Cable-FTTP (Dist.)	24263	0	0	0	0	0	0	0	0	0	100	100	100	100	100	101	103	53
54																			54

AUS TELEPHONE INDEX BULLETIN NO. 60

SCHEDULE No. T-1

AUS TELEPHONE PLANT INDEX

NORTH ATLANTIC REGION 1973=100

LINE NO	COST INDEX NUMBER																						LINE NO
	2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		
	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	Jan 1	Jul y 1	
1	251	256	245	248	258	260	279	282	282	282	285	283	284	285	289	287	283	282	288	290	298	304	304	306	1
2																									2
3																									3
4	263	257	272	273	274	269	272	273	280	279	286	282	291	287	291	295	299	298	305	301	307	304	309	305	4
5	461	471	495	480	485	490	497	502	514	520	523	528	532	537	541	543	543	547	548	553	557	562	567	574	5
6	476	485	499	504	503	503	507	518	529	541	548	555	557	564	566	570	572	576	577	581	583	578	602	612	6
7	435	445	457	457	456	458	462	474	479	485	489	494	497	503	505	509	510	513	514	519	522	533	541	549	7
8	281	286	290	286	286	288	288	290	291	294	295	296	304	307	309	315	318	322	322	324	327	330	333	335	8
9																									9
10																									10
11	492	497	506	494	506	507	521	518	530	532	542	539	550	552	585	580	586	589	604	608	633	647	647	647	11
12	389	402	417	415	418	420	415	429	433	437	433	437	439	450	449	454	454	455	457	461	464	482	491	498	12
13	162	171	184	171	169	169	170	171	173	173	164	165	166	166	171	172	172	172	173	171	171	169	170	152	13
14	2.7	2.6	2.6	2.1	2.01	1.98	1.97	1.49	0.82	0.66	0.67	0.50	0.57	0.60	0.55	0.63	0.64	0.65	0.73	0.71	0.67	0.64	0.60	0.60	14
15																									15
16																									16
17	180	179	178	178	177	177	174	175	174	174	174	175	176	176	176	176	177	177	177	179	177	179	179	179	17
18	24	24	25	25	25	25	25	25	26	26	26	27	27	27	27	28	28	28	28	29	29	29	29	30	18
19																									19
20																									20
21	439	445	456	458	460	469	474	481	486	478	484	491	497	495	499	499	496	497	502	502	509	506	513	525	21
22																									22
23	288	292	297	299	300	305	307	311	313	309	312	317	320	319	322	322	320	321	324	325	328	327	331	338	23
24																									24
25																									25
26																									26
27	91	90	90	90	89	89	88	89	88	88	88	88	89	89	89	89	89	89	89	90	90	90	90	91	27
28	131	132	134	134	135	137	138	138	137	138	138	138	138	138	139	140	140	140	140	141	141	142	143	144	28
29	140	139	139	139	138	138	137	138	137	137	137	138	139	139	140	140	141	141	141	142	142	143	143	144	29
30	41	41	41	41	40	40	40	41	41	42	42	42	43	43	44	44	44	45	45	45	46	46	47	47	30
31																									31
32	180	179	177	178	177	177	174	175	173	174	173	174	175	175	176	176	177	177	177	179	177	179	179	180	32
33																									33
34																									34
35	537	547	554	563	570	578	576	587	594	600	603	607	605	616	620	621	629	633	634	652	643	652	661	673	35
36	494	507	461	473	506	509	573	582	577	576	582	572	573	573	578	570	555	551	566	568	590	604	601	606	36
37	123	124	126	127	128	130	131	133	135	136	137	138	140	142	143	144	146	148	149	151	153	155	157	158	37
38	465	481	421	435	475	476	555	562	554	552	556	544	542	540	544	533	513	506	523	524	548	563	558	562	38
39	100	100	102	103	103	105	106	108	109	110	111	112	113	114	116	116	118	119	120	122	123	125	126	127	39
40	459	475	410	425	467	467	553	560	550	547	552	538	536	533	537	524	501	493	511	511	537	552	545	550	40
41	95	96	97	98	99	100	101	103	104	105	106	107	108	109	111	111	113	114	115	116	118	120	121	122	41
42	468	479	447	458	484	486	535	541	539	540	545	539	541	542	547	544	534	532	546	548	566	578	578	583	42
43	155	157	159	161	163	164	166	168	170	172	173	174	177	179	181	183	185	187	189	191	194	196	199	200	43
44	491	504	459	471	504	507	570	578	573	573	578	569	569	570	575	567	553	549	564	566	588	602	599	604	44
45	124	125	127	128	129	131	132	134	135	137	138	139	141	142	144	145	147	148	150	152	154	156	158	159	45
46	475	488	469	478	496	501	519	528	525	527	531	530	533	538	543	543	540	541	551	556	569	580	583	588	46
47	502	507	525	530	516	521	526	532	545	550	549	552	559	565	571	577	581	586	591	596	611	618	626	632	47
48																									48
49	82	77	75	73	65	58	55	53	52	50	50	50	50	50	50	49	50	49	49	50	50	50	51	50	49
50	94	92	89	87	83	80	75	70	66	62	58	54	54	54	53	53	54	54	54	53	52	51	52	51	50
51	92	82	78	74	71	68	66	63	61	59	57	54	54	55	54	54	54	53	53	54	54	54	55	54	51
52	94	92	89	87	83	80	75	70	66	62	58	54	54	54	53	53	54	54	54	53	52	51	52	51	52
53	104	105	90	75	68	61	54	47	43	39	39	39	39	39	38	38	39	44	43	43	43	42	43	42	53
54																									54

AUS TELEPHONE INDEX BULLETIN NO. 60

Pennsylvania American Water Company

Borough of Kane Authority's Wastewater System

Appraisal Work Papers
As of September 30, 2019

Cost Indices

United States Bureau of Labor Statistics – General Inf Cost Indexes

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AUS Consultants
Bureau of Labor Statistics Indexes

Index	Table	Region	Year	Begin Date	End Date	CPI	1	2 Communic Equipment pcu3342	3 Technical Labor ecu11122I linked CIU20154
Earliest Year							1913	1986	1985
Index	Table	Region					1	2	3
BLS	BLS	All	1913	1/1/1913	12/31/1913		10	7	6
BLS	BLS	All	1914	1/1/1914	12/31/1914		10	7	6
BLS	BLS	All	1915	1/1/1915	12/31/1915		10	7	6
BLS	BLS	All	1916	1/1/1916	12/31/1916		11	8	7
BLS	BLS	All	1917	1/1/1917	12/31/1917		13	10	8
BLS	BLS	All	1918	1/1/1918	12/31/1918		15	11	9
BLS	BLS	All	1919	1/1/1919	12/31/1919		17	12	10
BLS	BLS	All	1920	1/1/1920	12/31/1920		20	14	12
BLS	BLS	All	1921	1/1/1921	12/31/1921		18	13	11
BLS	BLS	All	1922	1/1/1922	12/31/1922		17	12	10
BLS	BLS	All	1923	1/1/1923	12/31/1923		17	12	10
BLS	BLS	All	1924	1/1/1924	12/31/1924		17	12	10
BLS	BLS	All	1925	1/1/1925	12/31/1925		18	13	11
BLS	BLS	All	1926	1/1/1926	12/31/1926		18	13	11
BLS	BLS	All	1927	1/1/1927	12/31/1927		17	12	10
BLS	BLS	All	1928	1/1/1928	12/31/1928		17	12	10
BLS	BLS	All	1929	1/1/1929	12/31/1929		17	12	10
BLS	BLS	All	1930	1/1/1930	12/31/1930		17	12	10
BLS	BLS	All	1931	1/1/1931	12/31/1931		15	11	9
BLS	BLS	All	1932	1/1/1932	12/31/1932		14	10	8
BLS	BLS	All	1933	1/1/1933	12/31/1933		13	9	7
BLS	BLS	All	1934	1/1/1934	12/31/1934		13	9	7
BLS	BLS	All	1935	1/1/1935	12/31/1935		14	10	7
BLS	BLS	All	1936	1/1/1936	12/31/1936		14	10	7
BLS	BLS	All	1937	1/1/1937	12/31/1937		14	10	7
BLS	BLS	All	1938	1/1/1938	12/31/1938		14	10	7
BLS	BLS	All	1939	1/1/1939	12/31/1939		14	10	7
BLS	BLS	All	1940	1/1/1940	12/31/1940		14	10	7
BLS	BLS	All	1941	1/1/1941	12/31/1941		15	11	8
BLS	BLS	All	1942	1/1/1942	12/31/1942		16	12	9
BLS	BLS	All	1943	1/1/1943	12/31/1943		17	13	10
BLS	BLS	All	1944	1/1/1944	12/31/1944		18	14	11
BLS	BLS	All	1945	1/1/1945	12/31/1945		18	14	11
BLS	BLS	All	1946	1/1/1946	12/31/1946		20	16	12
BLS	BLS	All	1947	1/1/1947	12/31/1947		22	18	13
BLS	BLS	All	1948	1/1/1948	12/31/1948		24	20	14
BLS	BLS	All	1949	1/1/1949	12/31/1949		24	20	14
BLS	BLS	All	1950	1/1/1950	12/31/1950		24	20	14
BLS	BLS	All	1951	1/1/1951	12/31/1951		26	22	15

AUS Consultants
Bureau of Labor Statistics Indexes

Index	Table	Region	Year	Begin Date	End Date	CPI	1	2 Communic Equipment pcu3342	3 Technical Labor ecu11122I linked CIU20154
Earliest Year							1913	1986	1985
Index	Table	Region					1	2	3
BLS	BLS	All	1952	1/1/1952	12/31/1952		27	23	16
BLS	BLS	All	1953	1/1/1953	12/31/1953		27	23	16
BLS	BLS	All	1954	1/1/1954	12/31/1954		27	23	16
BLS	BLS	All	1955	1/1/1955	12/31/1955		27	23	16
BLS	BLS	All	1956	1/1/1956	12/31/1956		27	23	16
BLS	BLS	All	1957	1/1/1957	12/31/1957		28	24	17
BLS	BLS	All	1958	1/1/1958	12/31/1958		29	25	18
BLS	BLS	All	1959	1/1/1959	12/31/1959		29	25	18
BLS	BLS	All	1960	1/1/1960	12/31/1960		30	26	19
BLS	BLS	All	1961	1/1/1961	12/31/1961		30	26	19
BLS	BLS	All	1962	1/1/1962	12/31/1962		30	26	19
BLS	BLS	All	1963	1/1/1963	12/31/1963		31	27	20
BLS	BLS	All	1964	1/1/1964	12/31/1964		31	27	20
BLS	BLS	All	1965	1/1/1965	12/31/1965		32	28	21
BLS	BLS	All	1966	1/1/1966	12/31/1966		32	28	21
BLS	BLS	All	1967	1/1/1967	12/31/1967		33	29	22
BLS	BLS	All	1968	1/1/1968	12/31/1968		35	31	23
BLS	BLS	All	1969	1/1/1969	12/31/1969		37	33	24
BLS	BLS	All	1970	1/1/1970	12/31/1970		39	35	25
BLS	BLS	All	1971	1/1/1971	12/31/1971		41	37	26
BLS	BLS	All	1972	1/1/1972	12/31/1972		42	38	27
BLS	BLS	All	1973	1/1/1973	12/31/1973		44	40	28
BLS	BLS	All	1974	1/1/1974	12/31/1974		49	44	31
BLS	BLS	All	1975	1/1/1975	12/31/1975		54	49	34
BLS	BLS	All	1976	1/1/1976	12/31/1976		57	52	36
BLS	BLS	All	1977	1/1/1977	12/31/1977		61	56	38
BLS	BLS	All	1978	1/1/1978	12/31/1978		65	60	40
BLS	BLS	All	1979	1/1/1979	12/31/1979		73	67	45
BLS	BLS	All	1980	1/1/1980	12/31/1980		82	75	50
BLS	BLS	All	1981	1/1/1981	12/31/1981		91	83	55
BLS	BLS	All	1982	1/1/1982	12/31/1982		97	89	59
BLS	BLS	All	1983	1/1/1983	12/31/1983		100	92	61
BLS	BLS	All	1984	1/1/1984	12/31/1984		104	96	63
BLS	BLS	All	1985	1/1/1985	12/31/1985		108	100	65
BLS	BLS	All	1986	1/1/1986	12/31/1986		110	102	66
BLS	BLS	All	1987	1/1/1987	12/31/1987		114	104	69
BLS	BLS	All	1988	1/1/1988	12/31/1988		118	104	72
BLS	BLS	All	1989	1/1/1989	12/31/1989		124	106	76
BLS	BLS	All	1990	1/1/1990	12/31/1990		131	108	80

AUS Consultants
Bureau of Labor Statistics Indexes

Index	Table	Region	Year	Begin Date	End Date	CPI	1	2 Communic Equipment pcu3342	3 Technical Labor ecu11122I linked CIU20154
Earliest Year							1913	1986	1985
Index	Table	Region					1	2	3
BLS	BLS	All	1991	1/1/1991	12/31/1991		136	109	84
BLS	BLS	All	1992	1/1/1992	12/31/1992		140	110	88
BLS	BLS	All	1993	1/1/1993	12/31/1993		145	112	92
BLS	BLS	All	1994	1/1/1994	12/31/1994		148	113	95
BLS	BLS	All	1995	1/1/1995	12/31/1995		152	114	97
BLS	BLS	All	1996	1/1/1996	12/31/1996		157	115	100
BLS	BLS	All	1997	1/1/1997	12/31/1997		161	116	102
BLS	BLS	All	1998	1/1/1998	12/31/1998		163	115	106
BLS	BLS	All	1999	1/1/1999	12/31/1999		167	113	109
BLS	BLS	All	2000	1/1/2000	12/31/2000		172	110	114
BLS	BLS	All	2001	1/1/2001	12/31/2001		177	109	119
BLS	BLS	All	2002	1/1/2002	12/31/2002		180	105	123
BLS	BLS	All	2003	1/1/2003	12/31/2003		184	102	127
BLS	BLS	All	2004	1/1/2004	12/31/2004		189	98	132
BLS	BLS	All	2005	1/1/2005	12/31/2005		195	97	135
BLS	BLS	All	2006	1/1/2006	12/31/2006		202	97	139
BLS	BLS	All	2007	1/1/2007	12/31/2007		207	96	146
BLS	BLS	All	2008	1/1/2008	12/31/2008		215	97	152
BLS	BLS	All	2009	1/1/2009	12/31/2009		215	97	155
BLS	BLS	All	2010	1/1/2010	12/31/2010		218	97	157
BLS	BLS	All	2011	1/1/2011	12/31/2011		225	96	161
BLS	BLS	All	2012	1/1/2012	12/31/2012		230	96	164
BLS	BLS	All	2013	1/1/2013	12/31/2013		233	95	167
BLS	BLS	All	2014	1/1/2014	12/31/2014		237	96	170
BLS	BLS	All	2015	1/1/2015	12/31/2015		237	96	173
BLS	BLS	All	2016	1/1/2016	12/31/2016		240	95	176
BLS	BLS	All	2017	1/1/2017	12/31/2017		245	94	179
BLS	BLS	All	2018	1/1/2018	12/31/2018		251	94	183
BLS	BLS	All	2019	1/1/2019	12/31/2019		251	93	184

Pennsylvania American Water Company

Borough of Kane Authority's Wastewater System

Appraisal Work Papers
As of September 30, 2019

Depreciation & Obsolescence

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DEPRECIATION AND FUNCTIONAL OBSOLESCENCE

An important step in the appraisal of property using the cost approach is the determination of the depreciation or condition of the property. Depreciation in this appraisal was segregated into normal (mostly physical) depreciation and functional obsolescence. The normal depreciation was determined based on the age of the property and its normal service life; while, functional obsolescence was based on the impact on the property's remaining life caused by factors such as changing technology, service requirements, and competition.

Depreciation - The depreciation was determined based on the property's age and it normal service life using the following formula:

$$\text{Condition} = \frac{\text{Remaining Life}}{\text{Age + Remaining Life}}$$

or

$$\text{Depreciation} = \frac{\text{Age}}{\text{Age + Remaining Life}}$$

Where: Remaining Life = f(Age, Survival Characteristic, Normal Service life)

Functional Obsolescence - The obsolescence inherent in the property was determined using the above described normal service life in comparison to the property's service life is adjusted for functional factors. The obsolescence was quantified base on the difference between the property's normal service life and its functional service life. The following formula was used to calculate the obsolescence:

$$\text{Obsolescence} = \frac{\text{Normal Service Life - Functional Service Life}}{\text{Normal Service Life}}$$

Service Lives - (normal versus functional) - The service life of property is that period of time in which it provides the service to which it was designed and placed into service. In most industrial properties there is a difference between a property's normal or physical life and its functional life. A piece of equipment may physically last for an extended

period; however, as that property ages changing technology, improvements or enhancement in similar equipment, functional and or service requirements change resulting in decreased utility of the existing equipment, and therefore decrease in value to it owner, this additional deterioration over that defined by the equipment's normal life is functional obsolescence.

Wastewater Industry Service Lives

The service lives used in the depreciation and functional obsolescence calculations were developed based on the property and its use, AUS Consultants' experience in developing depreciation studies for the water and wastewater industries. The following table details the lives used in the depreciation portion of the replacement cost new less depreciation analysis:

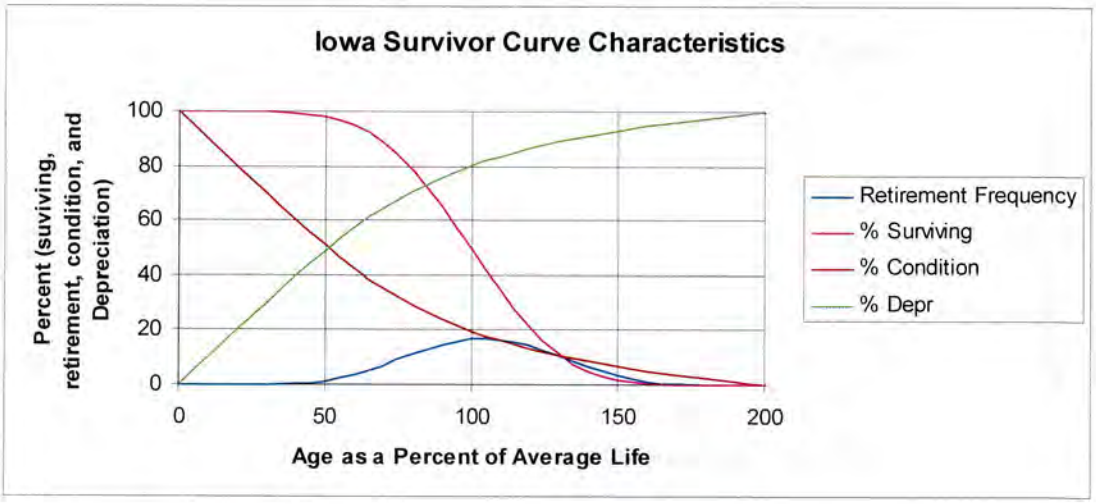
Pennsylvania American Water Company
Borough of Kane Authority
Wastewater Collection and Treatment System
Investor-Owned Utility
September 30, 2019

Summary of Account Costing and Depreciation Parameters Used in the Depreciation Original Cost and the Depreciated Replacement Cost New Studies

(1)	(2)	(4)		(5)	(6)	
		(4a)	(4b)		(6a)	(6b)
Account Number	Description	Iowa Survivor / Retirement Curve	Normal Service Life	Economic Obsolescence	Tax Depreciation	
			years	% of CORLD	Table	Life
353.00	Land & Land Rights	Non-Depr	0.00	0.00%	Non-Depr	0.00
354.00	Stuctures & Improvements	R4.0	55.00	0.00%	MACRS	25.00
360.00	Mains Force	R3.0	60.00	0.00%	MACRS	25.00
361.00	Mains Gravity	R3.0	75.00	0.00%	MACRS	25.00
363.00	Service Laterals	R3.0	55.00	0.00%	MACRS	25.00
364.00	Flow Measuring Devices	R3.0	35.00	0.00%	MACRS	25.00
371.00	Pumping Equipment	R3.0	35.00	0.00%	MACRS	25.00
380.00	Treatment and Disposal Equipment	R3.0	45.00	0.00%	MACRS	25.00
381.00	Plant Sewers	R3.0	45.00	0.00%	MACRS	25.00
389.00	Other Plant & Misc Equip	R3.0	45.00	0.00%	MACRS	25.00
391.00	Transportation Equipment	R3.0	10.00	0.00%	MACRS	10.00
392.00	Stores Equipment	R3.0	35.00	0.00%	MACRS	25.00
393.00	Tools, Shop, & Garage Equipment	R3.0	35.00	0.00%	MACRS	25.00
394.00	Laboratory Equipment	R3.0	20.00	0.00%	MACRS	20.00
395.00	Power Operated Equipment	R3.0	15.00	0.00%	MACRS	15.00
396.00	Communications Equipment	R3.0	12.00	0.00%	MACRS	12.00
397.00	Miscellaneous Equipment	R3.0	20.00	0.00%	MACRS	20.00

Iowa Survivor Curves

The Iowa Survivor Curves recommended in the McKeesport appraisal are used to determine the remaining life of the property, and therefore its condition, recognizing the properties' service life and age. The Iowa Survivor Curves allows the appraiser to recognize the property being studied (mains, treatment and pumping plant equipment etc placed in a particular year, say1985) is part of a larger group of property, i.e., all the property i.e., mains, treatment and pumping plant equipment, etc. As such, the service lives which we refer to in our appraisal are an average service lives for the group, i.e., the average life of all mains, treatment and pumping plant equipment, etc. The Iowa Survivor curve allows the appraiser to calculate the remaining life, and therefore condition, of a subset of the group (the mains placed in 1985) based on the groups': (1) Iowa Survivor Curve, (2) Service Life and the (3) age of property at the appraisal date. An Iowa Survivor Curves depicts how property from a group survives and retires about that groups' average life.

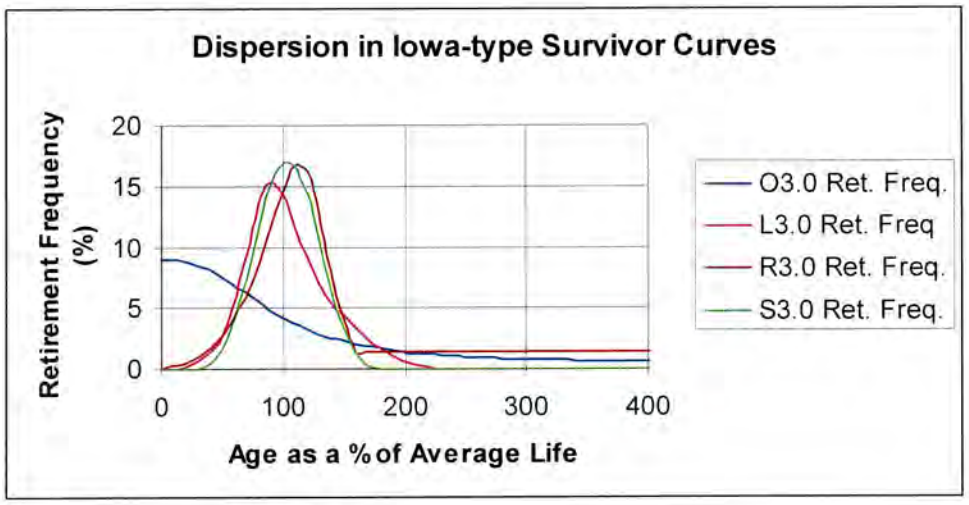


The above figure depicts a typical Iowa-type survivor curve, an S3.0 Iowa-type survivor curve. In this case the survivor curve has been generalized to a service life of 100% of the property's average life, in this generalized form the survivor curve statistics can be utilized with any individual service life in the age-life service life and depreciation calculations. There are four characteristics displayed in the above chart depicting the manner in which property survives and retires about the group's average life, those characteristics are: the retirement frequency (blue), the percent surviving (red), the percent condition (brown) and the percent depreciated (green). The retirement frequency represents the retirement of individual property items about the group's average service life. As can be seen the retirements are distributes about the group's average life with some items retiring before the average life and some items retiring at or after the group's service life. The group's survivor curve is developed from subtracting the retirements as they occur as the property ages. The depreciation curve depicts how much of the property group's life has been consumed; while, the condition curve depict

how much of the property group's life remains. The condition and depreciation curves are complementary in that condition equals 100% minus depreciation and vice versa.

The theory of Iowa Survivor Curves was presented in the 1920s and 30s by Robley Winfrey based on research at Iowa State University (then the Iowa Engineering Experiment Station). Winfrey's research was first published in Bulletin 103 - Life Characteristics of Physical Property and Bulletin 125 - Statistical Analysis of Industrial Property Retirements. (Incidentally, both publications are out of print, I have a copy of Bulletin 125 but not Bulletin 103, I'm still trying to get a copy of that piece of depreciation literature.). Bulletin 125 was updated in 1967 by Professor Harold Cowles of Iowa State University's Department of Industrial Engineering. In conducting his research, Winfrey collected data on industrial property survival and retirement from various sources and analyzed that data as a function of property's age at retirement and ultimately the property groups' service life when all the property in the group was fully retired.

Winfrey discovered the industrial property's survival and retirement fits three basic patterns with relationship to the property's average life:



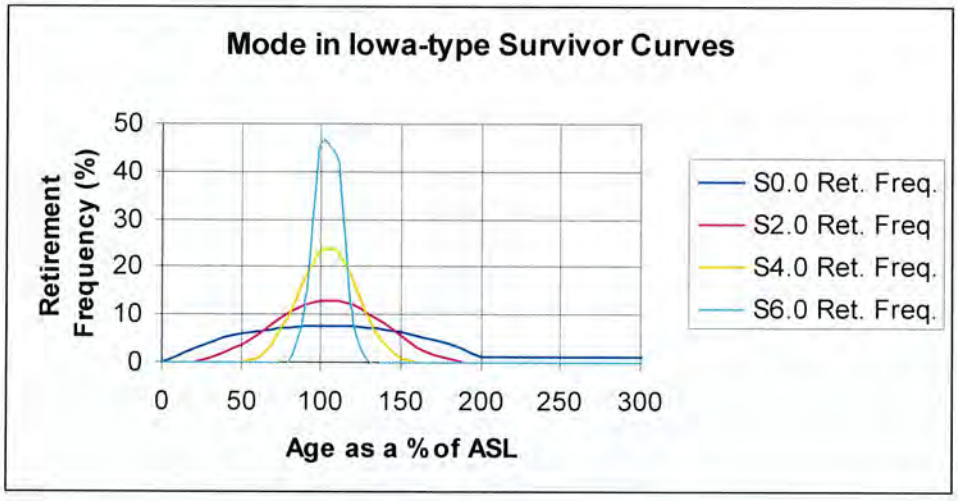
Symmetrically moded (S-type Iowa Survivor Curves) (green) – The S-type Iowa Survivor Curve is one wherein the property's retirements are symmetrically distributed about the mode. Mode in statistics is defined as the highest frequency, in this case retirement frequency. Thus an S-type Iowa curve is like a normal curve; however, its shape is not identical to a normal distribution function.

Right moded (R-type Iowa Curves) (brown) – the R-type Iowa curve has its mode skewed to the right of the property's average life; therefore the retirements tend to be distributed later in the property's life and there are less retirements earlier in the property's life.

Left moded (L-type Iowa Curve) (red) – The L-type Iowa curve has its mode skewed to the left of the property's average life; therefore the retirements tend to be distributed earlier in the property's life and there are less retirements later in the property's life.

In the utility industry, the plant, i.e., mains, treatment and pumping plant equipment tends to have a R-type survival/retirement dispersion as it is designed to provide service over extended periods, requiring little maintenance, and it designers have significant experience in designing and placing such property.

In conjunction with the above described R-, S-, and L-type survival/retirement patterns, Winfrey determine that there were several patterns of the manner in which the retirements' peakedness occur around the average life. In this case, Winfrey described the peakedness of the property retirements with peakedness enumerations of 0, 1, 2, 3, 4, 5, and 6. The low peakedness numbers 0 and 1 represent low levels of retirements being distributed over the property entire life, while high peakedness numbers, 5 and 6 represent retirement patterns where the majority or all the retirement occur tightly grouped around the property's average life. Peakedness numbers 2, 3, and 4 are middle of the road, so to speak, in terms of peakedness.



Origin moded (O-type) survivor curve (blue) – Harold Cowles in his 1967 update of Bulletin 125 introduced the O-type survivor curve with the mode of the curve at the origin or at age equal to zero (0) years. This class of Iowa curves was over looked by Winfrey possibly because it made little intuitive sense that industrial retirement of property would have their maximum retirement frequency at age equal to zero. However, Cowles felt for completeness they should be included. O-type survivor curves do reflect the survival pattern of intangible assets.

Iowa-type survivor curves are parametric, as opposed to formalistic, in that they were derived from empirical survival/retirement data which Winfrey collected. There are Iowa curve equations are presented in Bulletin 125; however in most cases users reference standardized Iowa Survivor Curve tables. The Iowa-type survivor curves used in this appraisal have been generalized to a service life of 100% of the property's average life. By generalizing the service life to 100% of average life these tables can be used to generate survival and retirement statistics for property of any service life.

It should be apparent that Iowa-types survivor curves are valid for any type property as the curves only depict how that property survives and retires about the average life of a group of similar property.

Generalized Iowa-type Survivor Curves

As was discussed earlier, most users of the Iowa-type survivor curves use standardized tables of Iowa curves. The most usable form of these standardized tables are tables which have been generalized to a standard life of 100% of the property's average life. Based on these generalized tables the user can determine the property's remaining life by knowing the Iowa-type survivor curve (mode and peakedness characteristics), the property's (group's) service life, and the specific property's (for which the remaining life is desired) age. The following table reflects how the remaining life, as well as its condition, is determined:

Year	Study Date	Age	Iowa Curve	Service Life	Age % of ASL	Iowa Lookup	Iowa Condition	Remaining Life	Total Life	Condition
				ASL						
		years		years	%			years	years	%
Input		Calc	Input	Input	Calc	Calc	lookup	Calc	Calc	Calc
1970	2006	35.5	R3.0	25	142	R3.0142	0.066388	1.7	37.2	4.47%
1980	2006	25.5	R3.0	25	102	R3.0102	0.192543	4.8	30.3	15.88%
1990	2006	15.5	R3.0	25	62	R3.0062	0.442050	11.1	26.6	41.62%
2000	2006	5.5	R3.0	25	22	R3.0022	0.787294	19.7	25.2	78.16%
2004	2006	1.5	R3.0	25	6	R3.0006	0.941117	23.5	25.0	94.01%
2005	2006	0.5	R3.0	25	2	R3.0002	0.980320	24.5	25.0	98.00%

The above table was develop with reference to the standardized Iowa Survivor curves contained and represent a R3.0 25 year Iowa curve and life table. The standardized Iowa Curves are located in tab database. In order to reference the proper line of the Iowa Curve data the user looks up that data by reference to the property's age as percent of the service life (age % of ASL column) and the Iowa Survivor curve (Iowa Curve column), combining these two criteria the Iowa Lookup column will get the user to the proper Iowa Curve data.

In the above calculation the Iowa-type survivor curve is R3, the service life of the group is 25 years, and its age is defined by property's accounting records which specifies the investment in property by account (A group in service life terms) and by the year of installation of that property. The age is dependent upon the appraisal year (study date) and the year of placement. It is customary to assume that the property placed in any particular placement year was placed continuously during that year and therefore its age is best represented as if that investment was placed in the middle of the year, i.e., July 1; hence, the adoption of the "mid-year" convention where all property is treated as if placed the mid-year.

Service Life and Survival/retirement pattern

The service life and survival/retirement pattern are determined by an analysis of historical survival and retirement experience of the company's property. This historical experience must be adjusted for factor which are known to be impacting the property's

service life but may not exhibited their effect on the property's retirement. Here it is important that a distinction is made between industrial property's physical service life and its functional service life. While physically a type of property may be deployed and remain in use for many years, over those years factors of changing technology, consumers demand and patterns, and even regulation, lessen the property functional life when compared to its physical life. In an industry such as the communications industry, function obsolescence is the primary driver of depreciation.

The following table details the impact of the above described lives on the condition calculations:

Year	Study Date	Age	Iowa Curve	Service Life	Age % of ASL	Iowa Lookup	Iowa Condition	Remaining Life	Total Life	Condition
				ASL						
		years		years	%			years	years	%
Input		Calc	Input	Input	Calc	Calc	lookup	Calc	Calc	Calc
1970	2006	35.5	R3.0	30	118	R3.0118	0.131771	4.0	39.5	10.02%
1979	2006	26.5	R3.0	30	88	R3.0088	0.264919	7.9	34.4	23.07%
1981	2006	24.5	R3.0	25	98	R3.0098	0.211333	5.3	29.8	17.74%
1989	2006	16.5	R3.0	25	66	R3.0066	0.411848	10.3	26.8	38.42%
1990	2006	15.5	R3.0	20	78	R3.0078	0.327281	6.5	22.0	29.69%
2000	2006	5.5	R3.0	20	28	R3.0028	0.731331	14.6	20.1	72.67%
2004	2006	1.5	R3.0	20	8	R3.0008	0.921605	18.4	19.9	92.47%
2005	2006	0.5	R3.0	20	3	R3.0003	0.970499	19.4	19.9	97.49%

Statistical Analyses of Industrial Property Retirements

by

Robley Winfrey

BULLETIN 125
REVISED

ENGINEERING RESEARCH INSTITUTE
IOWA STATE UNIVERSITY • AMES, IOWA

IOWA CURVES

Iowa-type survivor curves are based on a set of empirical data collected (mainly in the 1930s) for the purpose of statistically predicting future service expectancy (remaining service) for physical properties.

The techniques used and methods applied are exactly analogous to those used by the insurance industry for the purpose of predicting human mortality (life expectancy) when determining appropriate insurance premium rates. The only distinction to be made is that the life insurance companies are investigating the life or longevity characteristics of human beings and the studies which developed the Iowa-type survivor curves were developed to predict the longevity or service life experience for physical, inanimate objects. The seminal statistical analyses for industrial property were conducted under the auspices of the Iowa Research Station now known as Iowa State University and were published in Statistical Analyses of Industrial Property Retirements, Bulletin 125, Engineering Research Institute, Iowa State University.

From the preface to the revised 1967 edition of Bulletin 125:

> "With the original publication of Bulletin 125 by the Iowa Engineering Experiment Station in 1935 (now known as the Engineering Research Institute), a significant contribution was made to the practice of industrial property life estimation. This was in the form, first, of a single volume, readily available, which presented in considerable detail the procedures for statistically analyzing historical property retirement data. Secondly, but no less significant, was the presentation of a set of 18 generalized density functions descriptive of industrial property retirement dispersion, mathematically described in terms of the Pearson frequency curve family, but with parameters established empirically from the analysis of a wide range of actual retirement experience.
>
> These curves, the cumulative form of which are commonly referred to as the Iowa-type Survivor Curves, have been used extensively since their introduction and, at the present time, the set is accepted as the standard of industrial property retirement dispersion. Because of the very simple mnemonic coding system which suggests the varying statistical characteristics involved, the Iowa Curves have also become widely used and recognized in the identification or classification of retirement dispersions, even for patterns derived in terms of analytical techniques not using the Curves."

The tables which follow this discussion are the ones used to estimate the remaining life of investment at particular age for an account with a particular service life.

Statistical Analyses of Industrial Property Retirements

by Robley Winfrey

(Revised April, 1967 by Harold A. Cowles, Professor, Department of Industrial Engineering)

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ENGINEERING RESEARCH INSTITUTE
Iowa State University, Ames, Iowa

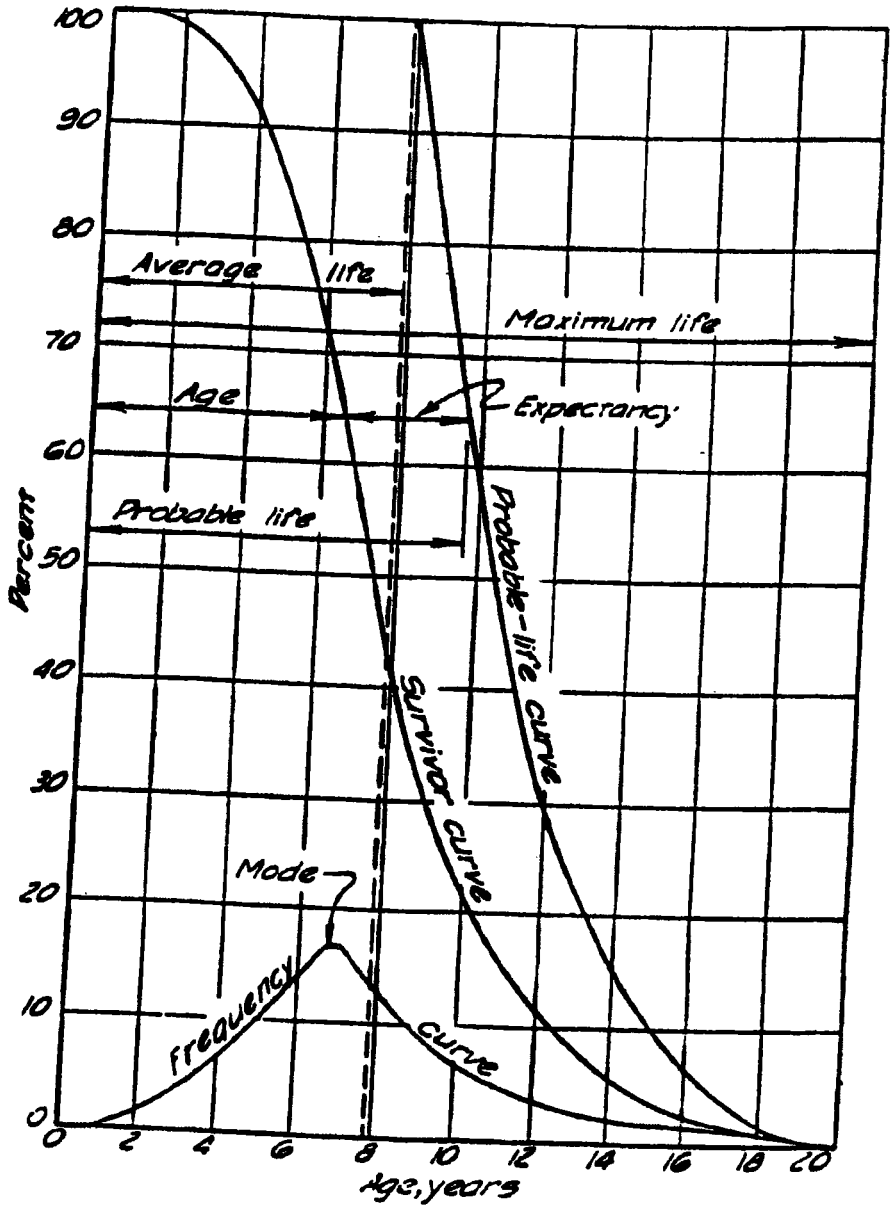


FIG. 1.—A typical survivor curve and its derived curves.

8. The *service life* of a unit is that period of time (or service) extending from the date of its installation to the date of its retirement from service. While the service life of physical property is usually expressed in years it may also be expressed in terms of units of production (screws, wheels, cars, pounds, miles, car-miles), time units of less than a year (months, hours, minutes), or combinations of physical units or services and time (lamp-hours, ton-years).

9. The *probable service life* of an individual unit is that period of time extending from its date of installation to the forecasted date when it probably will be retired from service.

10. The *expectancy* of life of an individual unit is that period of time extending from the observation age (usually the present) to the forecasted date when the unit probably will be retired from service. Age plus expectancy always equals probable life.

11. The *average service life of* a group of individual units is the quotient obtained by dividing the sum of the service lives of all the units by the number of units. The average service life (in years) is equal to the area under the survivor curve in percent-years (or unit-years) divided by 100 percent (or the total number of units).

12. The *probable average service life of* a group of individual units is the average of the probable service lives of the units of the group.

13. The *expectancy* of life of a group of individual units is that period of time extending from the observation age (usually the present) to the average of the forecasted dates when the units probably will be retired. The observation age plus the expectancy always equals the probable average service life.

> Note: Service life and average service life are always known quantities since they represent completed service life; probable service life and probable average service life always must be estimated since they are forecasts of uncompleted service.

14. *Maximum life* or *maximum age* is the age of the last unit of a given group to be retired from service; it is also the age at which the survivor curve has a zero ordinate, or zero percent surviving.

15. Property units which are taken out of service for any reason whatsoever are called *retirements*. Retirements may include original units (units of the initial installation) as well as "second-generation" units, that is, replacements (or renewals) which were installed to take the place of the original units as they were removed.

16. *Replacements* are the units put in service to replace retirements.

17. *Renewals* are replacements "in kind" which have exactly the same life characteristics as the retirements.

18. *Installations* are new units placed in service, not as replacement units, but as additions to the property.

19. All renewals, replacements, and installations are *placements*.

20. *Survivor curves* show the number of units of a given group

which are surviving in service at given ages. The ordinates to the curve give at any particular age the percentage (or the actual number) of the original number which are yet surviving in service. The abscissa is measured in years or other suitable service unit. The *original survivor curve* is the curve drawn through the points calculated from the original data without adjustment. Since this original survivor curve is generally irregular it is smoothed to produce a *smoothed survivor curve*, sometimes referred to as an *adjusted curve*.

Survivor curves have in some publications been referred to as *mortality curves*. However, the term *survivor curve* is used in this report because the curves referred to show the *percent surviving*, not the *percent retired*, and because the term *mortality* suggests human beings and not inanimate objects.

21. A *stub survivor curve* is an incomplete survivor curve; that is, one which does not extend to zero percent surviving because of a lack of retirement data on the longer-lived units.

22. A *probable-life curve* shows the probable average life of the survivors at any age from zero to maximum life.

23. If the percent surviving is read at the beginning of each successive age-interval and the differences in these successive readings plotted at ages corresponding to the midpoints of the intervals, the resulting points form a *frequency curve*, or *distribution curve*. Since the ordinates indicate the percentage of the units retired during each interval, the curve shows in what manner the retirements are distributed over the period from zero age to maximum life.

24. The point on the frequency curve having the highest ordinate is called the *mode*. The year in which the mode occurs is called the *modal year*.

25. A *maximum-life cycle* is a period of time corresponding in length to the maximum life of the units. An industrial property may continue to be operated through several maximum-life cycles of some of the units of which it is composed.

26. An *average-life cycle* is a period of time corresponding in length to the *average* life.

27. If a property is continued in service for a long time and maintained with a constant number of like units of substantially the same potential average life, it will reach a *normal condition* or *stabilized condition*, after which the average age of the units in service and the annual renewals will be constant year after year.

28. *Normal renewals* are the annual renewals after the property group has reached a stabilized condition. Normal renewals, in percent of the original number of units, are equal to 100 percent divided by the average life.

29. *Generalized curves* are those whose ordinates are expressed in percent of the total number of units and whose abscissas (age) are expressed in percent of average life.

30. *Type curves* are those theoretical curves derived by the methods described in this report from a study of actual retirements. They depict typical survivor and frequency curves for industrial property. Actual survivor curves are compared with type survivor curves in the process of determining probable average lives.

MORTALITY TABLES AND CURVES OF HUMAN BEINGS

By a study of population and deaths, life insurance companies have arrived at life tables for human beings of different nationalities. From these life tables the normal death rate and life expectancy for people at different ages can be determined as a basis for life insurance premiums and reserves. Life tables can be prepared from the vital statistics for any desired number of years in combination with census returns. By means of mathematical formulas a life table is adjusted to remove any slight irregularities that may exist in the original data.

Table 1 is the United States life table for white males, based upon deaths for the 10 years from 1901 to 1910. Unlike industrial property units whose average lives are continually being affected by many forces, the human average life and distribution of deaths according to age change very little over several generations. The life curve, however, varies considerably for different races as is illustrated in Fig. 2. The deaths at different ages are shown for the United States by the frequency curves in Fig. 3.

This reference to the United States life tables is made to show the similarity between the life characteristics of human beings and industrial properties. The essential differences are three. First, human beings experience a heavy infant mortality which results in a bi-modal frequency curve, one mode occurring between ages 0 and 1, and the other between ages 75 and 76. Second, the mode at the age-interval 75–76 occurs at a much greater percentage of average life than is usually found with physical property employed in industry. Third, the curves for industrial equipment vary in shape over wide limits while human mortality curves vary relatively little. The Makehamized curve in Fig. 3 is one that has been smoothed. (It does not represent the same group of lives as the lower curves of the figure.)

ANALYZING RETIREMENT DATA

The foregoing section discussed the life tables for humans and the accompanying curves. Similar analyses can be made of the behavior of the physical equipment employed in industry when sufficient information is available. The processes employed for analyzing the retirements of industrial property are not so easily handled as are those employed for mortality data of human beings, nor are the results usually as uniform because of the small number of units observed and the more numerous, less uniform causes of retirement of industrial

CHART NO. 9

SURVIVOR, PROBABLE LIFE AND FREQUENCY CURVES
FOR THE RIGHT-MODAL IOWA TYPE CURVES

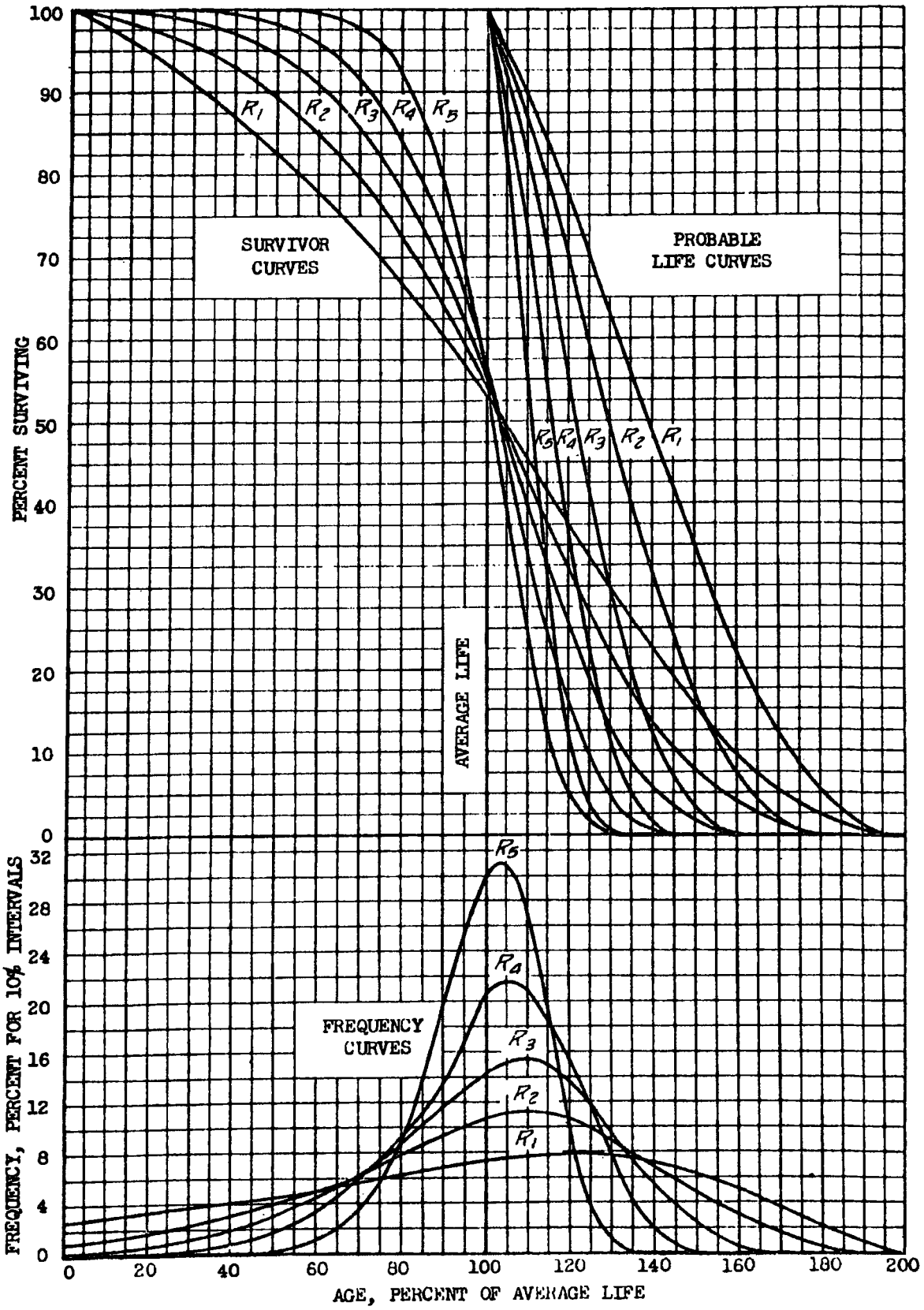


CHART NO. 8

SURVIVOR, PROBABLE LIFE AND FREQUENCY CURVES
FOR THE SYMMETRICAL IOWA TYPE CURVES

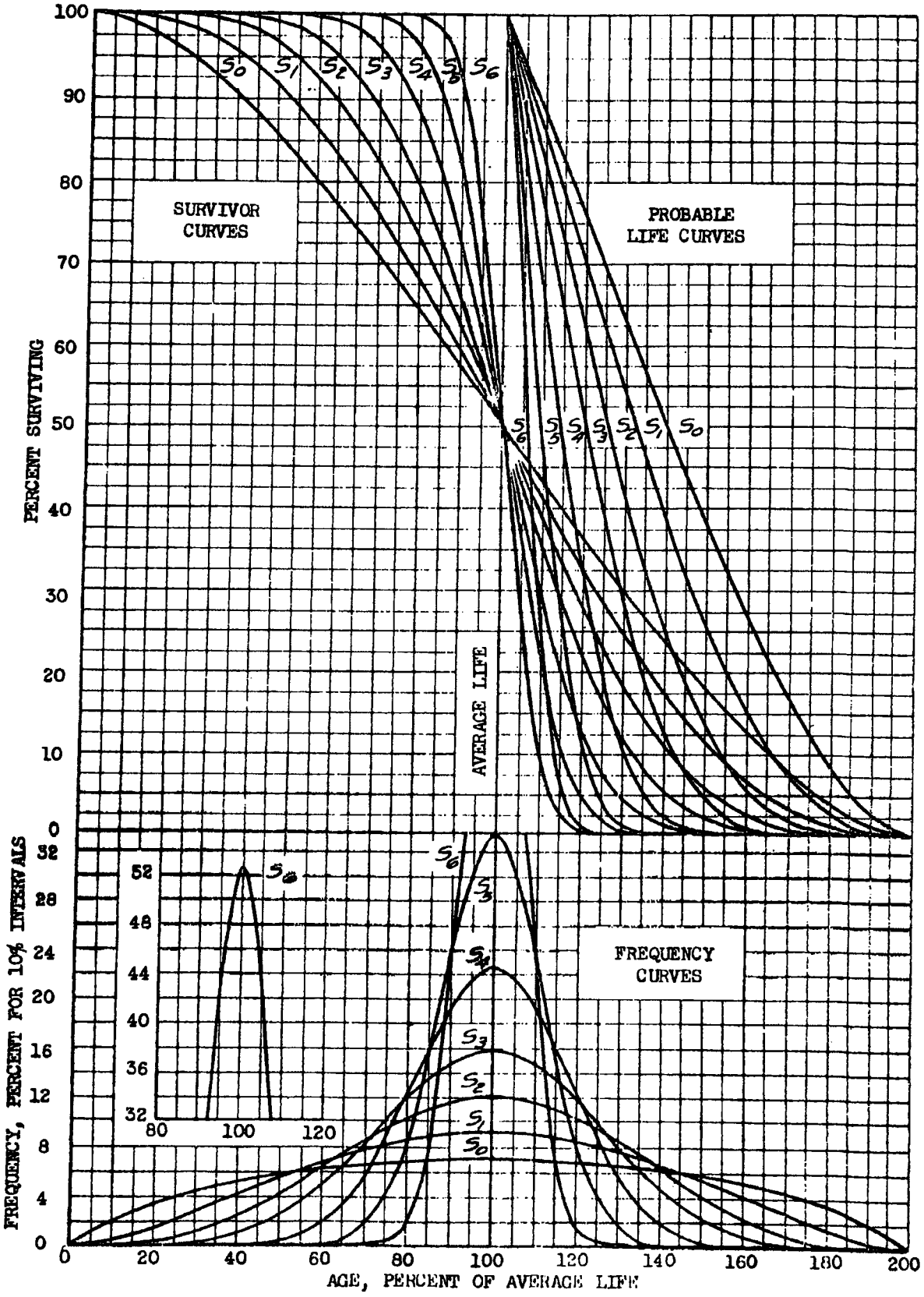
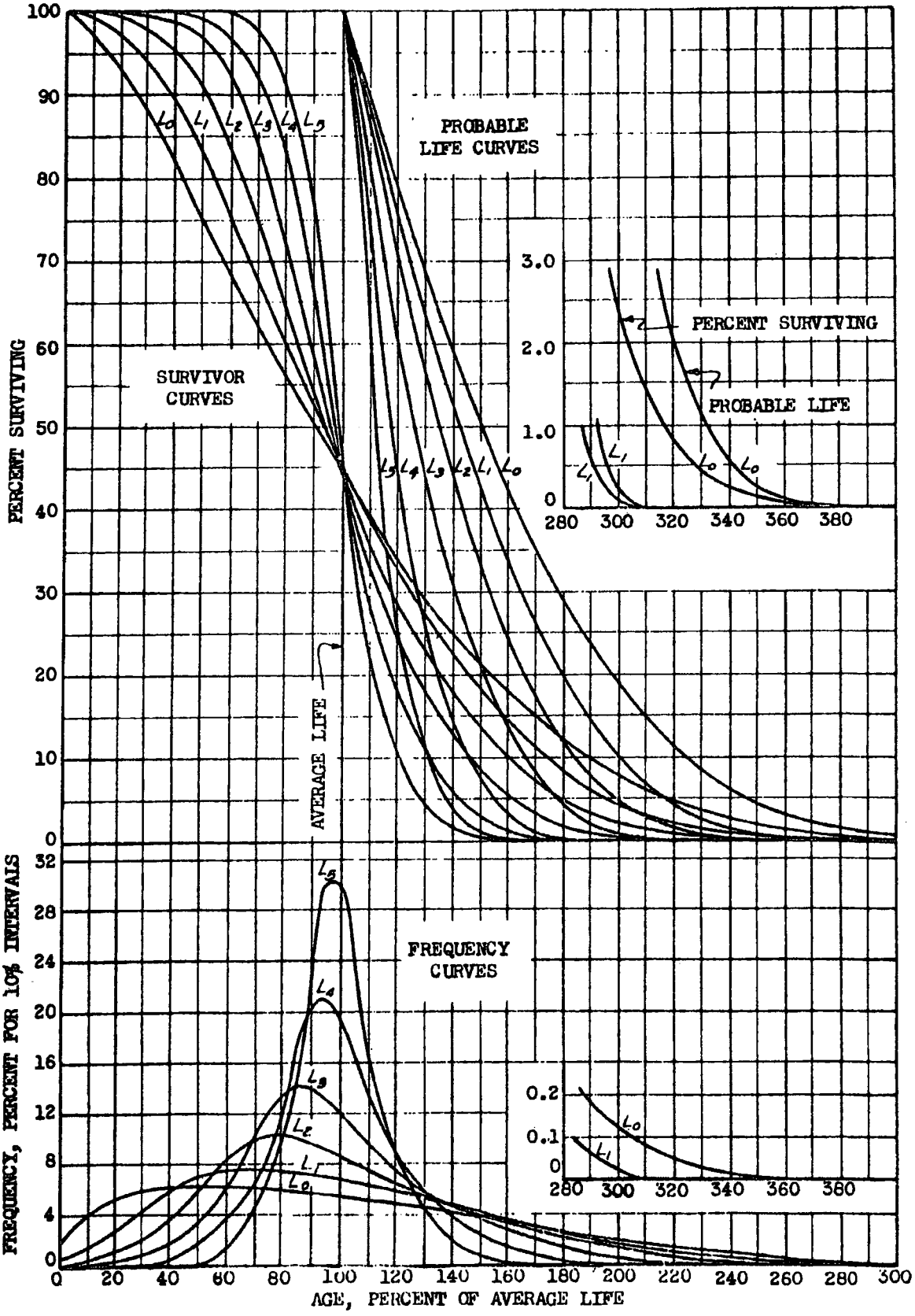


CHART NO. 7

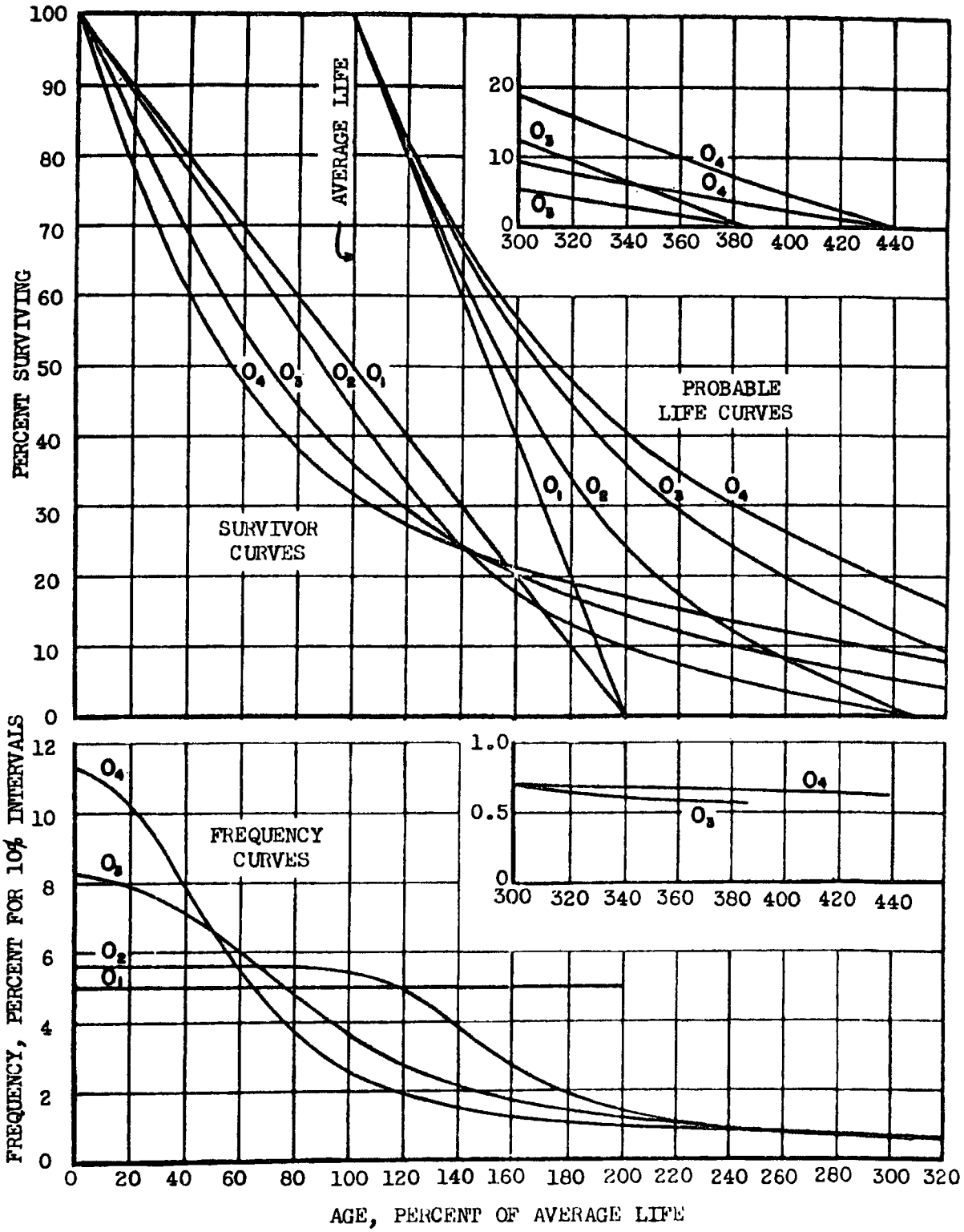
SURVIVOR, PROBABLE LIFE AND FREQUENCY CURVES
FOR THE LEFT-MODAL IOWA TYPE CURVES



Iowa Survivor Curves

CHART NO. 10

SURVIVOR, PROBABLE LIFE AND FREQUENCY CURVES
FOR THE ORIGIN-MODAL TYPE CURVES



Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.0000	R2.0	0	0.0948315	100.0000000	100.0000000	0.0000000
R2.0001	R2.0	1	0.0981016	99.9051685	99.0944462	0.9055538
R2.0002	R2.0	2	0.1014623	99.8070669	98.1913567	1.8086433
R2.0003	R2.0	3	0.1049099	99.7056046	97.2907686	2.7092314
R2.0004	R2.0	4	0.1084509	99.6006947	96.3927202	3.6072798
R2.0005	R2.0	5	0.1120825	99.4922438	95.4972458	4.5027542
R2.0006	R2.0	6	0.1158104	99.3801613	94.6043863	5.3956137
R2.0007	R2.0	7	0.1196318	99.2643509	93.7141762	6.2858238
R2.0008	R2.0	8	0.1235532	99.1447191	92.8266525	7.1733475
R2.0009	R2.0	9	0.1275731	99.0211659	91.9418526	8.0581474
R2.0010	R2.0	10	0.1316938	98.8935928	91.0598126	8.9401874
R2.0011	R2.0	11	0.1359167	98.7618990	90.1805687	9.8194313
R2.0012	R2.0	12	0.1402454	98.6259823	89.3041592	10.6958408
R2.0013	R2.0	13	0.1446791	98.4857369	88.4306173	11.5693827
R2.0014	R2.0	14	0.1492214	98.3410578	87.5599813	12.4400187
R2.0015	R2.0	15	0.1538735	98.1918364	86.6922846	13.3077154
R2.0016	R2.0	16	0.1586370	98.0379629	85.8275662	14.1724338
R2.0017	R2.0	17	0.1635142	97.8793259	84.9658604	15.0341396
R2.0018	R2.0	18	0.1685056	97.7158117	84.1072016	15.8927984
R2.0019	R2.0	19	0.1736164	97.5473061	83.2516279	16.7483721
R2.0020	R2.0	20	0.1788426	97.3736897	82.3991718	17.6008282
R2.0021	R2.0	21	0.1841926	97.1948471	81.5498714	18.4501286
R2.0022	R2.0	22	0.1896649	97.0106545	80.7037592	19.2962408
R2.0023	R2.0	23	0.1952619	96.8209896	79.8608723	20.1391277
R2.0024	R2.0	24	0.2009860	96.6257277	79.0212450	20.9787550
R2.0025	R2.0	25	0.2068376	96.4247417	78.1849127	21.8150873
R2.0026	R2.0	26	0.2128210	96.2179041	77.3519096	22.6480904
R2.0027	R2.0	27	0.2189369	96.0050831	76.5222740	23.4777260
R2.0028	R2.0	28	0.2251892	95.7861462	75.6960373	24.3039627
R2.0029	R2.0	29	0.2315760	95.5609570	74.8732357	25.1267643
R2.0030	R2.0	30	0.2381039	95.3293810	74.0539045	25.9460955
R2.0031	R2.0	31	0.2447710	95.0912771	73.2380800	26.7619200
R2.0032	R2.0	32	0.2515831	94.8465061	72.4257956	27.5742044
R2.0033	R2.0	33	0.2585392	94.5949230	71.6170883	28.3829117
R2.0034	R2.0	34	0.2656450	94.3363838	70.8119927	29.1880073
R2.0035	R2.0	35	0.2728977	94.0707388	70.0105457	29.9894543
R2.0036	R2.0	36	0.2803049	93.7978411	69.2127819	30.7872181
R2.0037	R2.0	37	0.2878657	93.5175362	68.4187384	31.5812616
R2.0038	R2.0	38	0.2955808	93.2296705	67.6284504	32.3715496
R2.0039	R2.0	39	0.3034544	92.9340897	66.8419552	33.1580448
R2.0040	R2.0	40	0.3114920	92.6306353	66.0592899	33.9407101
R2.0041	R2.0	41	0.3196878	92.3191433	65.2808571	34.7191429
R2.0042	R2.0	42	0.3280507	91.9994555	64.5055971	35.4944029
R2.0043	R2.0	43	0.3365783	91.6714048	63.7346439	36.2653561
R2.0044	R2.0	44	0.3452769	91.3348265	62.9676700	37.0323300

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.0045	R2.0	45	0.3541450	90.9895496	62.2047148	37.7952852
R2.0046	R2.0	46	0.3631840	90.6354046	61.4458170	38.5541830
R2.0047	R2.0	47	0.3723984	90.2722206	60.6910148	39.3089852
R2.0048	R2.0	48	0.3817892	89.8998222	59.9403491	40.0596509
R2.0049	R2.0	49	0.3913574	89.5180330	59.1938582	40.8061418
R2.0050	R2.0	50	0.4011030	89.1266756	58.4515839	41.5484161
R2.0051	R2.0	51	0.4110289	88.7255726	57.7135668	42.2864332
R2.0052	R2.0	52	0.4211368	88.3145437	56.9798470	43.0201530
R2.0053	R2.0	53	0.4314261	87.8934069	56.2504678	43.7495322
R2.0054	R2.0	54	0.4419002	87.4619808	55.5254688	44.4745312
R2.0055	R2.0	55	0.4525547	87.0200806	54.8048959	45.1951041
R2.0056	R2.0	56	0.4633961	86.5675259	54.0887899	45.9112101
R2.0057	R2.0	57	0.4744196	86.1041298	53.3771148	46.6228852
R2.0058	R2.0	58	0.4856272	85.6297102	52.6701531	47.3298469
R2.0059	R2.0	59	0.4970178	85.1440830	51.9677110	48.0322890
R2.0060	R2.0	60	0.5085907	84.6470652	51.2699108	48.7300892
R2.0061	R2.0	61	0.5203457	84.1384745	50.5767999	49.4232001
R2.0062	R2.0	62	0.5322781	83.6181288	49.8884211	50.1115789
R2.0063	R2.0	63	0.5443878	83.0858507	49.2042208	50.7957792
R2.0064	R2.0	64	0.5566711	82.5414629	48.5260449	51.4739551
R2.0065	R2.0	65	0.5691252	81.9847918	47.8521390	52.1478610
R2.0066	R2.0	66	0.5817490	81.4156666	47.1831479	52.8168521
R2.0067	R2.0	67	0.5945339	80.8339176	46.5191188	53.4808812
R2.0068	R2.0	68	0.6074762	80.2393837	45.8600979	54.1399021
R2.0069	R2.0	69	0.6205731	79.6319075	45.2061300	54.7938700
R2.0070	R2.0	70	0.6338167	79.0113344	44.5572619	55.4427381
R2.0071	R2.0	71	0.6471968	78.3775177	43.9135399	56.0864601
R2.0072	R2.0	72	0.6607103	77.7303209	43.2750101	56.7249899
R2.0073	R2.0	73	0.6743469	77.0696106	42.6417151	57.3582849
R2.0074	R2.0	74	0.6880913	76.3952637	42.0137038	57.9862962
R2.0075	R2.0	75	0.7019453	75.7071724	41.3910160	58.6089840
R2.0076	R2.0	76	0.7158861	75.0052271	40.7736988	59.2263012
R2.0077	R2.0	77	0.7299071	74.2893410	40.1617951	59.8382049
R2.0078	R2.0	78	0.7439918	73.5594339	39.5553460	60.4446540
R2.0079	R2.0	79	0.7581263	72.8154421	38.9543939	61.0456061
R2.0080	R2.0	80	0.7722978	72.0573158	38.3589792	61.6410208
R2.0081	R2.0	81	0.7864914	71.2850180	37.7691412	62.2308588
R2.0082	R2.0	82	0.8006802	70.4985266	37.1849198	62.8150802
R2.0083	R2.0	83	0.8148537	69.6978464	36.6063528	63.3936472
R2.0084	R2.0	84	0.8289880	68.8829927	36.0334740	63.9665260
R2.0085	R2.0	85	0.8430577	68.0540047	35.4663181	64.5336819
R2.0086	R2.0	86	0.8570489	67.2109470	34.9049168	65.0950832
R2.0087	R2.0	87	0.8709355	66.3538981	34.3493028	65.6506972
R2.0088	R2.0	88	0.8846855	65.4829626	33.7995038	66.2004962
R2.0089	R2.0	89	0.8982801	64.5982771	33.2555461	66.7444539

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.0090	R2.0	90	0.9116889	63.6999970	32.7174568	67.2825432
R2.0091	R2.0	91	0.9248881	62.7883081	32.1852560	67.8147440
R2.0092	R2.0	92	0.9378390	61.8634200	31.6589661	68.3410339
R2.0093	R2.0	93	0.9505158	60.9255810	31.1386020	68.8613980
R2.0094	R2.0	94	0.9628930	59.9750652	30.6241779	69.3758221
R2.0095	R2.0	95	0.9749274	59.0121722	30.1157100	69.8842900
R2.0096	R2.0	96	0.9865956	58.0372448	29.6132040	70.3867960
R2.0097	R2.0	97	0.9978571	57.0506492	29.1166680	70.8833320
R2.0098	R2.0	98	1.0086742	56.0527921	28.6261051	71.3738949
R2.0099	R2.0	99	1.0190200	55.0441179	28.1415110	71.8584890
R2.0100	R2.0	100	1.0288558	54.0250979	27.6628840	72.3371160
R2.0101	R2.0	101	1.0381442	52.9962421	27.1902180	72.8097820
R2.0102	R2.0	102	1.0468449	51.9580979	26.7234991	73.2765009
R2.0103	R2.0	103	1.0549312	50.9112530	26.2627111	73.7372889
R2.0104	R2.0	104	1.0623607	49.8563218	25.8078351	74.1921649
R2.0105	R2.0	105	1.0691033	48.7939611	25.3588469	74.6411531
R2.0106	R2.0	106	1.0751200	47.7248578	24.9157200	75.0842800
R2.0107	R2.0	107	1.0803718	46.6497378	24.4784200	75.5215800
R2.0108	R2.0	108	1.0848422	45.5693660	24.0469079	75.9530921
R2.0109	R2.0	109	1.0884819	44.4845238	23.6211450	76.3788550
R2.0110	R2.0	110	1.0912700	43.3960419	23.2010810	76.7989190
R2.0111	R2.0	111	1.0931697	42.3047719	22.7866659	77.2133341
R2.0112	R2.0	112	1.0941701	41.2116022	22.3778369	77.6221631
R2.0113	R2.0	113	1.0942240	40.1174321	21.9745369	78.0254631
R2.0114	R2.0	114	1.0933342	39.0232081	21.5766909	78.4233091
R2.0115	R2.0	115	1.0914621	37.9298739	21.1842289	78.8157711
R2.0116	R2.0	116	1.0885978	36.8384118	20.7970691	79.2029309
R2.0117	R2.0	117	1.0847301	35.7498140	20.4151239	79.5848761
R2.0118	R2.0	118	1.0798369	34.6650839	20.0383019	79.9616981
R2.0119	R2.0	119	1.0739369	33.5852470	19.6665001	80.3334999
R2.0120	R2.0	120	1.0669980	32.5113101	19.2996221	80.7003779
R2.0121	R2.0	121	1.0590372	31.4443121	18.9375479	81.0624521
R2.0122	R2.0	122	1.0501070	30.3852749	18.5801630	81.4198370
R2.0123	R2.0	123	1.0400660	29.3351679	18.2273769	81.7726231
R2.0124	R2.0	124	1.0290709	28.2951019	17.8789959	82.1210041
R2.0125	R2.0	125	1.0170991	27.2660310	17.5349121	82.4650879
R2.0126	R2.0	126	1.0041568	26.2489319	17.1949849	82.8050151
R2.0127	R2.0	127	0.9902881	25.2447751	16.8590529	83.1409471
R2.0128	R2.0	128	0.9755079	24.2544870	16.5269830	83.4730170
R2.0129	R2.0	129	0.9598532	23.2789791	16.1985951	83.8014049
R2.0130	R2.0	130	0.9433670	22.3191259	15.8737270	84.1262730
R2.0131	R2.0	131	0.9260879	21.3757589	15.5522090	84.4477910
R2.0132	R2.0	132	0.9080550	20.4496710	15.2338660	84.7661340
R2.0133	R2.0	133	0.8893190	19.5416160	14.9185150	85.0814850
R2.0134	R2.0	134	0.8699369	18.6522970	14.6059730	85.3940270

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.0135	R2.0	135	0.8499541	17.7823601	14.2960570	85.7039430
R2.0136	R2.0	136	0.8294290	16.9324060	13.9885750	86.0114250
R2.0137	R2.0	137	0.8084200	16.1029770	13.6833420	86.3166580
R2.0138	R2.0	138	0.7869870	15.2945570	13.3801709	86.6198291
R2.0139	R2.0	139	0.7651829	14.5075700	13.0788760	86.9211240
R2.0140	R2.0	140	0.7430681	13.7423871	12.7792740	87.2207260
R2.0141	R2.0	141	0.7207081	12.9993190	12.4811831	87.5188169
R2.0142	R2.0	142	0.6981599	12.2786109	12.1844341	87.8155659
R2.0143	R2.0	143	0.6754730	11.5804510	11.8888620	88.1111380
R2.0144	R2.0	144	0.6527110	10.9049780	11.5943070	88.4056930
R2.0145	R2.0	145	0.6299220	10.2522670	11.3006270	88.6993730
R2.0146	R2.0	146	0.6071579	9.6223450	11.0076849	88.9923151
R2.0147	R2.0	147	0.5844650	9.0151870	10.7153600	89.2846400
R2.0148	R2.0	148	0.5618890	8.4307220	10.4235460	89.5764540
R2.0149	R2.0	149	0.5394630	7.8688330	10.1321560	89.8678440
R2.0150	R2.0	150	0.5172310	7.3293700	9.8411110	90.1588891
R2.0151	R2.0	151	0.4952170	6.8121390	9.5503610	90.4496390
R2.0152	R2.0	152	0.4734520	6.3169220	9.2598670	90.7401331
R2.0153	R2.0	153	0.4519570	5.8434700	8.9696111	91.0303890
R2.0154	R2.0	154	0.4307510	5.3915130	8.6795980	91.3204020
R2.0155	R2.0	155	0.4098480	4.9607620	8.3898460	91.6101540
R2.0156	R2.0	156	0.3892590	4.5509140	8.1003940	91.8996060
R2.0157	R2.0	157	0.3689940	4.1616550	7.8112940	92.1887060
R2.0158	R2.0	158	0.3490550	3.7926610	7.5226200	92.4773800
R2.0159	R2.0	159	0.3294490	3.4436060	7.2344580	92.7655420
R2.0160	R2.0	160	0.3101780	3.1141570	6.9468990	93.0531010
R2.0161	R2.0	161	0.2912410	2.8039790	6.6600590	93.3399410
R2.0162	R2.0	162	0.2726440	2.5127380	6.3740460	93.6259540
R2.0163	R2.0	163	0.2543900	2.2400940	6.0889820	93.9110180
R2.0164	R2.0	164	0.2364840	1.9857040	5.8049920	94.1950080
R2.0165	R2.0	165	0.2189350	1.7492200	5.5221940	94.4778060
R2.0166	R2.0	166	0.2017570	1.5302850	5.2407130	94.7592870
R2.0167	R2.0	167	0.1849660	1.3285280	4.9606590	95.0393410
R2.0168	R2.0	168	0.1685830	1.1435620	4.6821490	95.3178510
R2.0169	R2.0	169	0.1526310	0.9749790	4.4052860	95.5947140
R2.0170	R2.0	170	0.1371620	0.8223480	4.1301220	95.8698780
R2.0171	R2.0	171	0.1221950	0.6851860	3.8568020	96.1431980
R2.0172	R2.0	172	0.1077830	0.5629910	3.5853840	96.4146160
R2.0173	R2.0	173	0.0939780	0.4552080	3.3159460	96.6840540
R2.0174	R2.0	174	0.0808330	0.3612300	3.0485230	96.9514770
R2.0175	R2.0	175	0.0684150	0.2803970	2.7832120	97.2167880
R2.0176	R2.0	176	0.0567860	0.2119820	2.5201260	97.4798740
R2.0177	R2.0	177	0.0460210	0.1551960	2.2592980	97.7407020
R2.0178	R2.0	178	0.0361913	0.1091750	2.0008840	97.9991160
R2.0179	R2.0	179	0.0273739	0.0729837	1.7451020	98.2548980

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Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.5000	R2.5	0	0.0551548	100.0000000	100.0000000	0.0000000
R2.5001	R2.5	1	0.0574713	99.9448452	99.0549097	0.9450903
R2.5002	R2.5	2	0.0598783	99.8873739	98.1116142	1.8883858
R2.5003	R2.5	3	0.0623808	99.8274956	97.1701632	2.8298368
R2.5004	R2.5	4	0.0649805	99.7651148	96.2306089	3.7693911
R2.5005	R2.5	5	0.0676823	99.7001343	95.2930031	4.7069969
R2.5006	R2.5	6	0.0704880	99.6324520	94.3573971	5.6426029
R2.5007	R2.5	7	0.0734014	99.5619640	93.4238472	6.5761528
R2.5008	R2.5	8	0.0764256	99.4885626	92.4924040	7.5075960
R2.5009	R2.5	9	0.0795669	99.4121370	91.5631256	8.4368744
R2.5010	R2.5	10	0.0828257	99.3325701	90.6360693	9.3639307
R2.5011	R2.5	11	0.0862064	99.2497444	89.7112904	10.2887096
R2.5012	R2.5	12	0.0897122	99.1635380	88.7888441	11.2111559
R2.5013	R2.5	13	0.0933485	99.0738258	87.8687897	12.1312103
R2.5014	R2.5	14	0.0971183	98.9804773	86.9511881	13.0488119
R2.5015	R2.5	15	0.1010247	98.8833590	86.0360956	13.9639044
R2.5016	R2.5	16	0.1050710	98.7823343	85.1235743	14.8764257
R2.5017	R2.5	17	0.1092635	98.6772633	84.2136803	15.7863197
R2.5018	R2.5	18	0.1136026	98.5679998	83.3064766	16.6935234
R2.5019	R2.5	19	0.1180954	98.4543972	82.4020252	17.5979748
R2.5020	R2.5	20	0.1227426	98.3363018	81.5003834	18.4996166
R2.5021	R2.5	21	0.1275521	98.2135592	80.6016140	19.3983860
R2.5022	R2.5	22	0.1325226	98.0860071	79.7057791	20.2942209
R2.5023	R2.5	23	0.1376619	97.9534845	78.8129368	21.1870632
R2.5024	R2.5	24	0.1429729	97.8158226	77.9231520	22.0768480
R2.5025	R2.5	25	0.1484576	97.6728497	77.0364828	22.9635172
R2.5026	R2.5	26	0.1541233	97.5243921	76.1529923	23.8470077
R2.5027	R2.5	27	0.1599703	97.3702688	75.2727404	24.7272596
R2.5028	R2.5	28	0.1660032	97.2102985	74.3957863	25.6042137
R2.5029	R2.5	29	0.1722278	97.0442953	73.5221920	26.4778080
R2.5030	R2.5	30	0.1786452	96.8720675	72.6520176	27.3479824
R2.5031	R2.5	31	0.1852608	96.6934223	71.7853222	28.2146778
R2.5032	R2.5	32	0.1920747	96.5081615	70.9221630	29.0778370
R2.5033	R2.5	33	0.1990958	96.3160868	70.0626001	29.9373999
R2.5034	R2.5	34	0.2063245	96.1169910	69.2066917	30.7933083
R2.5035	R2.5	35	0.2137642	95.9106665	68.3544951	31.6455049
R2.5036	R2.5	36	0.2214194	95.6969023	67.5060663	32.4939337
R2.5037	R2.5	37	0.2292928	95.4754829	66.6614609	33.3385391
R2.5038	R2.5	38	0.2373877	95.2461901	65.8207359	34.1792641
R2.5039	R2.5	39	0.2457084	95.0088024	64.9839459	35.0160541
R2.5040	R2.5	40	0.2542592	94.7630940	64.1511440	35.8488560
R2.5041	R2.5	41	0.2630376	94.5088348	63.3223858	36.6776142
R2.5042	R2.5	42	0.2720566	94.2457972	62.4977222	37.5022778
R2.5043	R2.5	43	0.2813111	93.9737406	61.6772060	38.3227940
R2.5044	R2.5	44	0.2908077	93.6924295	60.8608909	39.1391091

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Iowa Survivor Curves

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Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.5045	R2.5	45	0.3005543	93.4016218	60.0488248	39.9511752
R2.5046	R2.5	46	0.3105459	93.1010675	59.2410641	40.7589359
R2.5047	R2.5	47	0.3207922	92.7905216	58.4376559	41.5623441
R2.5048	R2.5	48	0.3312959	92.4697294	57.6386509	42.3613491
R2.5049	R2.5	49	0.3420601	92.1384335	56.8441010	43.1558990
R2.5050	R2.5	50	0.3530903	91.7963734	56.0540552	43.9459448
R2.5051	R2.5	51	0.3643885	91.4432831	55.2685661	44.7314339
R2.5052	R2.5	52	0.3759584	91.0788946	54.4876838	45.5123162
R2.5053	R2.5	53	0.3878079	90.7029362	53.7114601	46.2885399
R2.5054	R2.5	54	0.3999405	90.3151283	52.9399471	47.0600529
R2.5055	R2.5	55	0.4123592	89.9151878	52.1731982	47.8268018
R2.5056	R2.5	56	0.4250708	89.5028286	51.4112682	48.5887318
R2.5057	R2.5	57	0.4380798	89.0777578	50.6542120	49.3457880
R2.5058	R2.5	58	0.4513912	88.6396780	49.9020872	50.0979128
R2.5059	R2.5	59	0.4650126	88.1882868	49.1549511	50.8450489
R2.5060	R2.5	60	0.4789476	87.7232742	48.4128661	51.5871339
R2.5061	R2.5	61	0.4932022	87.2443266	47.6758952	52.3241048
R2.5062	R2.5	62	0.5077830	86.7511244	46.9441018	53.0558982
R2.5063	R2.5	63	0.5226945	86.2433414	46.2175550	53.7824450
R2.5064	R2.5	64	0.5379439	85.7206469	45.4963250	54.5036750
R2.5065	R2.5	65	0.5535354	85.1827030	44.7804852	55.2195148
R2.5066	R2.5	66	0.5694743	84.6291676	44.0701108	55.9298892
R2.5067	R2.5	67	0.5857687	84.0596933	43.3652830	56.6347170
R2.5068	R2.5	68	0.6024160	83.4739246	42.6660848	57.3339152
R2.5069	R2.5	69	0.6194267	82.8715086	41.9726019	58.0273981
R2.5070	R2.5	70	0.6368008	82.2520819	41.2849250	58.7150750
R2.5071	R2.5	71	0.6545391	81.6152811	40.6031480	59.3968520
R2.5072	R2.5	72	0.6726418	80.9607420	39.9273682	60.0726318
R2.5073	R2.5	73	0.6911087	80.2881002	39.2576852	60.7423148
R2.5074	R2.5	74	0.7099390	79.5969915	38.5942020	61.4057980
R2.5075	R2.5	75	0.7291259	78.8870525	37.9370279	62.0629721
R2.5076	R2.5	76	0.7486620	78.1579266	37.2862740	62.7137260
R2.5077	R2.5	77	0.7685376	77.4092646	36.6420512	63.3579488
R2.5078	R2.5	78	0.7887430	76.6407270	36.0044770	63.9955230
R2.5079	R2.5	79	0.8092565	75.8519840	35.3736682	64.6263318
R2.5080	R2.5	80	0.8300667	75.0427275	34.7497439	65.2502561
R2.5081	R2.5	81	0.8511477	74.2126608	34.1328259	65.8671741
R2.5082	R2.5	82	0.8724718	73.3615131	33.5230379	66.4769621
R2.5083	R2.5	83	0.8940096	72.4890413	32.9204998	67.0795002
R2.5084	R2.5	84	0.9157238	71.5950317	32.3253360	67.6746640
R2.5085	R2.5	85	0.9375753	70.6793079	31.7376659	68.2623341
R2.5086	R2.5	86	0.9595194	69.7417326	31.1576109	68.8423891
R2.5087	R2.5	87	0.9815073	68.7822132	30.5852881	69.4147119
R2.5088	R2.5	88	1.0034790	67.8007059	30.0208130	69.9791870
R2.5089	R2.5	89	1.0253773	66.7972269	29.4642980	70.5357020

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.5090	R2.5	90	1.0471344	65.7718496	28.9158480	71.0841520
R2.5091	R2.5	91	1.0686831	64.7247152	28.3755679	71.6244321
R2.5092	R2.5	92	1.0899420	63.6560321	27.8435540	72.1564460
R2.5093	R2.5	93	1.1108289	62.5660901	27.3198969	72.6801031
R2.5094	R2.5	94	1.1312651	61.4552612	26.8046770	73.1953230
R2.5095	R2.5	95	1.1511522	60.3239961	26.2979729	73.7020271
R2.5096	R2.5	96	1.1704039	59.1728439	25.7998481	74.2001519
R2.5097	R2.5	97	1.1889191	58.0024400	25.3103621	74.6896379
R2.5098	R2.5	98	1.2065949	56.8135209	24.8295610	75.1704390
R2.5099	R2.5	99	1.2233358	55.6069260	24.3574791	75.6425209
R2.5100	R2.5	100	1.2390403	54.3835902	23.8941431	76.1058569
R2.5101	R2.5	101	1.2536021	53.1445499	23.4395671	76.5604329
R2.5102	R2.5	102	1.2669158	51.8909478	22.9937501	77.0062499
R2.5103	R2.5	103	1.2788939	50.6240320	22.5566781	77.4433219
R2.5104	R2.5	104	1.2894273	49.3451381	22.1283281	77.8716719
R2.5105	R2.5	105	1.2984328	48.0557108	21.7086580	78.2913420
R2.5106	R2.5	106	1.3058210	46.7572780	21.2976141	78.7023859
R2.5107	R2.5	107	1.3115058	45.4514570	20.8951299	79.1048701
R2.5108	R2.5	108	1.3154220	44.1399512	20.5011189	79.4988811
R2.5109	R2.5	109	1.3175020	42.8245292	20.1154850	79.8845150
R2.5110	R2.5	110	1.3176890	41.5070272	19.7381129	80.2618871
R2.5111	R2.5	111	1.3159404	40.1893382	19.3688741	80.6311259
R2.5112	R2.5	112	1.3122248	38.8733978	19.0076220	80.9923780
R2.5113	R2.5	113	1.3065191	37.5611730	18.6541979	81.3458021
R2.5114	R2.5	114	1.2988228	36.2546539	18.3084259	81.6915741
R2.5115	R2.5	115	1.2891360	34.9558311	17.9701180	82.0298820
R2.5116	R2.5	116	1.2774830	33.6666951	17.6390679	82.3609321
R2.5117	R2.5	117	1.2638931	32.3892121	17.3150611	82.6849389
R2.5118	R2.5	118	1.2484150	31.1253190	16.9978631	83.0021369
R2.5119	R2.5	119	1.2311139	29.8769040	16.6872311	83.3127689
R2.5120	R2.5	120	1.2120590	28.6457901	16.3829119	83.6170881
R2.5121	R2.5	121	1.1913381	27.4337311	16.0846400	83.9153600
R2.5122	R2.5	122	1.1690731	26.2423930	15.7921439	84.2078561
R2.5123	R2.5	123	1.1452968	25.0733199	15.5051580	84.4948420
R2.5124	R2.5	124	1.1201971	23.9280231	15.2233681	84.7766319
R2.5125	R2.5	125	1.0938761	22.8078260	14.9465010	85.0534990
R2.5126	R2.5	126	1.0664589	21.7139499	14.6742671	85.3257329
R2.5127	R2.5	127	1.0380819	20.6474910	14.4063790	85.5936210
R2.5128	R2.5	128	1.0088780	19.6094091	14.1425540	85.8574460
R2.5129	R2.5	129	0.9789822	18.6005311	13.8825150	86.1174850
R2.5130	R2.5	130	0.9485328	17.6215489	13.6259940	86.3740060
R2.5131	R2.5	131	0.9176611	16.6730161	13.3727360	86.6272640
R2.5132	R2.5	132	0.8864870	15.7553550	13.1224999	86.8775001
R2.5133	R2.5	133	0.8551400	14.8688680	12.8750581	87.1249419
R2.5134	R2.5	134	0.8237340	14.0137280	12.6302040	87.3697960

database

Iowa Survivor Curves

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Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.5135	R2.5	135	0.7923711	13.1899940	12.3877521	87.6122479
R2.5136	R2.5	136	0.7611500	12.3976229	12.1475360	87.8524640
R2.5137	R2.5	137	0.7301579	11.6364729	11.9094091	88.0905909
R2.5138	R2.5	138	0.6994760	10.9063150	11.6732490	88.3267510
R2.5139	R2.5	139	0.6691670	10.2068390	11.4389530	88.5610470
R2.5140	R2.5	140	0.6392890	9.5376720	11.2064340	88.7935660
R2.5141	R2.5	141	0.6098980	8.8983830	10.9756200	89.0243800
R2.5142	R2.5	142	0.5810320	8.2884851	10.7464550	89.2535450
R2.5143	R2.5	143	0.5527210	7.7074530	10.5188921	89.4811079
R2.5144	R2.5	144	0.5249980	7.1547320	10.2928760	89.7071240
R2.5145	R2.5	145	0.4978830	6.6297340	10.0683579	89.9316421
R2.5146	R2.5	146	0.4713970	6.1318510	9.8452730	90.1547270
R2.5147	R2.5	147	0.4455530	5.6604540	9.6235380	90.3764620
R2.5148	R2.5	148	0.4203759	5.2149010	9.4030380	90.5969620
R2.5149	R2.5	149	0.3958700	4.7945250	9.1836420	90.8163580
R2.5150	R2.5	150	0.3720580	4.3986550	8.9651520	91.0348480
R2.5151	R2.5	151	0.3489550	4.0265970	8.7473331	91.2526670
R2.5152	R2.5	152	0.3265810	3.6776420	8.5298860	91.4701140
R2.5153	R2.5	153	0.3049580	3.3510610	8.3124470	91.6875531
R2.5154	R2.5	154	0.2841100	3.0461030	8.0945830	91.9054170
R2.5155	R2.5	155	0.2640620	2.7619930	7.8757930	92.1242070
R2.5156	R2.5	156	0.2448380	2.4979310	7.6555050	92.3444950
R2.5157	R2.5	157	0.2264680	2.2530930	7.4330760	92.5669240
R2.5158	R2.5	158	0.2089740	2.0266250	7.2078220	92.7921780
R2.5159	R2.5	159	0.1923820	1.8176510	6.9790150	93.0209850
R2.5160	R2.5	160	0.1767130	1.6252690	6.7459320	93.2540680
R2.5161	R2.5	161	0.1619790	1.4485560	6.5078890	93.4921110
R2.5162	R2.5	162	0.1481900	1.2865770	6.2642780	93.7357220
R2.5163	R2.5	163	0.1353470	1.1383870	6.0146450	93.9853550
R2.5164	R2.5	164	0.1234370	1.0030400	5.7587730	94.2412270
R2.5165	R2.5	165	0.1124400	0.8796030	5.4967510	94.5032490
R2.5166	R2.5	166	0.1023100	0.7671630	5.2291050	94.7708950
R2.5167	R2.5	167	0.0929890	0.6648530	4.9568360	95.0431640
R2.5168	R2.5	168	0.0843740	0.5718640	4.6815480	95.3184520
R2.5169	R2.5	169	0.0763160	0.4874900	4.4052840	95.5947160
R2.5170	R2.5	170	0.0685810	0.4111740	4.1301250	95.8698750
R2.5171	R2.5	171	0.0610970	0.3425930	3.8568110	96.1431890
R2.5172	R2.5	172	0.0538920	0.2814960	3.5853870	96.4146130
R2.5173	R2.5	173	0.0469890	0.2276040	3.3159430	96.6840570
R2.5174	R2.5	174	0.0404160	0.1806150	3.0485420	96.9514580
R2.5175	R2.5	175	0.0342080	0.1401990	2.7832260	97.2167740
R2.5176	R2.5	176	0.0283930	0.1059910	2.5201240	97.4798760
R2.5177	R2.5	177	0.0230100	0.0775980	2.2592850	97.7407150
R2.5178	R2.5	178	0.0181160	0.0545880	2.0008610	97.9991390
R2.5179	R2.5	179	0.0136670	0.0364720	1.7451220	98.2548780

database

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R2.5180	R2.5	180	0.0098240	0.0228050	1.4924140	98.5075860
R2.5181	R2.5	181	0.0065460	0.0129810	1.2434710	98.7565290
R2.5182	R2.5	182	0.0038930	0.0064350	0.9997670	99.0002330
R2.5183	R2.5	183	0.0019010	0.0025420	0.7651460	99.2348540
R2.5184	R2.5	184	0.0006080	0.0006410	0.5514820	99.4485180
R2.5185	R2.5	185	0.0000330	0.0000330	0.5000000	99.5000000
R2.5186	R2.5	186	0.0000000	0.0000000	0.0000000	100.0000000

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Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1 Lookup	2 Curve	3 Age %	4 % Ret	5 % Surv	6 % Cond	7 % Depr Resv
R3.0000	R3.0	0	0.0154791	100.0000000	100.0000000	0.0000000
R3.0001	R3.0	1	0.0168400	99.9845209	99.0154038	0.9845962
R3.0002	R3.0	2	0.0182953	99.9676809	98.0319996	1.9680004
R3.0003	R3.0	3	0.0198507	99.9493856	97.0498524	2.9501476
R3.0004	R3.0	4	0.0215111	99.9295349	96.0690317	3.9309683
R3.0005	R3.0	5	0.0232811	99.9080238	95.0896082	4.9103918
R3.0006	R3.0	6	0.0251655	99.8847427	94.1116552	5.8883448
R3.0007	R3.0	7	0.0271702	99.8595772	93.1352463	6.8647537
R3.0008	R3.0	8	0.0292997	99.8324070	92.1604576	7.8395424
R3.0009	R3.0	9	0.0315600	99.8031073	91.1873674	8.8126326
R3.0010	R3.0	10	0.0339584	99.7715473	90.2160540	9.7839460
R3.0011	R3.0	11	0.0364952	99.7375889	89.2465992	10.7534008
R3.0012	R3.0	12	0.0391798	99.7010937	88.2790852	11.7209148
R3.0013	R3.0	13	0.0420189	99.6619139	87.3135939	12.6864061
R3.0014	R3.0	14	0.0450144	99.6198950	86.3502102	13.6497898
R3.0015	R3.0	15	0.0481758	99.5748806	85.3890209	14.6109791
R3.0016	R3.0	16	0.0515060	99.5267048	84.4301109	15.5698891
R3.0017	R3.0	17	0.0550118	99.4751988	83.4735680	16.5264320
R3.0018	R3.0	18	0.0586996	99.4201870	82.5194798	17.4805202
R3.0019	R3.0	19	0.0625744	99.3614874	81.5679340	18.4320660
R3.0020	R3.0	20	0.0666428	99.2989130	80.6190205	19.3809795
R3.0021	R3.0	21	0.0709104	99.2322702	79.6728268	20.3271732
R3.0022	R3.0	22	0.0753794	99.1613598	78.7294426	21.2705574
R3.0023	R3.0	23	0.0800638	99.0859804	77.7889566	22.2110434
R3.0024	R3.0	24	0.0849600	99.0059166	76.8514566	23.1485434
R3.0025	R3.0	25	0.0900774	98.9209566	75.9170332	24.0829668
R3.0026	R3.0	26	0.0954256	98.8308792	74.9857712	25.0142288
R3.0027	R3.0	27	0.1010027	98.7354536	74.0577602	25.9422398
R3.0028	R3.0	28	0.1068191	98.6344509	73.1330843	26.8669157
R3.0029	R3.0	29	0.1128788	98.5276318	72.2118292	27.7881708
R3.0030	R3.0	30	0.1191874	98.4147530	71.2940807	28.7059193
R3.0031	R3.0	31	0.1257477	98.2955656	70.3799210	29.6200790
R3.0032	R3.0	32	0.1325683	98.1698179	69.4694319	30.5305681
R3.0033	R3.0	33	0.1396523	98.0372496	68.5626936	31.4373064
R3.0034	R3.0	34	0.1470041	97.8975973	67.6597862	32.3402138
R3.0035	R3.0	35	0.1546307	97.7505932	66.7607861	33.2392139
R3.0036	R3.0	36	0.1625337	97.5959625	65.8657694	34.1342306
R3.0037	R3.0	37	0.1707211	97.4334288	64.9748087	35.0251913
R3.0038	R3.0	38	0.1791944	97.2627077	64.0879793	35.9120207
R3.0039	R3.0	39	0.1879616	97.0835133	63.2053480	36.7946520
R3.0040	R3.0	40	0.1970244	96.8955517	62.3269858	37.6730142
R3.0041	R3.0	41	0.2063894	96.6985273	61.4529600	38.5470400
R3.0042	R3.0	42	0.2160606	96.4921379	60.5833340	39.4166660
R3.0043	R3.0	43	0.2260437	96.2760773	59.7181711	40.2818289
R3.0044	R3.0	44	0.2363405	96.0500336	58.8575339	41.1424661

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1 Lookup	2 Curve	3 Age %	4 % Ret	5 % Surv	6 % Cond	7 % Depr Resv
R3.0045	R3.0	45	0.2469616	95.8136931	58.0014839	41.9985161
R3.0046	R3.0	46	0.2579089	95.5667315	57.1500778	42.8499222
R3.0047	R3.0	47	0.2691869	95.3088226	56.3033738	43.6966262
R3.0048	R3.0	48	0.2808028	95.0396357	55.4614301	44.5385699
R3.0049	R3.0	49	0.2927637	94.7588329	54.6243000	45.3757000
R3.0050	R3.0	50	0.3050775	94.4660692	53.7920389	46.2079611
R3.0051	R3.0	51	0.3177452	94.1609917	52.9647021	47.0352979
R3.0052	R3.0	52	0.3307829	93.8432465	52.1423440	47.8576560
R3.0053	R3.0	53	0.3441897	93.5124636	51.3250179	48.6749821
R3.0054	R3.0	54	0.3579797	93.1682739	50.5127802	49.4872198
R3.0055	R3.0	55	0.3721629	92.8102942	49.7056861	50.2943139
R3.0056	R3.0	56	0.3867464	92.4381313	48.9037910	51.0962090
R3.0057	R3.0	57	0.4017400	92.0513849	48.1071558	51.8928442
R3.0058	R3.0	58	0.4171553	91.6496449	47.3158379	52.6841621
R3.0059	R3.0	59	0.4330063	91.2324896	46.5299010	53.4700990
R3.0060	R3.0	60	0.4493046	90.7994833	45.7494102	54.2505898
R3.0061	R3.0	61	0.4660597	90.3501787	44.9744310	55.0255690
R3.0062	R3.0	62	0.4832878	89.8841190	44.2050362	55.7949638
R3.0063	R3.0	63	0.5010013	89.4008312	43.4412990	56.5587010
R3.0064	R3.0	64	0.5192156	88.8998299	42.6832981	57.3167019
R3.0065	R3.0	65	0.5379458	88.3806143	41.9311161	58.0688839
R3.0066	R3.0	66	0.5572013	87.8426685	41.1848378	58.8151622
R3.0067	R3.0	67	0.5770016	87.2854672	40.4445572	59.5554428
R3.0068	R3.0	68	0.5973559	86.7084656	39.7103682	60.2896318
R3.0069	R3.0	69	0.6182804	86.1111097	38.9823709	61.0176291
R3.0070	R3.0	70	0.6397857	85.4928293	38.2606740	61.7393260
R3.0071	R3.0	71	0.6618805	84.8530436	37.5453868	62.4546132
R3.0072	R3.0	72	0.6845751	84.1911631	36.8366242	63.1633758
R3.0073	R3.0	73	0.7078676	83.5065880	36.1345072	63.8654928
R3.0074	R3.0	74	0.7317868	82.7987204	35.4391561	64.5608439
R3.0075	R3.0	75	0.7563066	82.0669336	34.7507062	65.2492938
R3.0076	R3.0	76	0.7814388	81.3106270	34.0692878	65.9307122
R3.0077	R3.0	77	0.8071690	80.5291882	33.3950372	66.6049628
R3.0078	R3.0	78	0.8334932	79.7220192	32.7280932	67.2719068
R3.0079	R3.0	79	0.8603878	78.8885260	32.0685968	67.9314032
R3.0080	R3.0	80	0.8878355	78.0281382	31.4166920	68.5833080
R3.0081	R3.0	81	0.9158049	77.1403027	30.7725229	69.2274771
R3.0082	R3.0	82	0.9442616	76.2244978	30.1362350	69.8637650
R3.0083	R3.0	83	0.9731655	75.2802362	29.5079711	70.4920289
R3.0084	R3.0	84	1.0024595	74.3070707	28.8878751	71.1121249
R3.0085	R3.0	85	1.0320921	73.3046112	28.2760870	71.7239130
R3.0086	R3.0	86	1.0619917	72.2725191	27.6727450	72.3272550
R3.0087	R3.0	87	1.0920782	71.2105274	27.0779829	72.9220171
R3.0088	R3.0	88	1.1222725	70.1184492	26.4919291	73.5080709
R3.0089	R3.0	89	1.1524744	68.9961767	25.9147060	74.0852940

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Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R3.0090	R3.0	90	1.1825809	67.8437023	25.3464310	74.6535690
R3.0091	R3.0	91	1.2124787	66.6611214	24.7872109	75.2127891
R3.0092	R3.0	92	1.2420444	65.4486427	24.2371471	75.7628529
R3.0093	R3.0	93	1.2711425	64.2065983	23.6963310	76.3036690
R3.0094	R3.0	94	1.2996359	62.9354558	23.1648400	76.8351600
R3.0095	R3.0	95	1.3273778	61.6358199	22.6427441	77.3572559
R3.0096	R3.0	96	1.3542113	60.3084421	22.1301019	77.8698981
R3.0097	R3.0	97	1.3799820	58.9542308	21.6269579	78.3730421
R3.0098	R3.0	98	1.4045148	57.5742488	21.1333439	78.8666561
R3.0099	R3.0	99	1.4276528	56.1697340	20.6492770	79.3507230
R3.0100	R3.0	100	1.4492231	54.7420812	20.1747630	79.8252370
R3.0101	R3.0	101	1.4690599	53.2928581	19.7097900	80.2902100
R3.0102	R3.0	102	1.4869881	51.8237982	19.2543340	80.7456660
R3.0103	R3.0	103	1.5028572	50.3368101	18.8083510	81.1916490
R3.0104	R3.0	104	1.5164928	48.8339529	18.3717880	81.6282120
R3.0105	R3.0	105	1.5277629	47.3174601	17.9445670	82.0554330
R3.0106	R3.0	106	1.5365224	45.7896972	17.5266011	82.4733989
R3.0107	R3.0	107	1.5426388	44.2531748	17.1177840	82.8822160
R3.0108	R3.0	108	1.5460029	42.7105360	16.7179930	83.2820070
R3.0109	R3.0	109	1.5465211	41.1645331	16.3270869	83.6729131
R3.0110	R3.0	110	1.5441080	39.6180120	15.9449101	84.0550899
R3.0111	R3.0	111	1.5387101	38.0739040	15.5712870	84.4287130
R3.0112	R3.0	112	1.5302810	36.5351939	15.2060260	84.7939740
R3.0113	R3.0	113	1.5188141	35.0049129	14.8489180	85.1510820
R3.0114	R3.0	114	1.5043109	33.4860988	14.4997360	85.5002640
R3.0115	R3.0	115	1.4868099	31.9817879	14.1582340	85.8417660
R3.0116	R3.0	116	1.4663680	30.4949780	13.8241530	86.1758470
R3.0117	R3.0	117	1.4430571	29.0286100	13.4972171	86.5027829
R3.0118	R3.0	118	1.4169929	27.5855529	13.1771280	86.8228720
R3.0119	R3.0	119	1.3882911	26.1685600	12.8635780	87.1364220
R3.0120	R3.0	120	1.3571188	24.7802689	12.5562360	87.4437640
R3.0121	R3.0	121	1.3236401	23.4231501	12.2547650	87.7452350
R3.0122	R3.0	122	1.2880390	22.0995100	11.9588110	88.0411890
R3.0123	R3.0	123	1.2505269	20.8114710	11.6680059	88.3319941
R3.0124	R3.0	124	1.2113230	19.5609441	11.3819740	88.6180260
R3.0125	R3.0	125	1.1706541	18.3496211	11.1003320	88.8996680
R3.0126	R3.0	126	1.1287601	17.1789670	10.8226880	89.1773120
R3.0127	R3.0	127	1.0858769	16.0502069	10.5486490	89.4513510
R3.0128	R3.0	128	1.0422470	14.9643300	10.2778220	89.7221780
R3.0129	R3.0	129	0.9981119	13.9220830	10.0098190	89.9901810
R3.0130	R3.0	130	0.9536992	12.9239711	9.7442570	90.2557430
R3.0131	R3.0	131	0.9092329	11.9702719	9.4807680	90.5192320
R3.0132	R3.0	132	0.8649200	11.0610390	9.2190000	90.7810000
R3.0133	R3.0	133	0.8209611	10.1961190	8.9586190	91.0413810
R3.0134	R3.0	134	0.7775309	9.3751580	8.6993200	91.3006800

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R3.0135	R3.0	135	0.7347881	8.5976270	8.4408310	91.5591691
R3.0136	R3.0	136	0.6928700	7.8628390	8.1829081	91.8170919
R3.0137	R3.0	137	0.6518970	7.1699690	7.9253460	92.0746540
R3.0138	R3.0	138	0.6119650	6.5180720	7.6679810	92.3320190
R3.0139	R3.0	139	0.5731500	5.9061070	7.4106960	92.5893040
R3.0140	R3.0	140	0.5355110	5.3329570	7.1534120	92.8465880
R3.0141	R3.0	141	0.4990880	4.7974460	6.8960930	93.1039070
R3.0142	R3.0	142	0.4639030	4.2983580	6.6387510	93.3612490
R3.0143	R3.0	143	0.4299690	3.8344550	6.3814340	93.6185660
R3.0144	R3.0	144	0.3972850	3.4044860	6.1242290	93.8757710
R3.0145	R3.0	145	0.3658450	3.0072010	5.8672540	94.1327460
R3.0146	R3.0	146	0.3356360	2.6413560	5.6106530	94.3893470
R3.0147	R3.0	147	0.3066410	2.3057200	5.3545910	94.6454090
R3.0148	R3.0	148	0.2788620	1.9990790	5.0992460	94.9007540
R3.0149	R3.0	149	0.2522770	1.7202170	4.8448220	95.1551780
R3.0150	R3.0	150	0.2268850	1.4679400	4.5915160	95.4084840
R3.0151	R3.0	151	0.2026930	1.2410550	4.3395140	95.6604860
R3.0152	R3.0	152	0.1797100	1.0383620	4.0890000	95.9110000
R3.0153	R3.0	153	0.1579600	0.8586520	3.8401530	96.1598470
R3.0154	R3.0	154	0.1374690	0.7006920	3.5931400	96.4068600
R3.0155	R3.0	155	0.1182750	0.5632230	3.3480970	96.6519030
R3.0156	R3.0	156	0.1004170	0.4449480	3.1051630	96.8948370
R3.0157	R3.0	157	0.0839420	0.3445310	2.8644800	97.1355200
R3.0158	R3.0	158	0.0688930	0.2605890	2.6261500	97.3738500
R3.0159	R3.0	159	0.0553160	0.1916960	2.3902580	97.6097420
R3.0160	R3.0	160	0.0432485	0.1363800	2.1569580	97.8430420
R3.0161	R3.0	161	0.0327163	0.0931315	1.9263620	98.0736380
R3.0162	R3.0	162	0.0237359	0.0604152	1.6987790	98.3012210
R3.0163	R3.0	163	0.0163033	0.0366793	1.4745100	98.5254900
R3.0164	R3.0	164	0.0103913	0.0203760	1.2542690	98.7457310
R3.0165	R3.0	165	0.0059434	0.0099847	1.0392430	98.9607570
R3.0166	R3.0	166	0.0028646	0.0040413	0.8322900	99.1677100
R3.0167	R3.0	167	0.0010104	0.0011767	0.6413070	99.3586930
R3.0168	R3.0	168	0.0001662	0.0001662	0.4999820	99.5000180
R3.0169	R3.0	169	0.0000000	0.0000000	0.0000000	100.0000000

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R4.0000	R4.0	0	0.0008278	100.0000000	100.0000000	0.0000000
R4.0001	R4.0	1	0.0009632	99.9991722	99.0013161	0.9986839
R4.0002	R4.0	2	0.0011139	99.9982090	98.0022631	1.9977369
R4.0003	R4.0	3	0.0012894	99.9970951	97.0033197	2.9966803
R4.0004	R4.0	4	0.0014858	99.9958057	96.0045939	3.9954061
R4.0005	R4.0	5	0.0017109	99.9943199	95.0060129	4.9939871
R4.0006	R4.0	6	0.0019645	99.9926090	94.0076304	5.9923696
R4.0007	R4.0	7	0.0022536	99.9906445	93.0094681	6.9905319
R4.0008	R4.0	8	0.0025768	99.9883909	92.0115519	7.9884481
R4.0009	R4.0	9	0.0029430	99.9858141	91.0139113	8.9860887
R4.0010	R4.0	10	0.0033541	99.9828711	90.0165749	9.9834251
R4.0011	R4.0	11	0.0038157	99.9795170	89.0195789	10.9804211
R4.0012	R4.0	12	0.0043325	99.9757013	88.0229569	11.9770431
R4.0013	R4.0	13	0.0049095	99.9713688	87.0267496	12.9732504
R4.0014	R4.0	14	0.0055561	99.9664593	86.0310001	13.9689999
R4.0015	R4.0	15	0.0062743	99.9609032	85.0357533	14.9642467
R4.0016	R4.0	16	0.0070753	99.9546289	84.0410605	15.9589395
R4.0017	R4.0	17	0.0079612	99.9475536	83.0469732	16.9530268
R4.0018	R4.0	18	0.0089484	99.9395924	82.0535498	17.9464502
R4.0019	R4.0	19	0.0100383	99.9306440	81.0608521	18.9391479
R4.0020	R4.0	20	0.0112429	99.9206057	80.0689449	19.9310551
R4.0021	R4.0	21	0.0125732	99.9093628	79.0778990	20.9221010
R4.0022	R4.0	22	0.0140372	99.8967896	78.0877886	21.9122114
R4.0023	R4.0	23	0.0156517	99.8827524	77.0986939	22.9013061
R4.0024	R4.0	24	0.0174217	99.8671007	76.1106977	23.8893023
R4.0025	R4.0	25	0.0193634	99.8496790	75.1238899	24.8761101
R4.0026	R4.0	26	0.0214911	99.8303156	74.1383648	25.8616352
R4.0027	R4.0	27	0.0238161	99.8088245	73.1542206	26.8457794
R4.0028	R4.0	28	0.0263576	99.7850084	72.1715622	27.8284378
R4.0029	R4.0	29	0.0291262	99.7586508	71.1904984	28.8095016
R4.0030	R4.0	30	0.0321426	99.7295246	70.2111445	29.7888555
R4.0031	R4.0	31	0.0354223	99.6973820	69.2336187	30.7663813
R4.0032	R4.0	32	0.0389815	99.6619597	68.2580481	31.7419519
R4.0033	R4.0	33	0.0428438	99.6229782	67.2845621	32.7154379
R4.0034	R4.0	34	0.0470247	99.5801344	66.3132954	33.6867046
R4.0035	R4.0	35	0.0515423	99.5331097	65.3443880	34.6556120
R4.0036	R4.0	36	0.0564251	99.4815674	64.3779860	35.6220140
R4.0037	R4.0	37	0.0616894	99.4251423	63.4142370	36.5857630
R4.0038	R4.0	38	0.0673580	99.3634529	62.4532971	37.5467029
R4.0039	R4.0	39	0.0734539	99.2960949	61.4953232	38.5046768
R4.0040	R4.0	40	0.0800018	99.2226410	60.5404782	39.4595218
R4.0041	R4.0	41	0.0870266	99.1426392	59.5889268	40.4110732
R4.0042	R4.0	42	0.0945492	99.0556126	58.6408401	41.3591599
R4.0043	R4.0	43	0.1025982	98.9610634	57.6963892	42.3036108
R4.0044	R4.0	44	0.1111975	98.8584652	56.7557492	43.2442508

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R4.0045	R4.0	45	0.1203727	98.7472677	55.8190970	44.1809030
R4.0046	R4.0	46	0.1301480	98.6268950	54.8866129	45.1133871
R4.0047	R4.0	47	0.1405506	98.4967470	53.9584770	46.0415230
R4.0048	R4.0	48	0.1516085	98.3561964	53.0348692	46.9651308
R4.0049	R4.0	49	0.1633424	98.2045879	52.1159720	47.8840280
R4.0050	R4.0	50	0.1757803	98.0412455	51.2019682	48.7980318
R4.0051	R4.0	51	0.1889468	97.8654652	50.2930360	49.7069640
R4.0052	R4.0	52	0.2028656	97.6765184	49.3893561	50.6106439
R4.0053	R4.0	53	0.2175588	97.4736528	48.4911060	51.5088940
R4.0054	R4.0	54	0.2326536	97.2560940	47.5984602	52.4015398
R4.0055	R4.0	55	0.2497578	97.0234404	46.7115922	53.2884078
R4.0056	R4.0	56	0.2665119	96.7736826	45.8306670	54.1693330
R4.0057	R4.0	57	0.2845173	96.5071707	44.9558511	55.0441489
R4.0058	R4.0	58	0.3034000	96.2226534	44.0873008	55.9126992
R4.0059	R4.0	59	0.3231707	95.9192534	43.2251711	56.7748289
R4.0060	R4.0	60	0.3438416	95.5960827	42.3696070	57.6303930
R4.0061	R4.0	61	0.3654260	95.2522411	41.5207481	58.4792519
R4.0062	R4.0	62	0.3879290	94.8868151	40.6787262	59.3212738
R4.0063	R4.0	63	0.4113550	94.4988861	39.8436651	60.1563349
R4.0064	R4.0	64	0.4357090	94.0875311	39.0156770	60.9843230
R4.0065	R4.0	65	0.4609852	93.6518221	38.1948690	61.8051310
R4.0066	R4.0	66	0.4871807	93.1908369	37.3813329	62.6186671
R4.0067	R4.0	67	0.5142860	92.7036562	36.5751538	63.4248462
R4.0068	R4.0	68	0.5422850	92.1893702	35.7764020	64.2235980
R4.0069	R4.0	69	0.5711651	91.6470852	34.9851360	65.0148640
R4.0070	R4.0	70	0.6009006	91.0759201	34.2014031	65.7985969
R4.0071	R4.0	71	0.6314631	90.4750195	33.4252348	66.5747652
R4.0072	R4.0	72	0.6628237	89.8435564	32.6566491	67.3433509
R4.0073	R4.0	73	0.6949434	89.1807327	31.8956490	68.1043510
R4.0074	R4.0	74	0.7277765	88.4857893	31.1422219	68.8577781
R4.0075	R4.0	75	0.7612782	87.7580128	30.3963370	69.6036630
R4.0076	R4.0	76	0.7953930	86.9967346	29.6579499	70.3420501
R4.0077	R4.0	77	0.8300562	86.2013416	28.9269941	71.0730059
R4.0078	R4.0	78	0.8652038	85.3712854	28.2033880	71.7966120
R4.0079	R4.0	79	0.9007626	84.5060816	27.4870250	72.5129750
R4.0080	R4.0	80	0.9366550	83.6053190	26.7777820	73.2222180
R4.0081	R4.0	81	0.9727898	82.6686640	26.0755160	73.9244840
R4.0082	R4.0	82	1.0092020	81.6958742	25.3800550	74.6199450
R4.0083	R4.0	83	1.0464849	80.6866722	24.6912470	75.3087530
R4.0084	R4.0	84	1.0855894	79.6401873	24.0091240	75.9908760
R4.0085	R4.0	85	1.1274805	78.5545979	23.3340089	76.6659911
R4.0086	R4.0	86	1.1729546	77.4271174	22.6665139	77.3334861
R4.0087	R4.0	87	1.2225552	76.2541628	22.0074830	77.9925170
R4.0088	R4.0	88	1.2765531	75.0316076	21.3579230	78.6420770
R4.0089	R4.0	89	1.3349047	73.7550545	20.7189319	79.2810681

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R4.0090	R4.0	90	1.3973417	72.4201498	20.0916240	79.9083760
R4.0091	R4.0	91	1.4632540	71.0228081	19.4770801	80.5229199
R4.0092	R4.0	92	1.5318708	69.5595541	18.8762820	81.1237180
R4.0093	R4.0	93	1.6022349	68.0276833	18.2900851	81.7099149
R4.0094	R4.0	94	1.6732702	66.4254484	17.7191961	82.2808039
R4.0095	R4.0	95	1.7437983	64.7521782	17.1641600	82.8358400
R4.0096	R4.0	96	1.8126111	63.0083799	16.6253510	83.3746490
R4.0097	R4.0	97	1.8785019	61.1957688	16.1029799	83.8970201
R4.0098	R4.0	98	1.9403057	59.3172669	15.5971090	84.4028910
R4.0099	R4.0	99	1.9969244	57.3769612	15.1076440	84.8923560
R4.0100	R4.0	100	2.0473556	55.3800368	14.6343750	85.3656250
R4.0101	R4.0	101	2.0907240	53.3326812	14.1769710	85.8230290
R4.0102	R4.0	102	2.1262794	51.2419572	13.7350060	86.2649940
R4.0103	R4.0	103	2.1534547	49.1156778	13.3079650	86.6920350
R4.0104	R4.0	104	2.1718040	46.9622231	12.8952750	87.1047250
R4.0105	R4.0	105	2.1810722	44.7904191	12.4962990	87.5037010
R4.0106	R4.0	106	2.1811419	42.6093469	12.1103610	87.8896390
R4.0107	R4.0	107	2.1720638	40.4282050	11.7367520	88.2632480
R4.0108	R4.0	108	2.1540241	38.2561412	11.3747400	88.6252600
R4.0109	R4.0	109	2.1273389	36.1021171	11.0235781	88.9764219
R4.0110	R4.0	110	2.0924511	33.9747782	10.6825140	89.3174860
R4.0111	R4.0	111	2.0498882	31.8823271	10.3507971	89.6492029
R4.0112	R4.0	112	2.0002858	29.8324389	10.0276790	89.9723210
R4.0113	R4.0	113	1.9443300	27.8321531	9.7124300	90.2875700
R4.0114	R4.0	114	1.8827472	25.8878231	9.4043380	90.5956620
R4.0115	R4.0	115	1.8162958	24.0050759	9.1027160	90.8972840
R4.0116	R4.0	116	1.7457612	22.1887801	8.8069040	91.1930960
R4.0117	R4.0	117	1.6718969	20.4430189	8.5162840	91.4837160
R4.0118	R4.0	118	1.5954540	18.7711220	8.2302750	91.7697250
R4.0119	R4.0	119	1.5171400	17.1756680	7.9483430	92.0516570
R4.0120	R4.0	120	1.4376240	15.6585280	7.6700060	92.3299940
R4.0121	R4.0	121	1.3575180	14.2209040	7.3948390	92.6051610
R4.0122	R4.0	122	1.2773730	12.8633860	7.1224760	92.8775240
R4.0123	R4.0	123	1.1976880	11.5860130	6.8526120	93.1473880
R4.0124	R4.0	124	1.1188790	10.3883250	6.5850130	93.4149870
R4.0125	R4.0	125	1.0413181	9.2694460	6.3195140	93.6804860
R4.0126	R4.0	126	0.9653040	8.2281280	6.0560060	93.9439940
R4.0127	R4.0	127	0.8910890	7.2628240	5.7944580	94.2055420
R4.0128	R4.0	128	0.8188760	6.3717350	5.5348880	94.4651120
R4.0129	R4.0	129	0.7488360	5.5528590	5.2773810	94.7226190
R4.0130	R4.0	130	0.6811100	4.8040230	5.0220640	94.9779360
R4.0131	R4.0	131	0.6158200	4.1229130	4.7691140	95.2308860
R4.0132	R4.0	132	0.5530780	3.5070930	4.5187400	95.4812600
R4.0133	R4.0	133	0.4930080	2.9540150	4.2715210	95.7284790
R4.0134	R4.0	134	0.4357350	2.4610070	4.0273490	95.9726510

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
R4.0135	R4.0	135	0.3814000	2.0252720	3.7864600	96.2135400
R4.0136	R4.0	136	0.3301680	1.6438720	3.5490210	96.4509790
R4.0137	R4.0	137	0.2822160	1.3137040	3.3315155	66.6848450
R4.0138	R4.0	138	0.2377380	1.0314880	3.0849780	96.9150220
R4.0139	R4.0	139	0.1969280	0.7937500	2.8585810	97.1414190
R4.0140	R4.0	140	0.1599700	0.5968220	2.6360510	97.3639490
R4.0141	R4.0	141	0.1270220	0.4368520	2.4174760	97.5825240
R4.0142	R4.0	142	0.0981870	0.3098300	2.2029340	97.7970660
R4.0143	R4.0	143	0.0734960	0.2116430	1.9925030	98.0074970
R4.0144	R4.0	144	0.0529003	0.1381470	1.7862840	98.2137160
R4.0145	R4.0	145	0.0362607	0.0852467	1.5844010	98.4155990
R4.0146	R4.0	146	0.0233463	0.0489860	1.3870900	98.6129100
R4.0147	R4.0	147	0.0138307	0.0256397	1.1948260	98.8051740
R4.0148	R4.0	148	0.0072948	0.0118090	1.0086400	98.9913600
R4.0149	R4.0	149	0.0032339	0.0045142	0.8306070	99.1693930
R4.0150	R4.0	150	0.0010741	0.0012803	0.6657290	99.3342710
R4.0151	R4.0	151	0.0002001	0.0002061	0.5292780	99.4707220
R4.0152	R4.0	152	0.0000060	0.0000060	0.5000830	99.4999170
R4.0153	R4.0	153	0.0000000	0.0000000	0.0000000	100.0000000

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
S3.0000	S3.0	0	0.0000000	100.0000000	100.0000000	0.0000000
S3.0001	S3.0	1	0.0000000	100.0000000	99.0000000	1.0000000
S3.0002	S3.0	2	0.0000000	100.0000000	98.0000000	2.0000000
S3.0003	S3.0	3	0.0000000	100.0000000	97.0000000	3.0000000
S3.0004	S3.0	4	0.0000000	100.0000000	96.0000000	4.0000000
S3.0005	S3.0	5	0.0000000	100.0000000	95.0000000	5.0000000
S3.0006	S3.0	6	0.0000009	100.0000000	94.0000000	6.0000000
S3.0007	S3.0	7	0.0000029	99.9999991	93.0000010	6.9999990
S3.0008	S3.0	8	0.0000057	99.9999962	92.0000038	7.9999962
S3.0009	S3.0	9	0.0000124	99.9999905	91.0000086	8.9999914
S3.0010	S3.0	10	0.0000229	99.9999781	90.0000200	9.9999800
S3.0011	S3.0	11	0.0000410	99.9999552	89.0000401	10.9999599
S3.0012	S3.0	12	0.0000706	99.9999142	88.0000773	11.9999227
S3.0013	S3.0	13	0.0001154	99.9998436	87.0001392	12.9998608
S3.0014	S3.0	14	0.0001821	99.9997282	86.0002394	13.9997606
S3.0015	S3.0	15	0.0002785	99.9995461	85.0003939	14.9996061
S3.0016	S3.0	16	0.0004120	99.9992676	84.0006294	15.9993706
S3.0017	S3.0	17	0.0005932	99.9988556	83.0009728	16.9990272
S3.0018	S3.0	18	0.0008402	99.9982624	82.0014629	17.9985371
S3.0019	S3.0	19	0.0011616	99.9974222	81.0021467	18.9978533
S3.0020	S3.0	20	0.0015783	99.9962606	80.0030832	19.9969168
S3.0021	S3.0	21	0.0021086	99.9946823	79.0043373	20.9956627
S3.0022	S3.0	22	0.0027761	99.9925737	78.0059929	21.9940071
S3.0023	S3.0	23	0.0036030	99.9897976	77.0081453	22.9918547
S3.0024	S3.0	24	0.0046177	99.9861946	76.0109024	23.9890976
S3.0025	S3.0	25	0.0058498	99.9815769	75.0143890	24.9856110
S3.0026	S3.0	26	0.0073300	99.9757271	74.0187492	25.9812508
S3.0027	S3.0	27	0.0090951	99.9683971	73.0241404	26.9758596
S3.0028	S3.0	28	0.0111771	99.9593020	72.0307388	27.9692612
S3.0029	S3.0	29	0.0136185	99.9481249	71.0387383	28.9612617
S3.0030	S3.0	30	0.0164585	99.9345064	70.0483513	29.9516487
S3.0031	S3.0	31	0.0197382	99.9180479	69.0598068	30.9401932
S3.0032	S3.0	32	0.0235014	99.8983097	68.0733528	31.9266472
S3.0033	S3.0	33	0.0277939	99.8748083	67.0892544	32.9107456
S3.0034	S3.0	34	0.0326624	99.8470144	66.1077900	33.8922100
S3.0035	S3.0	35	0.0381479	99.8143520	65.1292582	34.8707418
S3.0036	S3.0	36	0.0443048	99.7762041	64.1539688	35.8460312
S3.0037	S3.0	37	0.0511732	99.7318993	63.1822462	36.8177538
S3.0038	S3.0	38	0.0588046	99.6807261	62.2144260	37.7855740
S3.0039	S3.0	39	0.0672397	99.6219215	61.2508540	38.7491460
S3.0040	S3.0	40	0.0765267	99.5546818	60.2918859	39.7081141
S3.0041	S3.0	41	0.0867071	99.4781551	59.3378830	40.6621170
S3.0042	S3.0	42	0.0978231	99.3914480	58.3892121	41.6107879
S3.0043	S3.0	43	0.1099110	99.2936249	57.4462428	42.5537572
S3.0044	S3.0	44	0.1230097	99.1837139	56.5093489	43.4906511

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
S3.0045	S3.0	45	0.1371507	99.0607042	55.5788989	44.4211011
S3.0046	S3.0	46	0.1523667	98.9235535	54.6552620	45.3447380
S3.0047	S3.0	47	0.1686792	98.7711868	53.7388029	46.2611971
S3.0048	S3.0	48	0.1861134	98.6025076	52.8298788	47.1701212
S3.0049	S3.0	49	0.2046880	98.4163942	51.9288392	48.0711608
S3.0050	S3.0	50	0.2244149	98.2117062	51.0360251	48.9639749
S3.0051	S3.0	51	0.2453012	97.9872913	50.1517639	49.8482361
S3.0052	S3.0	52	0.2673512	97.7419901	49.2763739	50.7236261
S3.0053	S3.0	53	0.2905626	97.4746389	48.4101572	51.5898428
S3.0054	S3.0	54	0.3149290	97.1840763	47.5534000	52.4466000
S3.0055	S3.0	55	0.3404341	96.8691473	46.7063732	53.2936268
S3.0056	S3.0	56	0.3670616	96.5287132	45.8693328	54.1306672
S3.0057	S3.0	57	0.3947830	96.1616516	45.0425129	54.9574871
S3.0058	S3.0	58	0.4235687	95.7668686	44.2261319	55.7738681
S3.0059	S3.0	59	0.4533825	95.3432999	43.4203882	56.5796118
S3.0060	S3.0	60	0.4841824	94.8899174	42.6254621	57.3745379
S3.0061	S3.0	61	0.5159149	94.4057350	41.8415122	58.1584878
S3.0062	S3.0	62	0.5485287	93.8898201	41.0686789	58.9313211
S3.0063	S3.0	63	0.5819635	93.3412914	40.3070850	59.6929150
S3.0064	S3.0	64	0.6161499	92.7593279	39.5568309	60.4431691
S3.0065	S3.0	65	0.6510201	92.1431780	38.8179989	61.1820011
S3.0066	S3.0	66	0.6864967	91.4921579	38.0906539	61.9093461
S3.0067	S3.0	67	0.7224970	90.8056612	37.3748412	62.6251588
S3.0068	S3.0	68	0.7589350	90.0831642	36.6705899	63.3294101
S3.0069	S3.0	69	0.7957239	89.3242292	35.9779110	64.0220890
S3.0070	S3.0	70	0.8327675	88.5285053	35.2967982	64.7032018
S3.0071	S3.0	71	0.8699665	87.6957378	34.6272311	65.3727689
S3.0072	S3.0	72	0.9072227	86.8257713	33.9691749	66.0308251
S3.0073	S3.0	73	0.9444323	85.9185486	33.3225799	66.6774201
S3.0074	S3.0	74	0.9814892	84.9741163	32.6873822	67.3126178
S3.0075	S3.0	75	1.0182848	83.9926271	32.0635042	67.9364958
S3.0076	S3.0	76	1.0547151	82.9743423	31.4508619	68.5491381
S3.0077	S3.0	77	1.0906649	81.9196272	30.8493540	69.1506460
S3.0078	S3.0	78	1.1260299	80.8289623	30.2588730	69.7411270
S3.0079	S3.0	79	1.1606951	79.7029324	29.6793010	70.3206990
S3.0080	S3.0	80	1.1945553	78.5422373	29.1105120	70.8894880
S3.0081	S3.0	81	1.2275000	77.3476820	28.5523710	71.4476290
S3.0082	S3.0	82	1.2594261	76.1201820	28.0047390	71.9952610
S3.0083	S3.0	83	1.2902269	74.8607559	27.4674680	72.5325320
S3.0084	S3.0	84	1.3198013	73.5705290	26.9404030	73.0595970
S3.0085	S3.0	85	1.3480530	72.2507277	26.4233890	73.5766110
S3.0086	S3.0	86	1.3748846	70.9026747	25.9162619	74.0837381
S3.0087	S3.0	87	1.4002104	69.5277901	25.4188600	74.5811400
S3.0088	S3.0	88	1.4239378	68.1275797	24.9310110	75.0689890
S3.0089	S3.0	89	1.4459896	66.7036419	24.4525449	75.5474551

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
S3.0090	S3.0	90	1.4662924	65.2576523	23.9832900	76.0167100
S3.0091	S3.0	91	1.4847698	63.7913599	23.5230711	76.4769289
S3.0092	S3.0	92	1.5013619	62.3065901	23.0717111	76.9282889
S3.0093	S3.0	93	1.5160102	60.8052282	22.6290381	77.3709619
S3.0094	S3.0	94	1.5286632	59.2892180	22.1948710	77.8051290
S3.0095	S3.0	95	1.5392757	57.7605548	21.7690370	78.2309630
S3.0096	S3.0	96	1.5478119	56.2212791	21.3513601	78.6486399
S3.0097	S3.0	97	1.5542393	54.6734672	20.9416640	79.0583360
S3.0098	S3.0	98	1.5585370	53.1192279	20.5397761	79.4602239
S3.0099	S3.0	99	1.5606909	51.5606909	20.1455231	79.8544769
S3.0100	S3.0	100	1.5606909	50.0000000	19.7587349	80.2412651
S3.0101	S3.0	101	1.5585370	48.4393091	19.3792419	80.6207581
S3.0102	S3.0	102	1.5542393	46.8807721	19.0068769	80.9931231
S3.0103	S3.0	103	1.5478119	45.3265328	18.6414750	81.3585250
S3.0104	S3.0	104	1.5392757	43.7787209	18.2828729	81.7171271
S3.0105	S3.0	105	1.5286631	42.2394452	17.9309101	82.0690899
S3.0106	S3.0	106	1.5160103	40.7107821	17.5854299	82.4145701
S3.0107	S3.0	107	1.5013619	39.1947718	17.2462750	82.7537250
S3.0108	S3.0	108	1.4847698	37.6934099	16.9132950	83.0867050
S3.0109	S3.0	109	1.4662919	36.2086401	16.5863359	83.4136641
S3.0110	S3.0	110	1.4459901	34.7423482	16.2652550	83.7347450
S3.0111	S3.0	111	1.4239380	33.2963581	15.9499090	84.0500910
S3.0112	S3.0	112	1.4002102	31.8724201	15.6401500	84.3598500
S3.0113	S3.0	113	1.3748848	30.4722099	15.3358450	84.6641550
S3.0114	S3.0	114	1.3480530	29.0973251	15.0368600	84.9631400
S3.0115	S3.0	115	1.3198011	27.7492721	14.7430561	85.2569439
S3.0116	S3.0	116	1.2902269	26.4294710	14.4543080	85.5456920
S3.0117	S3.0	117	1.2594261	25.1392441	14.1704850	85.8295150
S3.0118	S3.0	118	1.2275000	23.8798180	13.8914710	86.1085290
S3.0119	S3.0	119	1.1945550	22.6523180	13.6171401	86.3828599
S3.0120	S3.0	120	1.1606951	21.4577630	13.3473700	86.6526300
S3.0121	S3.0	121	1.1260300	20.2970679	13.0820510	86.9179490
S3.0122	S3.0	122	1.0906648	19.1710379	12.8210681	87.1789319
S3.0123	S3.0	123	1.0547152	18.0803731	12.5643160	87.4356840
S3.0124	S3.0	124	1.0182848	17.0256579	12.3116800	87.6883200
S3.0125	S3.0	125	0.9814891	16.0073731	12.0630680	87.9369320
S3.0126	S3.0	126	0.9444329	15.0258840	11.8183630	88.1816370
S3.0127	S3.0	127	0.9072221	14.0814511	11.5774790	88.4225210
S3.0128	S3.0	128	0.8699670	13.1742290	11.3403140	88.6596860
S3.0129	S3.0	129	0.8327670	12.3042620	11.1067700	88.8932300
S3.0130	S3.0	130	0.7957240	11.4714950	10.8767610	89.1232390
S3.0131	S3.0	131	0.7589350	10.6757710	10.6501980	89.3498020
S3.0132	S3.0	132	0.7224970	9.9168360	10.4270001	89.5729999
S3.0133	S3.0	133	0.6864971	9.1943390	10.2070690	89.7929310
S3.0134	S3.0	134	0.6510199	8.5078420	9.9903250	90.0096750

database

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
S3.0135	S3.0	135	0.6161500	7.8568220	9.7766990	90.2233011
S3.0136	S3.0	136	0.5819630	7.2406720	9.5661089	90.4338911
S3.0137	S3.0	137	0.5485290	6.6587090	9.3584729	90.6415271
S3.0138	S3.0	138	0.5159150	6.1101800	9.1537210	90.8462790
S3.0139	S3.0	139	0.4841820	5.5942650	8.9517880	91.0482121
S3.0140	S3.0	140	0.4533830	5.1100830	8.7525981	91.2474020
S3.0141	S3.0	141	0.4235690	4.6567000	8.5560840	91.4439160
S3.0142	S3.0	142	0.3947830	4.2331310	8.3621800	91.6378200
S3.0143	S3.0	143	0.3670610	3.8383480	8.1708230	91.8291770
S3.0144	S3.0	144	0.3404340	3.4712870	7.9819520	92.0180480
S3.0145	S3.0	145	0.3149290	3.1308530	7.7955040	92.2044960
S3.0146	S3.0	146	0.2905630	2.8159240	7.6114220	92.3885780
S3.0147	S3.0	147	0.2673510	2.5253610	7.4296480	92.5703520
S3.0148	S3.0	148	0.2453010	2.2580100	7.2501270	92.7498730
S3.0149	S3.0	149	0.2244150	2.0127090	7.0728060	92.9271940
S3.0150	S3.0	150	0.2046880	1.7882940	6.8976320	93.1023680
S3.0151	S3.0	151	0.1861140	1.5836060	6.7245530	93.2754470
S3.0152	S3.0	152	0.1686790	1.3974920	6.5535220	93.4464780
S3.0153	S3.0	153	0.1523660	1.2288130	6.3844900	93.6155100
S3.0154	S3.0	154	0.1371510	1.0764470	6.2174110	93.7825890
S3.0155	S3.0	155	0.1230100	0.9392960	6.0522380	93.9477620
S3.0156	S3.0	156	0.1099110	0.8162860	5.8889290	94.1110710
S3.0157	S3.0	157	0.0978230	0.7063750	5.7274410	94.2725590
S3.0158	S3.0	158	0.0867070	0.6085520	5.5677320	94.4322680
S3.0159	S3.0	159	0.0765270	0.5218450	5.4097620	94.5902380
S3.0160	S3.0	160	0.0672400	0.4453180	5.2534920	94.7465080
S3.0161	S3.0	161	0.0588040	0.3780780	5.0988860	94.9011140
S3.0162	S3.0	162	0.0511730	0.3192740	4.9459060	95.0540940
S3.0163	S3.0	163	0.0443050	0.2681010	4.7945200	95.2054800
S3.0164	S3.0	164	0.0381480	0.2237960	4.6446910	95.3553090
S3.0165	S3.0	165	0.0326620	0.1856480	4.4963870	95.5036130
S3.0166	S3.0	166	0.0277940	0.1529860	4.3495800	95.6504200
S3.0167	S3.0	167	0.0235020	0.1251920	4.2042330	95.7957670
S3.0168	S3.0	168	0.0197375	0.1016900	4.0603190	95.9396810
S3.0169	S3.0	169	0.0164582	0.0819525	3.9178100	96.0821900
S3.0170	S3.0	170	0.0136189	0.0654943	3.7766790	96.2233210
S3.0171	S3.0	171	0.0111777	0.0518754	3.6369070	96.3630930
S3.0172	S3.0	172	0.0090944	0.0406977	3.4984640	96.5015360
S3.0173	S3.0	173	0.0073307	0.0316033	3.3613300	96.6386700
S3.0174	S3.0	174	0.0058498	0.0242726	3.2254840	96.7745160
S3.0175	S3.0	175	0.0046178	0.0184228	3.0909090	96.9090910
S3.0176	S3.0	176	0.0036030	0.0138050	2.9575850	97.0424150
S3.0177	S3.0	177	0.0027755	0.0102020	2.8255000	97.1745000
S3.0178	S3.0	178	0.0021089	0.0074265	2.6946400	97.3053600
S3.0179	S3.0	179	0.0015783	0.0053176	2.5649990	97.4350010

Iowa-type Retirement - Survival Tables

Percent Retired, Surviving, Condition, and Depreciation Reserve
as a function of Age as a Percent of Average Service Life

1	2	3	4	5	6	7
Lookup	Curve	Age %	% Ret	% Surv	% Cond	% Depr Resv
S3.0180	S3.0	180	0.0011617	0.0037393	2.4365660	97.5634340
S3.0181	S3.0	181	0.0008396	0.0025776	2.3093440	97.6906560
S3.0182	S3.0	182	0.0005946	0.0017381	2.1833410	97.8166590
S3.0183	S3.0	183	0.0004116	0.0011435	2.0585660	97.9414340
S3.0184	S3.0	184	0.0002778	0.0007319	1.9350420	98.0649580
S3.0185	S3.0	185	0.0001821	0.0004541	1.8128020	98.1871980
S3.0186	S3.0	186	0.0001156	0.0002720	1.6918880	98.3081120
S3.0187	S3.0	187	0.0000706	0.0001564	1.5723710	98.4276290
S3.0188	S3.0	188	0.0000413	0.0000858	1.4543500	98.5456500
S3.0189	S3.0	189	0.0000229	0.0000446	1.3379620	98.6620380
S3.0190	S3.0	190	0.0000119	0.0000217	1.2234140	98.7765860
S3.0191	S3.0	191	0.0000058	0.0000097	1.1110030	98.8889970
S3.0192	S3.0	192	0.0000025	0.0000040	1.0011880	98.9988120
S3.0193	S3.0	193	0.0000010	0.0000014	0.8946340	99.1053660
S3.0194	S3.0	194	0.0000003	0.0000004	0.7925260	99.2074740
S3.0195	S3.0	195	0.0000001	0.0000001	0.6968450	99.3031550
S3.0196	S3.0	196	0.0000000	0.0000000	0.6112800	99.3887200
S3.0197	S3.0	197	0.0000000	0.0000000	0.5431250	99.4568750
S3.0198	S3.0	198	0.0000000	0.0000000	0.5056800	99.4943200
S3.0199	S3.0	199	0.0000000	0.0000000	0.5000000	99.5000000
S3.0200	S3.0	200	0.0000000	0.0000000	0.0000000	100.0000000

Pennsylvania American Water Company

Borough of Kane Authority's Wastewater System

Appraisal Work Papers
As of September 30, 2019

Income Approach
Cost of Capital / Required Return

AUS Consultants
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Water and Wastewater Cost of Capital
Third Quarter 2019 (9-30-2019)

As a Investor-Owned Utility

Weighted Cost of Capital (Discount Rate)

(1)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)
	Portion of Capital AUS Input	Type of Data	Capital Cost AUS Input	Type of Data	Tax Rate	Tax affect on cost of capital	After-tax Market Capital Cost (2)*(3)*(4a)
Debt	30%	Market	4.45%	Market	28.89%	71.11%	0.95%
Equity	70%	Market	9.95%	Market	0.0%	100.0%	6.97%
Total Capital r	**100.0%**						**7.92%**
Growth (g)							**1.52%**
Rate without Growth: [(1+r)/(1+g)]-1							**6.31%**

Weighted Cost of Capital (Capitlization Rate)

(1)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)
	Portion of Capital AUS Input	Type of Data	Capital Cost AUS Input	Type of Data	Tax Rate	Tax affect on cost of capital	Market Capital Cost (2)*(3)
Debt	30%	Market	4.45%	Market	Not Applicable	Not Applicable	1.34%
Equity	70%	Market	9.95%	Market	Not Applicable	Not Applicable	6.97%
Total Capital r	**100.0%**						**8.31%**
Growth (g)							**1.52%**
Rate without Growth: [(1+r)/(1+g)]-1							**6.69%**

Weighted Cost of Capital (Rate of Return on Rate Base)

(1)	(2)	(2a)	(3)	(3a)	(4)	(4a)	(5)
	Portion of Capital AUS Input	Type of Data	Capital Cost AUS Input	Type of Data	Tax Rate	Tax affect on cost of capital	Required Return on Rate Base (2)*(3)
Debt	45%	Embedded	4.37%	Embedded	Not Applicable	Not Applicable	1.97%
Equity	55%	Embedded	9.95%	Market	Not Applicable	Not Applicable	5.47%
Total Capital r	**100.0%**						**7.44%**
Growth (g)						Not Applicable	**0.00%**
Rate without Growth: [(1+r)/(1+g)]-1							**7.44%**

Value Line Investment Surveys
Water Industry
As of Second Quarter 2018 (7-1-2018)

Company	Exchange	Ticker	Valueline No.	Valueline Issue	Total Debt	Market Debt	Long Term Debt	Long Term Interest	Long Term Interest Rate (embedded)	Proportion of Debt	Book Debt	Book Equity	Preferred Stock	% Preferred	Shares Outstanding	Price per Share	Market Equity	Portion Market Equity	Capitalization	Total Market Capital
Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	(6) / (21)	Input Value Line	Input Value Line	(9) / (8)	Input Value Line	Input Value Line	Input Value Line	Input Value Line	(14) / (21)	Input Value Line	Input Value Line	Input Value Line	(18) / (21)	Input Value Line	(6)+(14)+(18)
					$s Million	%	$s Million	$s Million	%	%	%	%	$s Million	%	Shares Million	$s per Share	$s Million	%		$s Million
American States Water	NYSE	AWR	1787	7/12/2019	416.9	13.22%	376.6	24.0	6.37%	33.0%	42.0%	58.0%	-	0.00%	36.79521800	74.38	2,736.8	86.78%	Mid Cap	3,153.7
American Water	NYSE	AWK	1788	7/12/2019	8,831.0	29.70%	7,562.0	328.0	4.34%	56.0%	57.0%	43.0%	7.0	0.02%	180.51881000	115.73	20,891.4	70.27%	Large Cap	29,729.4
Aqua American	NYSE	WTR	1789	7/12/2019	2,652.0	24.99%	2,463.0	96.0	3.90%	55.0%	51.5%	48.5%	-	0.00%	215.73926600	36.90	7,960.8	75.01%	Large Cap	10,612.8
California Water	NYSE	CWT	1790	7/12/2019	940.7	28.11%	710.6	40.0	5.63%	49.0%	48.5%	51.5%	-	0.00%	48.13400000	49.99	2,406.2	71.89%	Mid Cap	3,346.9
Connecticut Water	NDQ	CTWS	1791	7/12/2019	261.4	23.86%	257.4	10.0	3.89%	47.0%	46.5%	53.5%	-	0.00%	12.06325200	69.13	833.9	76.14%	Small Cap	1,095.3
Consolidated Water Company	NDQ	CWCO	1792	7/12/2019	-	0.00%	-	-		0.0%	0.0%	100.0%	-	0.00%	15.02033400	14.29	214.6	100.00%	Small Cap	214.6
Middlesex Water	NDQ	MSEX	1793	7/12/2019	215.2	18.01%	158.4	6.8	4.29%	38.0%	38.0%	61.5%	2.4	0.20%	16.46884620	59.36	977.6	81.79%	Small Cap	1,195.2
SJW Corporation	NYSE	SJW	1794	7/12/2019	510.9	22.69%	510.9	20.0	3.91%	37.0%	36.5%	63.5%	-	0.00%	28.43456000	61.23	1,741.0	77.31%	Mid Cap	2,251.9
York Water	NDQ	YORW	1795	7/12/2019	94.1	17.05%	94.1	5.5	5.84%	42.0%	40.0%	60.0%	-	0.00%	12.95497600	35.34	457.8	82.95%	Small Cap	551.9
Total					13,922.2	26.70%	12,133.0	530.3	4.37%				9.4	0.02%			38,220.3	73.29%		52,151.9
Minimum						0.00%			3.89%	0.00%	0.00%	43.00%		0.00%				70.27%		
wtd Mean						26.70%			4.37%					0.02%				73.29%		
Mean						19.74%			4.77%	39.67%	40.00%	59.94%		0.02%				80.24%		
Median						22.69%			4.32%	42.00%	42.00%	58.00%		0.00%				77.31%		
Maximum						29.70%			6.37%	56.00%	57.00%	100.00%		0.20%				100.00%		

Water Industry Capital Structure

	Market		Embedded	
Capital Structure	Proportion	Reference	Proportion	Reference
Debt	26.70%	wtd mean col 7	39.67%	mean col 11
Preferred	0.02%	wtd mean col 15	0.02%	mean col 15
Equity	73.29%	wtd mean col 19	59.94%	mean col 13
Total	100.01%		99.64%	
Use				
Debt	30%	AUS Input	45%	AUS Input Jurisdictional Execption
Equity	70%	AUS Input	55%	AUS Input Jurisdictional Execption
Total	100%		100%	

Value Line Investment Surveys
Water Industry
As of Second Quarter 2018 (7-1-2018)

Company	Exchange	Ticker	Valueline No.	Valueline Issue	Beta	Divided	Revenues			Cash Flows			Earnings			Dividends			Book Value		
							Past 10 yrs	Past 5 yrs	Est'd 16-18 to 22-24	Past 10 yrs	Past 5 yrs	Est'd 16-18 to 22-24	Past 10 yrs	Past 5 yrs	Est'd 16-18 to 22-24	Past 10 yrs	Past 5 yrs	Est'd 16-18 to 22-24	Past 10 yrs	Past 5 yrs	Est'd 16-18 to 22-24
Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line
American States Water	NYSE	AWR	1787	7/12/2019	0.7	1.6%	3.5%		4.5%	6.0%	3.0%	6.0%	9.0%	4.5%	8.0%	7.5%	9.0%	9.5%	5.0%	4.0%	5.0%
American Water	NYSE	AWK	1788	7/12/2019	0.6	1.8%	3.0%	3.5%	4.0%	18.5%	6.0%	7.0%		6.5%	9.5%		10.5%	9.0%	1.5%	4.0%	5.0%
Aqua American	NYSE	WTR	1789	7/12/2019	0.7	2.2%	3.0%	1.5%	3.5%	6.5%	5.0%	6.5%	8.0%	5.5%	8.0%	7.5%	8.0%	8.0%	6.5%	6.5%	9.0%
California Water	NYSE	CWT	1790	7/12/2019	0.7	1.6%	4.5%	2.0%	2.0%	6.0%	5.0%	4.0%	5.0%	5.5%	8.0%	2.0%	3.0%	6.5%	4.5%	4.5%	2.5%
Connecticut Water	NDQ	CTWS	1791	7/12/2019	0.55	1.9%	3.0%	1.0%	6.5%	6.0%	5.5%	6.5%	6.5%	5.5%	9.0%	3.0%	4.0%	4.5%	7.0%	6.0%	2.5%
Consolidated Water Company	NDQ	CWCO	1792	7/12/2019	0.9	2.4%	5.0%	0.5%	14.5%	2.0%	0.5%	11.0%	3.0%	4.5%	20.5%	5.0%		15.5%	5.0%	2.0%	3.5%
Middlesex Water	NDQ	MSEX	1793	7/12/2019	0.75	1.6%	2.5%	3.5%	3.0%	5.5%	9.0%	6.5%	6.0%	11.0%	7.5%	2.0%	3.0%	5.0%	3.5%	4.5%	3.5%
SJW Corporation	NYSE	SJW	1794	7/12/2019	0.6	2.0%	5.0%	5.5%		7.0%	11.0%	2.5%	8.0%	18.5%	6.0%	4.5%	5.0%	7.0%	5.5%	8.0%	6.5%
York Water	NDQ	YORW	1795	7/12/2019	0.75	2.0%	3.0%	3.0%	5.5%	6.0%	6.0%	9.0%	5.5%	6.5%	9.5%	3.5%	4.0%	6.5%	4.5%	4.0%	4.5%
Minimum					0.55	1.60%	2.50%	0.50%	2.00%	2.00%	0.50%	2.50%	-3.00%	-4.50%	6.00%	2.00%	3.00%	4.50%	1.50%	2.00%	2.50%
wtd Mean																					
Mean					0.69	1.90%	3.61%	2.56%	5.44%	7.06%	5.67%	6.56%	5.63%	6.56%	9.56%	4.38%	5.81%	7.94%	4.78%	4.83%	4.67%
Median					0.70	1.90%	3.00%	2.50%	4.25%	6.00%	5.50%	6.50%	6.25%	5.50%	8.00%	4.00%	4.50%	7.00%	5.00%	4.50%	4.50%
Maximum					0.90	2.40%	5.00%	5.50%	14.50%	18.50%	11.00%	11.00%	9.00%	18.50%	20.50%	7.50%	10.50%	15.50%	7.00%	8.00%	9.00%

Cost of Equity Dividend Growth Model

Dividend 1.90% mean Col 7

Growth	Past 10 yrs	Past 5 yrs	Est'd 13-15 to 19-21	Beta
Revenues	3.61%	2.56%	5.44%	
Cash Flow	6.00%	5.67%	6.56%	
Earnings	5.63%	6.56%	9.56%	
Dividends	4.00%	5.81%	7.94%	
Book Value	5.00%	4.83%	4.67%	Input Min-Max
Mean	4.85%	5.09%	6.83%	0.69 0.55-0.9

Growth 6.83% AUS Input

Cost of Equity Dividend Growth Model
Dividend 1.90%
Growth 6.83%
Cost of Equity 8.73%

Cost of Equity Capital Asset Pricing Model (CAPM)

Cost of Equity Capital Asset Pricing Model (CAPM)

Risk Free Rate			4.97% Input	Long term Government Bonds Income Return SBBI (Mean)
Risk Premium				
Beta			0.69	
Risk Premia	6.90%	Input SBBI	6.90% Input	$r_p=r_m-r_f$ per PA PUC
Size Premia			$ Millions	$ Millions
Micro	5.80%	Input SBBI	-	289.7
Small	3.10%	Input SBBI	289.7	1,341.7
Mid	1.70%	Input SBBI	1,341.7	3,636.9
Large	0.00%	Input SBBI	3,636.9	
Size Premia			0.00% Input	
Cost of Equity			9.76%	

Cost of Equity
Dividend Growth Model 8.73%
Capital Asset Pricing Model (CAPM) 9.76%
Mean 9.25%
PA PUC Equity 9.95%
Cost of Equity 9.95% AUS Input Jurisdictional Exception
Growth 6.87% Input
Inflation 1.52% SBBI

Pennsylvania PUC 9.95%
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of Jurisdictional Utilities
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Value Line Investment Surveys
Water Industry
As of Second Quarter 2018 (7-1-2018)

Company	Exchange	Ticker	Valueline No.	Valueline Issue	Tax Rate			
					2018	2019	2020	22-24
Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line
American States Water	NYSE	AWR	1787	7/12/2019	22.0%	23.0%	23.0%	23.0%
American Water	NYSE	AWK	1788	7/12/2019	28.2%	21.0%	21.0%	21.0%
Aqua American	NYSE	WTR	1789	7/12/2019	6.6%		5.0%	50.0%
California Water	NYSE	CWT	1790	7/12/2019	24.5%	21.0%	21.0%	21.0%
Connecticut Water	NDQ	CTWS	1791	7/12/2019	19.0%	21.0%	21.0%	21.0%
Consolidated Water Company	NDQ	CWCO	1792	7/12/2019				
Middlesex Water	NDQ	MSEX	1793	7/12/2019	2.8%	21.0%	21.0%	21.0%
SJW Corporation	NYSE	SJW	1794	7/12/2019	20.6%	21.0%	21.0%	21.0%
York Water	NDQ	YORW	1795	7/12/2019	15.7%	21.0%	21.0%	21.0%
Minimum					2.80%	21.00%	5.00%	21.00%
wtd Mean								
Mean					17.43%	21.29%	19.25%	24.88%
Median					19.80%	21.00%	21.00%	21.00%
Maximum					28.20%	23.00%	23.00%	50.00%

	Historical		Current	
Embedded Tax Rate	17.43%	Mean 2017	21.29%	Mean 2018
Federal Tax Rate (Marginal)	35.00%	AUS Input	21.00%	AUS Input
US 50-state average	4.91%	AUS Input	4.91%	AUS Input
Pennsylvania	9.99%	AUS Input	9.99%	AUS Input
Composite Federal and State Tax Rate	41.49%	Calculated =Federal Tax * (1-State Tax)+State Tax	28.89%	Calculated =Federal Tax * (1-State Tax)+State Tax

Value Line Investment Surveys
Water Industry
As of Second Quarter 2018 (7-1-2018)

	S&P Debt Rating	Long Term Debt	Long Term Interest	Long Term Interest Rate (embedded)
		Input Value Line	Input Value Line	(4) / (3)
American States Water		376.6	24.0	6.37%
American Water		7,562.0	328.0	4.34%
Aqua American		2,463.0	96.0	3.90%
California Water		710.6	40.0	5.63%
Connecticut Water		257.4	10.0	3.89%
Consolidated Water Company		-	-	
Middlesex Water		158.4	6.8	4.29%
SJW Corporation		510.9	20.0	3.91%
York Water		94.1	5.5	5.84%
		12,133.0	530.3	4.37%
Minimum				3.89%
wtd Mean				4.37%
Mean				4.77%
Median				4.32%
Maximum				6.37%

Debt Rating and Cost of Debt

Embedded 4.37% wtd mean col 5

Rating (S&P) A Input
Market Cost of Debt @Bond Rating
Mergent Bond Record 4.45% Input October 2018

Use 4.45% AUS Input

Value Line Investment Surveys
Water Industry
As of Second Quarter 2018 (7-1-2018)

Company	Exchange	Ticker	Valueline No.	Valueline Issue	Total Return				
					1 year	3 Years	3 years annualized	5 Years	5 years annualized
Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Input Value Line	Calculation	Input Value Line	Calculation
							=((1+3 year Total Return)^(1/3))-1		=((1+5 year Total Return)^(1/5))-1
American States Water	NYSE	AWR	1787	7/12/2019	33.8%	82.0%	22.1%	151.2%	20.2%
American Water	NYSE	AWK	1788	7/12/2019	38.6%	45.8%	13.4%	161.2%	21.2%
Aqua American	NYSE	WTR	1789	7/12/2019	20.5%	24.8%	7.7%	78.3%	12.3%
California Water	NYSE	CWT	1790	7/12/2019	32.2%	53.4%	15.3%	134.0%	18.5%
Connecticut Water	NDQ	CTWS	1791	7/12/2019	8.7%	31.8%	9.6%	131.5%	18.3%
Consolidated Water Company	NDQ	CWCO	1792	7/12/2019	13.4%	17.9%	5.6%	37.7%	6.6%
Middlesex Water	NDQ	MSEX	1793	7/12/2019	43.0%	45.5%	13.3%	217.6%	26.0%
SJW Corporation	NYSE	SJW	1794	7/12/2019	-6.5%	62.9%	17.7%	148.2%	19.9%
York Water	NDQ	YORW	1795	7/12/2019	14.7%	18.3%	5.8%	91.2%	13.8%
Total					22.0%		12.3%		17.4%
Minimum					-6.50%		5.64%		6.61%
wtd Mean									
Mean					22.04%		12.28%		17.43%
Median					20.50%		13.32%		18.53%
Maximum					43.00%		22.09%		26.00%

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2019 SBBI® Yearbook

Stocks, Bonds, Bills, and Inflation®

U.S. Capital Markets Performance by
Asset Class 1926–2018

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Company Size	Arithmetic Mean Return 1926-2018	Risk Premia over Income Return Long-term Government Bonds	Size Risk Premia over Large Company Risk Premia	Capitalization Size	
Decile 1 (Largest)	11.00%	6.0%	-0.9%	19,292,756,366	19,292,756,366
Large Company (Decile 1-2)					
Total Return	11.9%	6.9%	0.0%	1,736,953,613	19,292,756,366
Income Return	4.0%				
Capital Appreciation Return	7.7%				
Decile 2	12.70%	7.7%	0.8%	1,736,953,613	3,374,015,549
Decile 3	13.40%	8.4%	1.5%	1,163,165,541	1,736,953,613
Mid-cap Stocks (Decile 3-5)					
Total Return	13.6%	8.6%	1.7%	631,058,072	3,636,881,230
Income Return					
Capital Appreciation Return					
Decile 4	13.60%	8.6%	1.7%	736,762,076	1,163,165,541
Decile 5	14.30%	9.3%	2.4%	631,058,072	736,762,076
Decile 6	14.60%	9.6%	2.7%	403,045,100	631,058,072
Low-cap Stocks (Decile 6-8)					
Total Return	15.0%	10.0%	3.1%	289,657,971	1,341,668,214
Income Return					
Capital Appreciation Return					
Decile 7	15.20%	10.2%	3.3%	307,565,042	403,045,100
Decile 8	15.80%	10.8%	3.9%	200,061,186	307,565,042
Decile 9	16.70%	11.7%	4.8%	89,596,785	200,061,186
Micro-cap Stocks (Decile 9-10)					
Total Return	17.7%	12.7%	5.8%	-	289,657,971
Income Return					
Capital Appreciation Return					
Decile 10	19.80%	14.8%	7.9%	-	89,596,785
Long-term Government Bonds					
Total Return	5.9%	0.9%			
Income Return	5.0%				
Capital Appreciation Return	0.7%				

Inputs

Exhibit 6.9 presents summary statistics of annual total return, and where applicable, income and capital appreciation, for each asset class. The summary statistics presented here are arithmetic mean, geometric mean, standard deviation, and serial correlation. Exhibit 6.10 presents summary statistics for the six inflation-adjusted total return series.

Exhibit 6.9: Total Returns, Income Returns, and Capital Appreciation Returns of the SBBI® Asset Classes; Summary Statistics of Annual Returns (%)
1926–2018

	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation
Large-Cap Stocks				
Total Return	10.0	11.9	19.8	0.01
Income	3.9	4.0	1.6	0.91
Capital Appreciation	5.8	7.7	19.1	0.01
Small-Cap Stocks (TR)	11.8	16.2	31.6	0.06
Long-term Corp Bonds (TR)	5.9	6.3	8.4	0.03
Long-term Gov't Bonds				
Total Return	5.5	5.9	9.8	-0.15
Income	4.9	5.0	2.6	0.96
Capital Appreciation	0.3	0.7	8.8	-0.26
Inter-term Gov't Bonds				
Total Return	5.1	5.2	5.6	0.15
Income	4.4	4.4	2.9	0.96
Capital Appreciation	0.5	0.6	4.4	-0.17
U.S. Treasury Bills (TR)	3.3	3.4	3.1	0.92
Inflation	2.9	3.0	4.0	0.64

Exhibit 6.9 shows that over 1926–2018 small-cap stocks were the riskiest asset class with a standard deviation of 31.6%, but provided the greatest rewards to long-term investors, with an arithmetic mean annual return of 16.2%. The geometric mean of the small-cap series is 11.8%.

Large-cap stocks, long-term government bonds, long-term corporate bonds, and intermediate-term government bonds are progressively less risky, and have lower average returns. U.S. Treasury bills were nearly riskless and had the lowest return. In general, risk is rewarded by a higher return over the long term.

Exhibit 10.2: Building Blocks for Expected Return Construction

Yields (Riskless Rates)*	Value (%)
Long-term (20-year) U.S. Treasury Coupon Bond Yield	2.84
Intermediate-term (5-year) U.S. Treasury Coupon Note Yield	2.50
Short-term (30-day) U.S. Treasury Bill Yield	2.44
Fixed Income Risk Premiums **	
Expected default premium: long-term corporate bond total returns minus long-term government bond total returns	0.10
Expected long-term horizon premium: long-term government bond income returns minus U.S. Treasury bill total returns*	1.81
Expected intermediate-term horizon premium: intermediate-term government bond income returns minus U.S. Treasury bill total returns*	1.10
Equity Risk Premiums ***	
Long-horizon expected equity risk premium: large-cap stock total returns minus long-term government bond income returns	6.91
Intermediate-horizon expected equity risk premium: large-cap stock total returns minus intermediate-term government bond income returns	7.49
Short-horizon expected equity risk premium: large-cap stock total returns minus U.S. Treasury bill total returns ****	8.50
Small-cap premium: small-cap stock total return minus large-cap stock total return	4.33

* As of December 31, 2018. Maturities are approximate. Source: (i) SBBI Long-term Government Bond series (20-year maturity yield), SBBI Intermediate-term Government Bond series (5-year maturity yield), Treasury constant maturities/1-month/Business day (30-day U.S. Treasury Bill yield), Board of Governors of the Federal Reserve website at: http://www.federalreserve.gov/releases/h15/. (ii) Morningstar, Inc. Used with permission. All rights reserved. All calculations

** Expected risk premiums for fixed income are based on the differences of historical arithmetic mean returns from 1970–2018. Source: (i) SBBI Long-term Corporate Bond total return series (20-year maturity), (ii) SBBI Long-term Government Bond total return series (20-year maturity), (iii) SBBI Long-term Government Bond income return series (20-year maturity), (iv) SBBI Intermediate-term Government Bond income return series (5-year maturity), and (v) SBBI 30-Day T-Bill total return series. SBBI series retrieved from Morningstar *Direct* database.

*** Expected risk premiums for equities are based on the differences of historical arithmetic mean returns from 1926–2018. Source: (i) SBBI Large-cap Stocks total return series (essentially the S&P 500 Index), (ii) SBBI Long-term Government Bond income return series (20-year maturity), (iii) SBBI Intermediate-term Government Bond income return series (5-year maturity), (iv) SBBI 30-Day T-Bill total return series, and (v) SBBI Small-cap stock total return series. SBBI series retrieved from Morningstar *Direct* database.

**** For U.S. Treasury Bills, the income return and total return are the same.

With a 20-year horizon, the relevant riskless rate is the yield on a 20-year coupon bond. This riskless rate is the baseline from which the expected return on every other asset class is derived by adding or subtracting risk premiums.

Large-Cap Stocks

The expected return on large-cap stocks is the riskless rate, plus the expected risk premium of large-cap stocks over bonds that are riskless over the investment horizon. With a 20-year horizon, this risk premium is 6.91%, shown as the long-horizon expected equity risk premium in Exhibit 10.2. Hence, the expected return on large-cap stocks is 2.84% (the long-term riskless rate) plus 6.91% (the long-term equity risk premium), or 9.75%.

Bonds and Bills

For default-free bonds with a maturity equal to the planning horizon, the expected return is the yield on the bond; that is, the expected return is the long-term riskless rate of 2.84%. For bonds with other maturities, the expected bond horizon premium should be added to the riskless rate (for longer maturities) or subtracted from the riskless rate (for shorter maturities). Because expected capital gains on a bond are zero, the expected horizon premium is estimated by the historical average difference of the income returns on the bonds.[10.4]

For U.S. Treasury Bills, the expected return over a given time horizon equals the expected return on a Treasury bond of a similar horizon, less the expected horizon premium of bonds over bills. The long-term horizon premium is estimated by the historical average of the difference of the income return on bonds and the return on bills. From Exhibit 10.2, this is 1.81%. Subtracting this from the riskless rate (2.84%) gives us an expected return on bills of 1.03%. Of course, this forecast typically differs from the current yield on a U.S. Treasury Bill because a portfolio of U.S. Treasury Bills is rolled over (the proceeds of maturing bills are invested in new bills, at yields not yet known) during the time horizon described.

[10.4] The expected capital gain on a par bond is self-evidently zero. For a zero coupon (or other discount) bond, investors expect the price to rise as the bond ages, but the expected portion of this price increase should not be considered a capital gain. It is a form of income return.

Exhibit 7.1: Aggregate Market Capitalization and Company Counts of the CRSP (NYSE/NYSE MKT/NASDAQ) Deciles and Size Groupings
December 31, 2018

Decile	Historic Average Percentage of Total Capitalization	Recent Number of Companies	Recent Decile Market Capitalization (in $thousands)	Recent Percentage of Total Capitalization
1-Largest	63.22%	191	19,292,756,366	69.06%
2	13.91%	202	3,374,015,549	12.08%
3	7.53%	192	1,736,953,613	6.22%
4	4.72%	222	1,163,165,541	4.16%
5	3.25%	219	736,762,076	2.64%
6	2.41%	286	631,058,072	2.26%
7	1.79%	284	403,045,100	1.44%
8	1.33%	348	307,565,042	1.10%
9	1.02%	444	200,061,186	0.72%
10-Smallest	0.81%	725	89,596,785	0.32%
Mid-Cap 3-5	15.50%	633	3,636,881,230	13.02%
Low-Cap 6-8	5.52%	918	1,341,668,214	4.80%
Micro-Cap 9-10	1.84%	1,169	289,657,971	1.04%

Source of data: CRSP U.S. Stock Database and CRSP U.S. Indices Database © 2019 Center for Research in Security Prices (CRSP®), University of Chicago Booth School of Business. To learn more about CRSP, visit crsp.com.

In Exhibit 7.2, the largest company in each of the CRSP (NYSE/NYSE MKT/NASDAQ) deciles and size groupings (by market capitalization) are listed as of September 30, 2018.

Exhibit 7.6: Summary Statistics of Annual Returns (CRSP NYSE/NYSE MKT/NASDAQ Deciles) (%) 1926–2018

Decile	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation
1 - Largest	9.3	11.0	18.8	0.06
2	10.4	12.7	21.4	0.00
3	10.9	13.4	23.2	-0.03
4	10.7	13.6	25.4	-0.03
5	11.2	14.3	26.0	-0.03
6	11.2	14.6	27.0	0.01
7	11.4	15.2	28.9	0.01
8	11.3	15.8	32.7	0.00
9	11.3	16.7	36.8	0.06
10	12.9	19.8	42.1	0.14
Mid-Cap	10.9	13.6	24.3	-0.03
Low-Cap	11.3	15.0	28.5	0.01
Micro-Cap	11.9	17.7	38.5	0.08
The "Market" (Deciles 1-10)	9.8	11.7	19.9	0.01

Source of underlying data: CRSP U.S. Stock Database and CRSP U.S. Indices Database © 2019 Center for Research in Security Prices (CRSP®), University of Chicago Booth School of Business. To learn more about CRSP, visit crsp.com. All calculations performed by Duff & Phelps.

Exhibit 7.7 is a graphical depiction of the year-end index levels presented in Exhibit 7.5 for mid-cap stocks (a portfolio comprised of CRSP deciles 3, 4, and 5), low-cap stocks (a portfolio comprised of CRSP deciles 6, 7, and 8), micro-cap stocks (a portfolio comprised of CRSP deciles 9 and 10), and the "market" (a portfolio comprised of CRSP deciles 1–10).

Chapter 7
Company Size and Return[7.1]

One of the most remarkable discoveries of modern finance is the finding of a relationship between company size and return, generally referred to as the "size effect." The size effect is based on the empirical observation that companies of smaller size tend to have higher returns than do larger companies.

In 1981, study by Rolf Banz examined the returns of New York Stock Exchange (NYSE) small-cap companies compared to the returns of NYSE large-cap companies over the period 1926–1975.[7.2] What Banz found was that the returns of small-cap companies were *greater* than the returns for large-cap companies. Banz's 1981 study is often cited as the first comprehensive study of the size effect. There is a significant (negative) relationship between size and historical equity returns as size decreases, returns tend to increase, and vice versa.

Possible Explanations for the Greater Returns of Smaller Companies

Some valuation analysts treat small firms as equivalent to scaled-down large firms. This is likely an erroneous assumption.

There are theoretical reasons for the greater returns of smaller companies (i.e., the "size effect"), which might include: (i) small stocks are less liquid (with higher associated transaction costs), (ii) small stocks are riskier and harder to diversify, (iii) small stocks have higher betas which tend to be underestimated, (iv) investors must do more analysis per dollar invested, (v) investment data is less available.

Valuation analysts also cite more practical reasons that small firms have risk characteristics that differ from those of large firms. For example, large firms may have greater ability to enter the market of the small firm and take market share away. Large companies likely have more resources to "weather the storm" in economic downturns. Large firms can generally spend more cash on R&D, advertising, and typically even have greater ability to hire the "best and brightest". Larger firms may

7.1 This chapter is an overview of the relationship between size and return that is limited to analyzing the relative historical performance of "large-cap stocks" and "small-cap stocks," and does not include the much expanded analyses of the "size effect" as it relates to the development of cost of equity capital found on the Duff & Phelps online Cost of Capital Navigator platform at dpcostofcapital.com. The Cost of Capital Navigator guides the Analyst through the process of estimating the cost of equity capital, a key component of any valuation analysis. The Cost of Capital Navigator includes all of the critical information and data from the 1999–2019 CRSP Deciles Size Study and Risk Premium Report Study that were previously published in the *Valuation Handbook – U.S. Guide to Cost of Capital* from 2014 to 2017, and, before that, in the Ibbotson Associates/Morningstar *Stocks, Bonds, Bills, and Inflation® (SBBI®) Valuation Yearbook* and *Risk Premium Report*, respectively, from 1999 to 2013. The valuation data and information in the Cost of Capital Navigator is the actual "as published" valuation data from those former publications. The 1999–2013 Ibbotson Associates/Morningstar size premia, industry risk premia, and other valuation data that are available within the Cost of Capital Navigator are used with permission from Morningstar, Inc. The Cost of Capital Navigator is web-based, so you can access it from your desktop, laptop, or tablet. To learn more and purchase, visit dpcostofcapital.com.

7.2 Rolf W. Banz, "The Relationship between Return and Market Value of Common Stocks," *Journal of Financial Economics* (March 1981): 3–18. This paper is often cited as the first comprehensive study of the size effect.

have greater access to capital, broader management depth, and less dependency on just a few customers. A larger number of analysts typically follow large firms relative to small firms, so there is probably more information available about large firms. Small firms have fewer resources to fend off competition and redirect themselves after changes in the market occur.[7.3]

Any one of these differences (not an all-encompassing list) would tend to increase investors' required rate of return to induce them to invest in small companies rather than investing in large companies.

The size effect is not without controversy, nor is this controversy something new. Traditionally, small companies are believed to have greater required rates of return than large companies because small companies are inherently riskier. It is not clear, however, whether this is due to size itself, or to other factors closely related to or correlated with size, and thus the qualification that Banz noted in his 1981 article remains pertinent today:[7.4, 7.5]

> *"It is not known whether size [as measured by market capitalization] per se is responsible for the effect or whether size is just a proxy for one or more true unknown factors correlated with size."*

Construction of the CRSP Size Decile Portfolios

The portfolios used in this chapter are those created by the Center for Research in Security Prices, or CRSP, at the University of Chicago's Booth School of Business. CRSP has refined the methodology of creating size-based portfolios and has applied this methodology to the entire universe of NYSE/NYSE MKT/NASDAQ-listed securities going back to 1926.[7.6] The universe of companies excludes:

- Closed-end mutual funds
- Preferred stocks
- Real estate investment trusts
- Foreign stocks
- American Depositary Receipts

7.3 M. S. Long and J. Zhang, "Growth Options, Unwritten Call Discounts and Valuing Small Firms", EFA 2004 Maastricht Meetings Paper no. 4057, March 2004. Available at [illegible]

7.4 Even after controlling for size, research suggests that liquidity is still a systematic factor and a predictor of returns. See: Ibbotson, Roger G., and Daniel Y.-J Kim, "Liquidity as an Investment Style: 2018 Update," available at [illegible] Updated version of: Ibbotson, Roger G., Chen, Zhiwu, Kim, Daniel Y.-J., and Hu, Wendy Y. "Liquidity as an Investment Style," *Financial Analysts Journal*, May/June 2013.

7.5 "Liquidity" is discussed in detail in Chapter 9, "Liquidity Investing."

7.6 In October, 2008, NYSE Euronext acquired the American Stock Exchange (AMEX). The "NYSE MKT" is the former American Stock Exchange, or AMEX. The CRSP standard market-cap-based NYSE/AMEX/NASDAQ indices are therefore called the NYSE/NYSE MKT/ NASDAQ indices herein.

- Unit investment trusts
- Americus Trusts

All companies on the NYSE are ranked by the combined market capitalization of their eligible equity securities. The companies are then split into 10 equally populated groups, or deciles. Eligible companies traded on the NYSE MKT (the former AMEX) and the Nasdaq National Market (NASDAQ) are then assigned to the appropriate deciles according to their capitalization in relation to the NYSE breakpoints.

The portfolios are rebalanced quarterly, using closing prices for the last trading day of March, June, September, and December. Securities added during the quarter are assigned to the appropriate portfolio when two consecutive month-end prices are available. If the final NYSE price of a security that becomes delisted is a month-end price, then that month's return is included in the quarterly return of the security's portfolio. When a month-end NYSE price is missing, the month-end value of the security is derived from merger terms, quotations on regional exchanges, and other sources. If a month-end value still is not determined, the last available daily price is used. Base security returns are monthly holding period returns. All distributions are added to the month-end prices, and appropriate price adjustments are made to account for stock splits and dividends. The return on a portfolio for one month is calculated as the weighted average of the returns for its individual stocks. Annual portfolio returns are calculated by compounding the monthly portfolio returns.[7.7]

Size of the Deciles

Exhibit 7.1 (next page) provides an overview of the CRSP deciles and size groupings in terms of relative size (by aggregate market capitalization) and number of companies as of December 31, 2018.

Decile 1 has 191 companies in it, and accounts for nearly two-thirds of aggregate market cap (69.06%). Decile 10 has 725 companies in it, and accounts for less than 1% of aggregate market cap (0.32%).

[7.7] According to CRSP, in 2016 CRSP "performed a comprehensive check and found changes to index levels back to 1977. Almost all of the changes are due to CRSP adding factor[s] to adjust price values for distribution codes 5663 & 5773. These edits were made in the 201612 iteration...". These edits are detailed in the CRSP document "STOCK & INDEX RELEASE NOTES, December 2016 Annual UPDATE" (available at: http://www.crsp.com/files/images/release_notes/crsp_2016_annual.pdf). This review of the database caused small changes in the returns over the 1926–2015 period (calculated using the December 31, 2015 data cut) compared to the returns over the 1926–2015 period (calculated using the December 31, 2016 data cut). These changes were not material: the largest/smallest change to the geometric mean return of CRSP standard market-cap-weighted deciles 1–10 over this period was 0.0044%/-0.0146%; the average/median change was -0.0007%/0.0003%. CRSP publishes index release notes; to view CRSP's most recent "Stock & Index Release Notes" through December 2018, visit: http://www.crsp.com/files/images/release_notes/crsp_2018_annual.pdf.

Exhibit 7.1: Aggregate Market Capitalization and Company Counts of the CRSP (NYSE/NYSE MKT/NASDAQ) Deciles and Size Groupings
December 31, 2018

Decile	Historic Average Percentage of Total Capitalization	Recent Number of Companies	Recent Decile Market Capitalization (in $thousands)	Recent Percentage of Total Capitalization
1-Largest	63.22%	191	19,292,756,366	69.06%
2	13.91%	202	3,374,015,549	12.08%
3	7.53%	192	1,736,953,613	6.22%
4	4.72%	222	1,163,165,541	4.16%
5	3.25%	219	736,762,076	2.64%
6	2.41%	286	631,058,072	2.26%
7	1.79%	284	403,045,100	1.44%
8	1.33%	348	307,565,042	1.10%
9	1.02%	444	200,061,186	0.72%
10-Smallest	0.81%	725	89,596,785	0.32%
Mid-Cap 3-5	15.50%	633	3,636,881,230	13.02%
Low-Cap 6-8	5.52%	918	1,341,668,214	4.80%
Micro-Cap 9-10	1.84%	1,169	289,657,971	1.04%

Source of data: CRSP U.S. Stock Database and CRSP U.S. Indices Database © 2019 Center for Research in Security Prices (CRSP®), University of Chicago Booth School of Business. To learn more about CRSP, visit crsp.com.

In Exhibit 7.2, the largest company in each of the CRSP (NYSE/NYSE MKT/NASDAQ) deciles and size groupings (by market capitalization) are listed as of September 30, 2018.

Exhibit 7.2: Largest Company (by market capitalization) in CRSP (NYSE/NYSE MKT/NASDAQ) Deciles and Size Groupings as of September 30, 2018

Decile	Company Name	Recent Market Capitalization (in $thousands)
1-Largest	Apple Inc	1,073,390,566
2	Dollar General Corp New	29,022,867
3	Yum China Holdings Inc	13,455,802
4	O G E Energy Corp	7,254,230
5	Dolby Laboratories Inc	4,503,549
6	Owens Ill Inc	2,992,251
7	Prestige Consumer Healthcare Inc	1,960,201
8	Group 1 Automotive Inc	1,292,224
9	Federal Agricultural Mort Corp	727,843
10-Smallest	Foresight Energy LP	321,578

Source of data: CRSP U.S. Stock Database and CRSP U.S. Indices Database © 2019 Center for Research in Security Prices (CRSP®), University of Chicago Booth School of Business. To learn more about CRSP, visit crsp.com.

The CRSP deciles are re-constituted and rebalanced at the end of each calendar quarter (March, June, September, and December). These quarter-end portfolios are then followed for the subsequent three months. For example, the breakpoints in Exhibit 7.2 were a key input in defining the companies placed in each decile at the end of September 2018; these portfolio compositions were then used to calculate the October, November, and December 2018 returns associated with each decile.[7.8]

Presentation of the Decile Data

Exhibit 7.3 is a year-by-year history of the annual returns for the ten CRSP deciles over the 1926–2018 time horizon.

Exhibit 7.4 provides the year-by-year growth of $1.00 over the 1926–2018 time horizon. These are year-end index levels, assuming an investment of $1.00 at year-end 1925.

Exhibit 7.5 is a year-by-year history of the annual *returns*, and the year-by-year *growth* of $1.00 (i.e., year-end index levels; assuming an investment of $1.00 at year-end 1925) over the 1926–2018 time horizon for (i) mid-cap stocks (a portfolio comprised of CRSP deciles 3, 4, and 5), (ii) low-cap stocks (a portfolio comprised of CRSP deciles 6, 7, and 8), (iii) micro-cap stocks (a portfolio comprised of CRSP deciles 9 and 10), and (iv) the "market" (a portfolio comprised of CRSP deciles 1–10).

[7.8] In the online Duff & Phelps Cost of Capital Navigator, as of Dec 31, 2018, large-capitalization companies (those in CRSP deciles 1–2) have equity capitalizations greater than $13,455.802 million; mid-capitalization companies (those in CRSP deciles 3–5) have equity capitalizations between $2,996.003 million and $13,455.802 million (inclusive), low-capitalization companies (those in CRSP deciles 6–8) have equity capitalizations between $730.047 million and $2,992.251 million (inclusive), and micro-capitalization companies (those in CRSP deciles 9–10) have equity capitalizations of equal to or less than $727.843 million.

Exhibit 7.3: Size Decile Portfolios of the NYSE/NYSE MKT/NASDAQ
Annual Returns (decimal format)
1926–2018

Year	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
1926	0.1415	0.0710	0.0320	0.0080	-0.0216	0.0398	-0.0265	-0.0655	-0.0952	-0.0678
1927	0.3362	0.2925	0.3216	0.3838	0.3645	0.2241	0.3689	0.2521	0.2992	0.2620
1928	0.4011	0.3530	0.3699	0.3449	0.5592	0.3583	0.3337	0.2688	0.3701	0.6634
1929	-0.1087	-0.0663	-0.2393	-0.3198	-0.2625	-0.3804	-0.3785	-0.3915	-0.4936	-0.5131
1930	-0.2481	-0.3653	-0.3715	-0.3588	-0.3447	-0.3808	-0.3680	-0.4762	-0.4601	-0.4473
1931	-0.4195	-0.5032	-0.4748	-0.4655	-0.4521	-0.5218	-0.4784	-0.4980	-0.4994	-0.4750
1932	-0.1048	0.0140	-0.0119	-0.1060	-0.1444	-0.0099	-0.0825	0.0109	-0.0192	0.4054
1933	0.4607	0.7273	0.9892	1.1528	1.0079	1.0293	1.0803	1.6907	2.0605	1.9584
1934	0.0052	0.0588	0.0733	0.1596	0.1355	0.2030	0.1897	0.1949	0.3098	0.3214
1935	0.4266	0.5307	0.4033	0.4216	0.5600	0.5756	0.6717	0.5890	0.5750	0.8195
1936	0.3010	0.3410	0.2900	0.3931	0.4980	0.5091	0.5700	0.5231	0.7158	0.8638
1937	-0.3164	-0.3713	-0.3723	-0.4466	-0.4891	-0.4548	-0.5083	-0.5424	-0.5177	-0.5394
1938	0.2509	0.3438	0.3674	0.3536	0.4511	0.4368	0.4021	0.4714	0.2659	0.0912
1939	0.0482	-0.0481	-0.0236	-0.0305	0.0327	0.0637	0.0209	0.0443	-0.0616	0.1829
1940	-0.0703	-0.0986	-0.0594	-0.0561	-0.0231	-0.0494	-0.0575	-0.0512	-0.0727	-0.2836
1941	-0.1119	-0.0818	-0.0726	-0.0734	-0.1164	-0.1039	-0.1134	-0.0801	-0.1512	-0.1117
1942	0.1369	0.2393	0.2085	0.2080	0.2275	0.2137	0.3015	0.3271	0.4377	0.6913
1943	0.2325	0.3475	0.3324	0.3892	0.4910	0.4408	0.7466	0.6446	0.8818	1.4050
1944	0.1680	0.2542	0.2528	0.3066	0.4195	0.4174	0.4011	0.4436	0.5668	0.7905
1945	0.3040	0.4548	0.5459	0.6334	0.5116	0.6112	0.6521	0.7092	0.7956	0.9086
1946	-0.0531	-0.0549	-0.0614	-0.1138	-0.0948	-0.0873	-0.1211	-0.1444	-0.1112	-0.1773
1947	0.0541	0.0098	-0.0040	0.0208	0.0342	-0.0309	-0.0341	-0.0178	-0.0403	-0.0037
1948	0.0337	0.0026	0.0263	-0.0225	-0.0192	-0.0408	-0.0283	-0.0701	-0.0800	-0.0390
1949	0.1852	0.2538	0.2597	0.1983	0.1822	0.2342	0.2189	0.1594	0.1984	0.2509
1950	0.2952	0.2875	0.2685	0.3186	0.3615	0.3406	0.3799	0.4002	0.4034	0.5643
1951	0.2164	0.2263	0.2117	0.1660	0.1483	0.1311	0.1845	0.1517	0.1072	0.0735
1952	0.1433	0.1301	0.1218	0.1190	0.1117	0.0997	0.1031	0.0795	0.0813	0.0259
1953	0.0124	0.0153	0.0030	-0.0137	-0.0288	-0.0096	-0.0253	-0.0772	-0.0434	-0.0825
1954	0.4888	0.4731	0.5887	0.5081	0.5726	0.5956	0.5750	0.5278	0.6148	0.6869
1955	0.2875	0.1806	0.1859	0.1932	0.1771	0.2295	0.1839	0.1976	0.2080	0.2574
1956	0.0811	0.1138	0.0701	0.0885	0.0794	0.0606	0.0724	0.0642	0.0483	-0.0100
1957	-0.0923	-0.0864	-0.1315	-0.1080	-0.1409	-0.1833	-0.1631	-0.1869	-0.1446	-0.1694
1958	0.4070	0.4943	0.5458	0.5893	0.5619	0.5636	0.6832	0.6490	0.7154	0.6834
1959	0.1242	0.1001	0.1305	0.1555	0.1939	0.1537	0.2012	0.1784	0.2041	0.1351
1960	0.0037	0.0613	0.0466	0.0075	-0.0157	-0.0076	-0.0618	-0.0455	-0.0375	-0.0787
1961	0.2627	0.2739	0.2847	0.2941	0.2874	0.2633	0.3242	0.3234	0.3070	0.3235
1962	-0.0878	-0.0961	-0.1197	-0.1249	-0.1689	-0.1739	-0.1628	-0.1579	-0.1695	-0.1490
1963	0.2249	0.2133	0.1655	0.1720	0.1279	0.1838	0.1801	0.1951	0.1291	0.1117
1964	0.1599	0.1431	0.2001	0.1609	0.1606	0.1690	0.1574	0.1706	0.1565	0.2103
1965	0.0893	0.1940	0.2468	0.2391	0.3217	0.3827	0.3329	0.3224	0.3193	0.4315
1966	-0.1033	-0.0547	-0.0511	-0.0606	-0.0732	-0.0467	-0.0935	-0.0884	-0.0577	-0.1008
1967	0.2197	0.2079	0.3169	0.4564	0.5145	0.5343	0.6472	0.8133	0.9064	1.1416
1968	0.0753	0.1654	0.1979	0.1829	0.2759	0.3047	0.2673	0.4047	0.3711	0.6136
1969	-0.0584	-0.1295	-0.1172	-0.1662	-0.1808	-0.1871	-0.2445	-0.2471	-0.3158	-0.3290
1970	0.0231	0.0182	0.0330	-0.0699	-0.0601	-0.0593	-0.0973	-0.1614	-0.1526	-0.1785
1971	0.1484	0.1328	0.2011	0.2472	0.1890	0.2244	0.2018	0.1735	0.1647	0.1853

Exhibit 7.3: Size Decile Portfolios of the NYSE/NYSE MKT/NASDAQ
Annual Returns (decimal format)
1926–2018

Year	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
1972	0.2212	0.1278	0.0938	0.0881	0.0863	0.0695	0.0632	0.0205	-0.0229	-0.0057
1973	-0.1274	-0.2266	-0.2278	-0.2680	-0.3217	-0.3191	-0.3702	-0.3534	-0.3897	-0.4203
1974	-0.2803	-0.2441	-0.2458	-0.2834	-0.2167	-0.2694	-0.2558	-0.2423	-0.2635	-0.2715
1975	0.3169	0.4573	0.5363	0.6168	0.5966	0.5675	0.6326	0.6579	0.6649	0.7579
1976	0.2073	0.3045	0.3811	0.4008	0.4363	0.4808	0.5018	0.5690	0.5101	0.5516
1977	-0.0884	-0.0367	0.0109	0.0376	0.1126	0.1413	0.1754	0.2261	0.2022	0.2310
1978	0.0637	0.0229	0.1084	0.0974	0.1213	0.1637	0.1705	0.1632	0.1605	0.2815
1979	0.1619	0.2871	0.3065	0.3521	0.3545	0.4925	0.4181	0.4638	0.4594	0.4158
1980	0.3275	0.3442	0.3186	0.3043	0.3193	0.3141	0.3623	0.3233	0.3823	0.3071
1981	-0.0833	0.0059	0.0372	0.0403	0.0484	0.0677	-0.0040	0.0055	0.0802	0.0856
1982	0.1964	0.1749	0.2081	0.2567	0.3076	0.2940	0.2914	0.2955	0.2608	0.2855
1983	0.2056	0.1711	0.2649	0.2584	0.2646	0.2589	0.2767	0.3675	0.3150	0.3686
1984	0.0840	0.0758	0.0273	-0.0465	-0.0267	0.0244	-0.0411	-0.0749	-0.0896	-0.1952
1985	0.3137	0.3754	0.2946	0.3355	0.3159	0.3086	0.3255	0.3651	0.3077	0.2587
1986	0.1801	0.1811	0.1619	0.1706	0.1561	0.0893	0.1246	0.0393	0.0570	0.0042
1987	0.0504	0.0039	0.0393	0.0163	-0.0382	-0.0519	-0.0849	-0.0813	-0.1262	-0.1489
1988	0.1486	0.1982	0.2126	0.2239	0.2138	0.2339	0.2394	0.2854	0.2285	0.2105
1989	0.3295	0.3008	0.2629	0.2308	0.2423	0.2107	0.1784	0.1788	0.1058	0.0553
1990	-0.0088	-0.0853	-0.1015	-0.0877	-0.1410	-0.1849	-0.1531	-0.1977	-0.2451	-0.3128
1991	0.3039	0.3463	0.4140	0.3887	0.4810	0.5357	0.4421	0.4723	0.5069	0.4807
1992	0.0474	0.1568	0.1406	0.1249	0.2587	0.1895	0.1920	0.1287	0.2497	0.3398
1993	0.0733	0.1316	0.1614	0.1567	0.1657	0.1788	0.1877	0.1844	0.1687	0.2548
1994	0.0174	-0.0177	-0.0404	-0.0118	-0.0159	0.0041	-0.0261	-0.0286	-0.0321	-0.0291
1995	0.3943	0.3501	0.3566	0.3276	0.3319	0.2660	0.3292	0.2966	0.3498	0.3044
1996	0.2376	0.1959	0.1696	0.1905	0.1322	0.1779	0.1941	0.1693	0.2074	0.1711
1997	0.3488	0.2984	0.2515	0.2601	0.1591	0.2837	0.2993	0.2576	0.2473	0.2310
1998	0.3513	0.1289	0.0737	0.0725	0.0065	0.0111	-0.0068	0.0086	-0.0517	-0.1153
1999	0.2451	0.2009	0.3313	0.2990	0.2586	0.3526	0.2496	0.3939	0.3410	0.2787
2000	-0.1358	-0.0119	-0.0645	-0.0997	-0.0794	-0.1052	-0.1049	-0.1297	-0.1341	-0.1341
2001	-0.1531	-0.0869	-0.0413	-0.0050	-0.0252	0.0941	0.1170	0.2161	0.3142	0.3639
2002	-0.2238	-0.1766	-0.1938	-0.1794	-0.1750	-0.2144	-0.2283	-0.2001	-0.1867	-0.0555
2003	0.2568	0.3750	0.3990	0.4473	0.4081	0.4769	0.5108	0.5821	0.6859	0.9212
2004	0.0789	0.2033	0.1809	0.1873	0.1752	0.2216	0.1894	0.2186	0.1483	0.1886
2005	0.0370	0.1255	0.1153	0.1101	0.0995	0.0302	0.1054	0.0757	0.0229	0.0575
2006	0.1561	0.1577	0.1453	0.1157	0.1585	0.1496	0.1613	0.1793	0.1676	0.1968
2007	0.0712	0.0733	0.0400	0.0440	0.0765	0.0520	-0.0141	-0.0562	-0.0635	-0.0996
2008	-0.3509	-0.4175	-0.4018	-0.3677	-0.3532	-0.4009	-0.3607	-0.3564	-0.3690	-0.4793
2009	0.2249	0.3889	0.3775	0.4517	0.4452	0.4102	0.4229	0.4856	0.5044	0.8173
2010	0.1312	0.2172	0.3058	0.2136	0.2940	0.2741	0.3194	0.3258	0.2903	0.2926
2011	0.0227	-0.0018	-0.0217	0.0114	-0.0095	-0.0141	-0.0504	-0.0601	-0.0756	-0.1411
2012	0.1594	0.1589	0.1666	0.1618	0.1577	0.1843	0.1827	0.1829	0.1472	0.2145
2013	0.3267	0.3725	0.3614	0.4190	0.4117	0.4309	0.4188	0.4599	0.5030	0.4909
2014	0.1236	0.1568	0.1014	0.0763	0.0541	0.0414	0.0681	0.0174	0.0207	0.0280
2015	0.0173	-0.0361	-0.0286	-0.0473	-0.0739	-0.0732	-0.0589	-0.0781	-0.1127	-0.1155
2016	0.1163	0.1696	0.1685	0.1354	0.1667	0.1878	0.2546	0.2177	0.3129	0.2150
2017	0.2349	0.1869	0.2326	0.1808	0.1574	0.2018	0.1473	0.1208	0.1272	0.1366
2018	-0.0293	-0.0825	-0.0977	-0.0992	-0.1116	-0.1388	-0.0721	-0.1035	-0.0882	-0.1629

Source of data: CRSP U.S. Stock Database and CRSP U.S. Indicees Database © 2019 Center for Research in Security Prices (CRSP®), The University of Chicago Booth School of Business (2019). To learn more about CRSP, visit

Aspects of the Company Size Effect

The company size phenomenon is remarkable in several ways. First, the greater risk of small-cap does not, in the context of the capital asset pricing model, fully account for their higher returns over the long term. In the CAPM only systematic, or beta risk, is rewarded; small-cap stock returns have exceeded those implied by their betas.

Second, the calendar annual return differences between small- and large-cap companies are serially correlated. This suggests that past annual returns may be of some value in predicting future annual returns. Such serial correlation, or autocorrelation, is practically unknown in the market for large-cap stocks and in most other equity markets but is evident in the size premium series.

Third, the size effect is seasonal. For example, small-cap stocks outperformed large-cap stocks in January in a large majority of the years. Such predictability is surprising and suspicious in light of modern capital market theory. These three aspects of the size effect – long-term returns in excess of systematic risk, serial correlation, and seasonality – will be discussed in the following sections.

The Size Effect: Empirical Evidence

Summary statistics over the 1926–2018 period for CRSP NYSE/NYSE MKT/NASDAQ deciles 1–10 are shown in Exhibit 7.6. As size (in this case, as measured by market cap) *decreases*, return tends to *increase*.[7.9]

For example, the annual arithmetic mean return of decile 1 (the largest-cap companies) was 11.0% over the 1926–2018 period, while the annual arithmetic mean return of decile 10 (the smallest-cap companies) was 19.8%. Note that this increased return comes at a price: risk (as measured by standard deviation) increases from 18.8% for decile 1 to 42.1% for decile 10. The relationship between risk and return is a fundamental principle of finance.

History tells us that small companies are riskier than large companies. Exhibit 7.6 shows the standard deviation (a measure of risk) for each decile of the NYSE/NYSE AMEX/NASDAQ. As one moves from CRSP decile 1 (comprised of the largest companies) to CRSP decile 10 (comprised of the smallest companies), the standard deviation of return grows. Investors are compensated for taking on this additional risk by the higher returns provided by small companies.

[7.9] Traditionally, researchers have used market value of equity (market capitalization, or simply "market cap") as a measure of size in conducting historical rate of return studies. However, market cap is not the only measure of size that can be used to predict return, nor is it necessarily the best measure of size to use. In the online Duff & Phelps Cost of Capital Navigator platform, the size effect is examined in relation to *eight* measures of company size (including market cap): (i) market capitalization, (ii) book value of equity, (iii) 5-year average net income, (iv) market value of invested capital (MVIC), (v) total assets, (vi) 5-year average EBITDA, (vii) sales, and (viii) number of employees. The Cost of Capital Navigator guides the Analyst through the process of estimating the cost of equity capital, a key component of any valuation analysis. The Cost of Capital Navigator includes the critical information and data from the 1999–2019 CRSP Deciles Size Study and Risk Premium Report Study that were published in the former *Valuation Handbook – U.S. Guide to Cost of Capital* from 2014 to 2017, and, before that, in the former Ibbotson Associates/Morningstar *Stocks, Bonds, Bills, and Inflation® (SBBI®) Valuation Yearbook* and *Risk Premium Report*, respectively, from 1999 to 2013. The valuation data and information in the Cost of Capital Navigator is the actual "as published" valuation data from those former publications. The 1999–2013 Ibbotson Associates/Morningstar size premia, industry risk premia, and other valuation data that are available within the Cost of Capital Navigator are used with permission from Morningstar, Inc. The Cost of Capital Navigator is web-based, so you can access it from your desktop, laptop, or tablet. To learn more and purchase, visit dpcostofcapital.com.

Exhibit 7.6: Summary Statistics of Annual Returns (CRSP NYSE/NYSE MKT/NASDAQ Deciles) (%) 1926–2018

Decile	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation
1 - Largest	9.3	11.0	18.8	0.06
2	10.4	12.7	21.4	0.00
3	10.9	13.4	23.2	-0.03
4	10.7	13.6	25.4	-0.03
5	11.2	14.3	26.0	-0.03
6	11.2	14.6	27.0	0.01
7	11.4	15.2	28.9	0.01
8	11.3	15.8	32.7	0.00
9	11.3	16.7	36.8	0.06
10	12.9	19.8	42.1	0.14
Mid-Cap	10.9	13.6	24.3	-0.03
Low-Cap	11.3	15.0	28.5	0.01
Micro-Cap	11.9	17.7	38.5	0.08
The "Market" (Deciles 1-10)	9.8	11.7	19.9	0.01

Source of underlying data: CRSP U.S. Stock Database and CRSP U.S. Indices Database © 2019 Center for Research in Security Prices (CRSP®), University of Chicago Booth School of Business. To learn more about CRSP, visit crsp.com. All calculations performed by Duff & Phelps.

Exhibit 7.7 is a graphical depiction of the year-end index levels presented in Exhibit 7.5 for mid-cap stocks (a portfolio comprised of CRSP deciles 3, 4, and 5), low-cap stocks (a portfolio comprised of CRSP deciles 6, 7, and 8), micro-cap stocks (a portfolio comprised of CRSP deciles 9 and 10), and the "market" (a portfolio comprised of CRSP deciles 1–10).

Exhibit 10.2: Building Blocks for Expected Return Construction

Yields (Riskless Rates)*	Value (%)
Long-term (20-year) U.S. Treasury Coupon Bond Yield	2.84
Intermediate-term (5-year) U.S. Treasury Coupon Note Yield	2.50
Short-term (30-day) U.S. Treasury Bill Yield	2.44
Fixed Income Risk Premiums **	
Expected default premium: long-term corporate bond total returns minus long-term government bond total returns	0.10
Expected long-term horizon premium: long-term government bond income returns minus U.S. Treasury bill total returns*	1.81
Expected intermediate-term horizon premium: intermediate-term government bond income returns minus U.S. Treasury bill total returns*	1.10
Equity Risk Premiums ***	
Long-horizon expected equity risk premium: large-cap stock total returns minus long-term government bond income returns	6.91
Intermediate-horizon expected equity risk premium: large-cap stock total returns minus intermediate-term government bond income returns	7.49
Short-horizon expected equity risk premium: large-cap stock total returns minus U.S. Treasury bill total returns ****	8.50
Small-cap premium: small-cap stock total return minus large-cap stock total return	4.33

* As of December 31, 2018. Maturities are approximate. Source: (i) SBBI Long-term Government Bond series (20-year maturity yield), SBBI Intermediate-term Government Bond series (5-year maturity yield), Treasury constant maturities/1-month/Business day (30-day U.S. Treasury Bill yield), Board of Governors of the Federal Reserve website at: https://www.federalreserve.gov/releases.htm. (ii) Morningstar, Inc. Used with permission. All rights reserved. All calculations

** Expected risk premiums for fixed income are based on the differences of historical arithmetic mean returns from 1970–2018. Source: (i) SBBI Long-term Corporate Bond total return series (20-year maturity), (ii) SBBI Long-term Government Bond total return series (20-year maturity), (iii) SBBI Long-term Government Bond income return series (20-year maturity), (iv) SBBI Intermediate-term Government Bond income return series (5-year maturity), and (v) SBBI 30-Day T-Bill total return series. SBBI series retrieved from Morningstar *Direct* database.

*** Expected risk premiums for equities are based on the differences of historical arithmetic mean returns from 1926–2018. Source: (i) SBBI Large-cap Stocks total return series (essentially the S&P 500 Index), (ii) SBBI Long-term Government Bond income return series (20-year maturity), (iii) SBBI Intermediate-term Government Bond income return series (5-year maturity), (iv) SBBI 30-Day T-Bill total return series, and (v) SBBI Small-cap stock total return series. SBBI series retrieved from Morningstar *Direct* database.

**** For U.S. Treasury Bills, the income return and total return are the same.

PENNSYLVANIA PUBLIC UTILITY COMMISSION

Public Meeting held August 29, 2019

Docket Number: M-2019-3012175

BUREAU OF TECHNICAL UTILITY SERVICES

REPORT ON THE QUARTERLY EARNINGS

OF JURISDICTIONAL UTILITIES

FOR THE YEAR ENDED

March 31, 2019

Gladys Brown Dutrieuille, Chairman
David W. Sweet, Vice Chairman
Norman J. Kennard, Commissioner
Andrew G. Place, Commissioner, Statement
John F. Coleman, Jr., Commissioner

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Introduction:

On September 20, 1991, the Commission initiated a rulemaking at L-00910061 pertaining to earnings disclosures by the public utilities subject to its jurisdiction. At that docket, the Commission stated that the submission of accurate, reliable and complete earnings disclosure reports, at regular intervals, is essential to the fulfillment of the broad regulatory oversight responsibilities entrusted to the Commission by the Legislature in the Public Utility Code. The earnings disclosure regulations promulgated by the Commission were adopted October 1, 1992, and published January 23, 1993, at 23 Pa.B. 463. Based upon those regulations, codified at 52 Pa. Code, Chapter 71, a reporting format was developed and distributed to the jurisdictional fixed utilities of Pennsylvania.

All fixed utilities having jurisdictional revenues of $1,000,000 or more, for a calendar year, are required to file the report by March 31 of each year. Such reports are to be based upon the results of operations for the 12-month period ending December 31 of the prior year. Utilities having more than $10,000,000 in jurisdictional revenues are also required to file reports for the 12 months ending on March 31, June 30, and September 30 of each year. On November 30, 2004, however, the Pennsylvania General Assembly signed into law Act 183 concerning alternative telecommunications regulation and broadband deployment. As a result of Act 183, the reporting requirements for the PUC jurisdictional telecommunications companies of Pennsylvania have been streamlined at section 3015(e) of the Public Utility Code. A quarterly earnings report is not listed among those reports now required of PUC jurisdictional telecommunications utilities in Pennsylvania and, therefore, this report does not address telephone company earnings.

The reports have been filed for the period ended March 31, 2019.[1] The Finance Staff of the Bureau of Technical Utility Services has reviewed the reports and has prepared this summary report for public release. This report sets forth the achieved return on equity for each company, the last allowed return for that utility, a market return as determined through the analysis of the barometer group data and the most recent returns allowed, per industry, by the Pennsylvania Public Utility Commission and by other regulatory bodies. Where a utility has not filed a report, the reasons for not filing are indicated.

Questions pertaining to the preparation and contents of this Report should be directed to Ms. Erin Laudenslager, Manager - Finance, Bureau of Technical Utility Services, at (717) 705-4364.

[1] SUEZ Water, Aqua Pennsylvania, Superior Water Company, Peoples Natural Gas Company, Peoples Nat'l – Equitable, UGI Utilities, Inc. – South, UGI Utilities, Inc. – North, and UGI Utilities, Inc. – Central, have rate filings at Docket Nos. R-2018-3000834, R-2018-3003558, R-2018-3003561, R-2018-3006818, R-2018-3006818, R-2018-3006814, R-2018-3006814, and R-2018-3006814 respectively, and filed a letter with the Secretary in place of a report in accordance with 52 Pa. Code § 71.4.

The equity return summaries that follow in Attachment A are, for each quarter;

ACTUAL

1. Based on actual results of operations

and

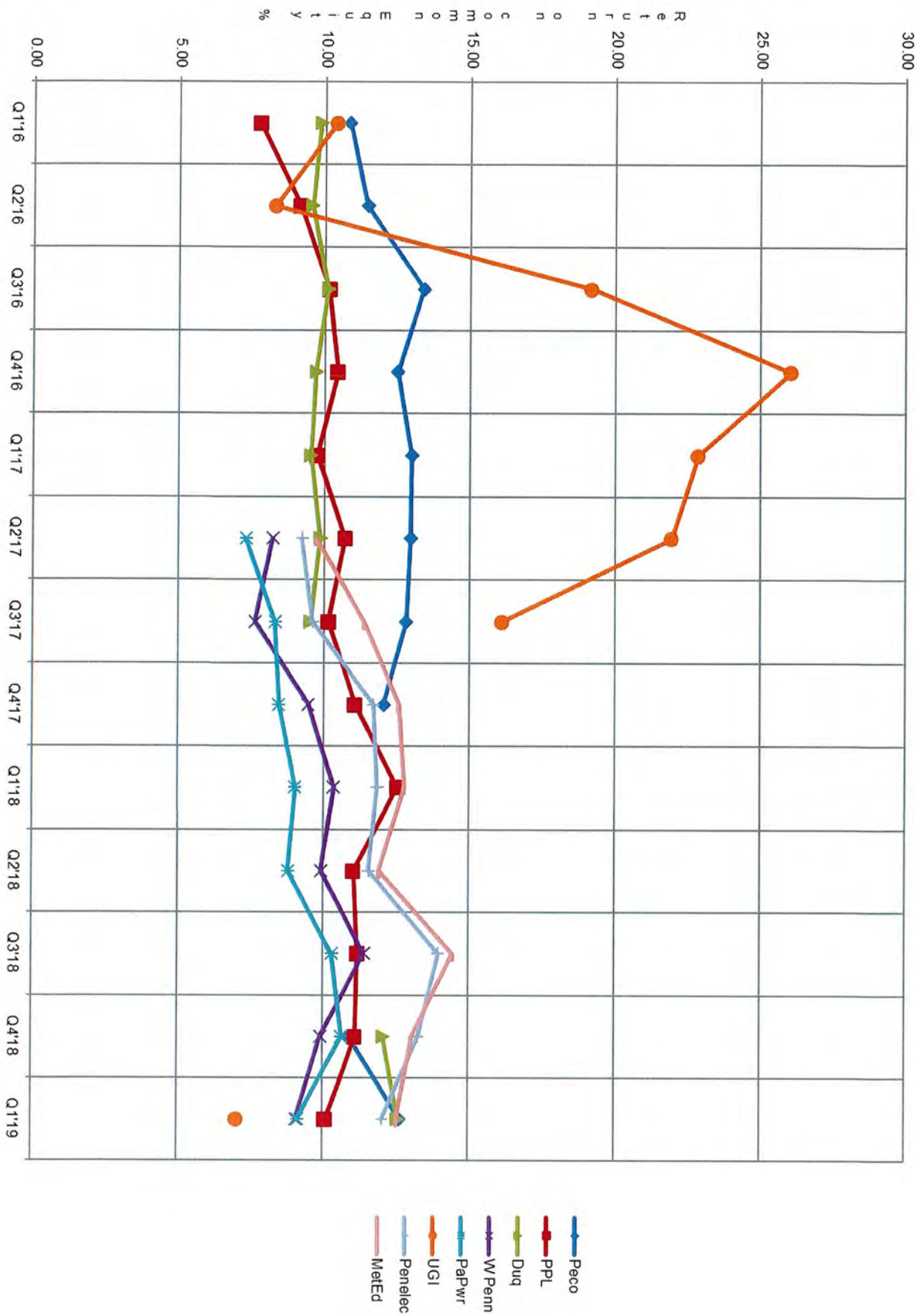
ADJUSTED

2. Based on company proposed pro forma and ratemaking adjustments

ELECTRIC UTILITIES
EQUITY RETURNS BY QUARTER

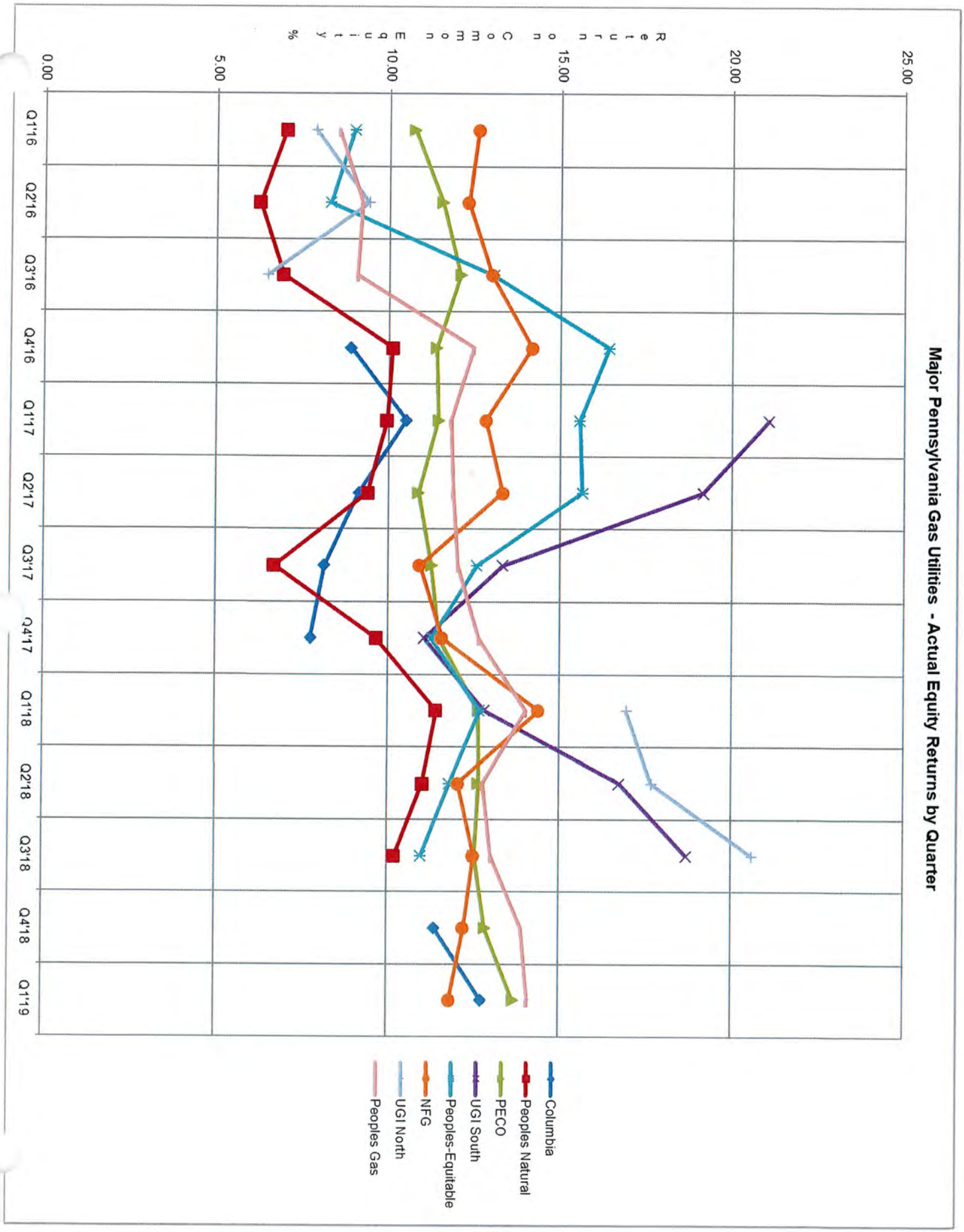
QTR END		PECO		PPL		Duq		W Penn		PaPwr		UGI		Penelec		MetEd	
		ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ
2013	2	11.40	10.74	7.80	7.37			12.34	12.34	8.85	8.70	11.53	10.49	5.86	8.21	5.36	6.79
	3	11.09	10.96	8.67	8.38			9.13	9.13	8.49	8.34	10.74	10.65	-0.77	2.07	-12.43	-10.43
	4	11.97	10.52	10.01	9.79			13.73	13.73	14.49	14.30	14.25	11.99	4.85	2.99	-6.06	-7.87
	1	9.97	10.34	10.02	10.04			11.58	9.45	15.28	15.04	13.36	10.25	5.17	3.34	-6.40	-8.13
2014	2	10.05	10.08	9.50	10.09	9.77	9.29					12.64	9.21				
	3	8.93	9.25	10.07	9.99	9.97	9.48					8.76	9.22				
	4	8.23	9.58			9.77	9.40					9.01	10.00				
	1					10.08	9.65					10.88	10.39				
2015	2					9.80	9.42					13.57	9.49				
	3					10.11	9.73	6.45	6.45	5.77	5.77	15.93	7.57	2.94	2.94	3.69	3.69
	4	10.74	8.84	8.89	8.48	9.73	9.36	8.09	8.09	5.13	5.13	9.74	9.21	5.45	5.45	7.04	7.04
	1	10.86	9.74	7.75	6.94	9.87	9.89					10.41	8.69				
2016	2	11.46	10.15	9.15	8.51	9.57	9.47					8.29	8.10				
	3	13.42	11.44	10.15	9.59	10.12	9.46					19.18	6.99				
	4	12.52	10.65	10.45	10.29	9.71	9.01					26.07	7.30				
	1	13.01	11.40	9.76	8.49	9.53	8.99					22.86	6.81				
2017	2	12.98	11.40	10.71	9.70	9.86	9.24	8.23	7.38	7.32	7.97	21.96	6.74	9.23	9.20	9.74	9.35
	3	12.84	10.52	10.15	9.30	9.53	9.23	7.63	7.24	8.32	9.08	16.13	5.22	9.61	9.50	11.37	10.97
	4	12.07	9.11	11.07	10.63			9.47	9.12	8.46	8.19			11.70	10.93	12.58	11.67
	1			12.53	11.36			10.35	9.08	9.03	8.08			11.84	9.93	12.77	11.38
2018	2			11.05	9.49			9.92	8.52	8.79	7.57			11.56	9.39	11.90	10.26
	3			11.19	9.83			11.41	6.74	10.30	5.80			13.97	8.44	14.46	9.62
	4	10.88	7.61	11.10	10.15	12.06	9.39	9.92	6.78	10.64	7.43			13.27	9.31	13.05	7.40
2019	1	12.65	7.93	10.10	8.96	12.58	9.73	9.08	6.62	9.14	7.61	7.05	5.22	12.03	8.07	12.54	7.66

Major Pennsylvania Electric Utilities - Actual Equity Returns by Quarter



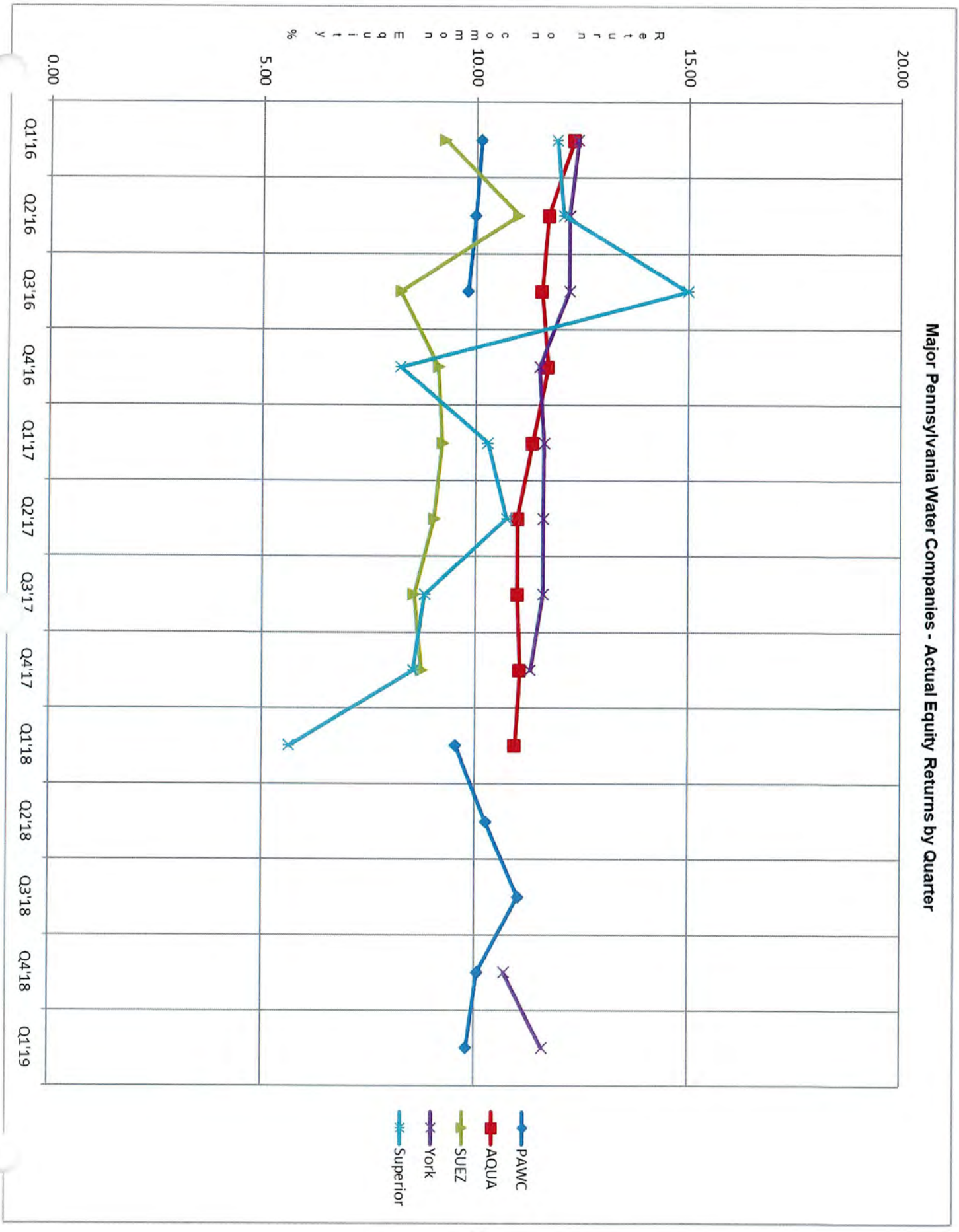
GAS UTILITIES
EQUITY RETURNS BY QUARTER

QTR		Columbia		Peoples Natural		PECO		UGI South		Peoples-Equitable		NFG		UGI North		Peoples Gas	
END		ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ
2013	2	10.85	7.15	16.59	8.35	14.43	14.40	13.02	10.21	10.40	8.92	20.18	10.25	10.98	10.27		
	3	9.36	9.86	17.39	8.72	14.14	14.01	12.60	9.38	9.84	9.48	19.61	10.72	10.59	10.76		
	4	10.60	10.78	16.33	10.02	14.35	13.97	16.08	9.20	10.52	9.76	20.51	10.07	13.41	10.49	7.21	12.23
	1			14.68	9.94	15.23	13.52	16.81	8.35	12.00	8.73	23.11	9.78	16.67	10.06	12.19	11.87
2014	2			13.05	9.78	15.32	13.24	16.71	8.39	13.54	8.49	22.97	12.00	15.30	10.90	14.06	12.32
	3			13.43	9.16	15.45	13.21	16.63	8.64	14.41	9.15	21.36	11.03	13.77	10.15	15.07	12.62
	4	9.71	9.97	11.85	7.89	13.86	12.59	15.00	7.93	14.52	12.46	20.40	10.79	15.64	9.82	16.91	11.83
	1			14.22	7.90	14.60	13.01	15.76	7.87	15.36	12.14	20.17	10.31	15.57	9.52	16.36	11.23
2015	2			14.37	8.88	13.89	12.32	14.07	7.62	14.08	11.26	18.82	10.39	13.76	8.90	16.15	12.90
	3			13.55	8.14	13.29	11.77	15.67	6.51	11.30	10.87	16.41	10.27	13.16	8.32	15.69	12.58
	4	9.75	9.73	8.80	9.83	12.50	12.70			10.60	10.00	15.01	10.59	9.17	7.25	12.71	12.14
	1			7.01	10.02	10.73	13.58			8.98	10.20	12.60	10.97	7.85	8.85	8.54	10.48
2016	2			6.24	9.99	11.55	13.85			8.29	10.40	12.31	11.08	9.41	8.37	9.20	10.43
	3			6.93	9.34	12.09	14.40			13.05	10.82	13.00	10.34	6.47	8.81	9.07	12.02
	4	8.90	9.26	10.11	11.03	11.39	12.37			16.42	11.07	14.18	9.58			12.47	11.87
	1	10.52	10.17	9.96	9.27	11.45	12.55	21.08	10.09	15.85	10.58	12.84	9.26			11.82	12.34
2017	2	9.15	9.81	9.41	9.71	10.87	12.17	19.16	9.44	15.66	10.30	13.33	10.53			11.89	13.47
	3	8.15	8.77	6.69	6.40	11.26	10.92	13.34	9.03	12.59	9.85	10.92	10.00			12.04	13.36
	4	7.76	8.48	9.66	7.27	11.48	9.83	11.06	8.62	11.28	9.23	11.58	10.56			12.65	11.79
	1			11.42	7.00	12.65	9.77	12.82	7.90	12.68	8.22	14.40	10.20	16.95	7.83	14.02	10.17
2018	2			11.03	6.80	12.66	9.05	16.75	6.80	11.81	9.57	12.06	9.89	17.68	8.02	12.78	10.15
	3			10.21	7.43	12.54	8.36	18.69	8.04	10.99	9.44	12.52	10.12	20.60	9.16	13.03	10.20
	4	11.39	9.81			12.86	8.68					12.24	10.21			13.92	11.13
2019	1	12.76	10.22			13.68	9.06					11.83	10.93			14.10	10.71


Major Pennsylvania Gas Utilities - Actual Equity Returns by Quarter
Return on Common Equity %
0.00
5.00
10.00
15.00
20.00
25.00
Q1'16
Q2'16
Q3'16
Q4'16
Q1'17
Q2'17
Q3'17
Q4'17
Q1'18
Q2'18
Q3'18
Q4'18
Q1'19
Columbia
Peoples Natural
PECO
UGI South
Peoples-Equitable
NFG
UGI North
Peoples Gas

WATER UTILITIES
EQUITY RETURNS BY QUARTER

QTR		PAWC		AQUA		SUEZ		York		Superior	
END		ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ	ACT	ADJ
2013	2			14.26	12.52	8.99	9.15			8.57	7.85
	3			15.49	12.21	8.83	9.01			7.46	6.85
	4			13.77	11.97	8.43	9.05	10.2	10.8	10.71	10.01
	1	10.52	9.98	13.29	11.56	8.45	9.02	10.2	10.2	13.12	9.97
2014	2	10.51	10.02	13.01	11.42	8.81	9.32	10.7	10.7	17.09	9.61
	3	11.11	10.57	12.82	11.29	8.57	9.06	10.9	10.9	34.68	9.88
	4	10.49	9.38	12.62	11.49	8.90	9.44	12.3	11.6	16.74	7.96
	1	10.33	9.14	12.46	11.11	9.11	9.83	12.7	12.7	15.92	8.37
2015	2	10.51	9.31	12.66	11.62	8.36	9.25	12.7	12.7	14.65	8.93
	3	10.06	8.81	12.41	11.95	8.39	9.37	13.6	13.6	12.54	9.37
	4	9.80	8.48	12.61	12.16	8.54	8.77	12.50	11.10	12.73	9.50
	1	10.12	8.68	12.31	11.71	9.27	10.19	12.40	10.90	11.91	8.17
2016	2	9.99	8.47	11.71	11.21	11.00	12.37	12.20	10.80	12.07	7.90
	3	9.82	8.47	11.55	10.32	8.23	9.99	12.20	11.00	14.99	7.25
	4	9.37	8.51	11.70	10.57	9.13	9.90	11.50	10.40	8.24	5.04
	1			11.34	10.04	9.22	9.60	11.61	9.50	10.29	9.13
2017	2			10.99	9.22	9.03	9.07	11.60	9.10	10.74	8.61
	3			10.99	9.23	8.57	8.57	11.60	8.70	8.82	8.25
	4			11.05	8.63	8.75	8.73	11.30	8.40	8.56	8.69
	1	9.55	8.97	10.94	8.41					5.64	7.39
2018	2	10.27	9.65								
	3	11.03	9.48								
	4	10.08	9.03					10.70	10.30		
2019	1	9.82	8.87					11.60	11.60		


Major Pennsylvania Water Companies - Actual Equity Returns by Quarter
Return on Equity %
0.00
5.00
10.00
15.00
20.00
Q1'16
Q2'16
Q3'16
Q4'16
Q1'17
Q2'17
Q3'17
Q4'17
Q1'18
Q2'18
Q3'18
Q4'18
Q1'19
PAWC
AQUA
SUEZ
York
Superior

Attachment B includes:

A. Overall Returns on rate base
1. Actual
2. Company proposed pro forma and ratemaking adjustments

and

B. Equity Returns
1. Actual
2. Company proposed pro forma and ratemaking adjustments

Summary of Returns
For the Year Ended March 31, 2019

COMPANY NAME	OVERALL RETURN ACTUAL	OVERALL RETURN ADJ	EQUITY RETURN ACTUAL	EQUITY RETURN ADJ	ROE AUTH	YEAR AUTH
ELECTRIC						
$10,000,000 Revenues						
PECO Energy - Electric Operations	8.83	6.15	12.65	7.93	Settled	2018
PPL Electric Utilities Corp.	7.58	6.95	10.10	8.96	Settled	2015
Duquesne Light Company	8.89	7.32	12.58	9.73	Settled	2018
West Penn Power Company	6.84	5.45	9.08	6.62	Settled	2017
Pennsylvania Power Company	7.30	6.45	9.14	7.61	Settled	2017
UGI Utilities, Inc. - Electric Division	6.24	4.95	7.05	5.22	9.85	2018
Pennsylvania Electric Company	8.60	6.62	12.03	8.07	Settled	2017
Metropolitan Edison Company	8.16	5.78	12.54	7.66	Settled	2017
GAS						
$10,000,000 Revenues						
Columbia Gas of PA, Inc.	9.36	7.93	12.76	10.22	Settled	2018
Peoples Natural Gas Company LLC*					Settled	2012
PECO Energy - Gas Operations	9.30	6.64	13.68	9.06	Settled	2010
UGI Utilities, Inc. – South*					Settled	2016
Peoples Nat'l - Equitable Division*					Settled	2008
National Fuel Gas Distribution Co.	8.16	7.66	11.83	10.93	Settled	2006
UGI Utilities, Inc. – North*					Settled	2017
Peoples Gas Company, LLC	10.19	8.06	14.10	10.71	Settled	2013
UGI Utilities, Inc. – Central*					Settled	2009
WATER						
$10,000,000 Revenues						
PA American Water Company	7.61	7.07	9.82	8.87	Settled	2018
Aqua Pennsylvania*					Settled	2012
York Water Company	9.00	9.00	11.60	11.60	Settled	2019
SUEZ Water Pennsylvania, Inc.*					Settled	2018

* UGI Utilities, Inc. - Electric Division, SUEZ Water, Aqua Pennsylvania, Superior Water Company, Peoples Natural Gas Company, Peoples Nat'l – Equitable, UGI Utilities, Inc. – South, UGI Utilities, Inc. – North, UGI Utilities, Inc. – Central, and Newtown Artesian Water Co. have rate filings at Docket Nos. R-2017-2640058, R-2018-3000834, R-2018-3003558, R-2018-3003561, R-2018-3006818, R-2018-3006818, R-2018-3006814, R-2018-3006814, R-2018-3006814, and R-2019-3006904 respectively, and filed a letter with the Secretary in place of a report in accordance with 52 Pa. Code § 71.4.

ALLOWED RATES OF RETURN ON COMMON EQUITY

This is a historical chart that shows the most recent fully litigated rate cases for select companies in electric, gas, and water. A docket number followed by their final return on equity and year is also given.

ELECTRIC	Docket Number	ROE (%)	Year
Recent PA PUC Allowed			
Duquesne Light Company	R-2018-3000124	Settled	2018
PECO Energy Company	R-2018-3000164	Settled	2018
UGI - Electric	R-2017-2640058	9.85	2018
Pennsylvania Electric Company	R-2016-2537352	Settled	2017
Metropolitan Edison Company	R-2016-2537349	Settled	2017
Pennsylvania Power Company	R-2016-2537359	Settled	2017
West Penn Power Company	R-2016-2537355	Settled	2017
Current Market Indicated ROE as calculated by the Bureau of Technical Utility Services.			**7.06-9.61**

GAS			
Recent PA PUC Allowed			
Columbia Gas of Pa.	R-2018-2647577	Settled	2018
UGI Utilities, Inc. - South	R-2015-2518438	Settled	2016
Peoples Natural Gas	R-2012-2285985	Settled	2012
UGI Utilities, Inc. - North	R-2016-2580030	Settled	2017
UGI Utilities, Inc. - Central	R-2008-2079675	Settled	2009
PECO Energy	R-2010-2161592	Settled	2010
Peoples TWP	R-2013-2355886	Settled	2013
Current Market Indicated ROE as calculated by the Bureau of Technical Utility Services.			**7.38-10.00**

WATER			
Recent PA PUC Allowed			
Aqua Pennsylvania	R-2011-2267958	Settled	2012
PA American Water	R-2017-2595853	Settled	2017
Columbia Water	R-2017-2598203	Settled	2015
York Water	R-2018-3000019	Settled	2019
SUEZ Water	R-2018-3000834	Settled	2018
Current Market Indicated ROE as calculated by the Bureau of Technical Utility Services.			**8.02-10.58**

Distribution System Improvement Charge (DSIC) Eligible Utilities
Return on Equity (ROE) Summary

	Utility Adjusted ROE[2] (%)	Commission Approved ROE[3] (%)
ELECTRIC		
PECO Energy – Electric Operations	7.93	9.55
PPL Electric Utilities Corp.	8.96	9.55
Duquesne Light Company	9.73	9.55
West Penn Power Company	6.62	9.55
Pennsylvania Power Company	7.61	9.55
Pennsylvania Electric Company	8.07	9.55
Metropolitan Edison Company	7.66	9.55
GAS		
Columbia Gas of PA, Inc.	10.22	10.00
Peoples Natural Gas Company LLC*		10.00
PECO Energy – Gas Operations	9.06	10.00
UGI Utilities, Inc. – South*		10.00
Peoples-Equitable Division*		10.00
UGI Utilities, Inc. – North*		10.00
Peoples Gas Company, LLC	10.71	10.00
UGI Utilities, Inc. – Central*		10.00
WATER		
PA American Water Company	8.87	9.95
PA American – Wastewater	8.87	9.95
AQUA Pennsylvania*		9.95
AQUA Pennsylvania – Wastewater*		9.95
York Water Company	11.60	9.95
SUEZ Water Pennsylvania Inc.*		9.95
Columbia Water Company	-0.07	9.95
Newtown Artesian Water*		9.95
Superior Water*		9.95

* SUEZ Water, Aqua Pennsylvania, Superior Water Company, Peoples Natural Gas Company, Peoples Nat'l – Equitable, UGI Utilities, Inc. – South, UGI Utilities, Inc. – North, UGI Utilities, Inc. – Central, and Newtown Artesian Water Co. have rate filings at Docket Nos. R-2018-3000834, R-2018-3003558, R-2018-3003561, R-2018-3006818, R-2018-3006818, R-2018-3006814, R-2018-3006814, R-2018-3006814, and R-2019-3006904 respectively, and filed a letter with the Secretary in place of a report in accordance with 52 Pa. Code § 71.4.

2 Each utility lists adjustments on Schedule B of their quarterly financial report.

3 The ROE is approved in a utility's most recent fully litigated base rate proceeding for which a final order was entered not more than two years prior to the effective date of the DSIC. If more than two years have elapsed between the entry of a final order and the DSIC

Explanation of Discounted Cash Flow (DCF) and Capital Asset Pricing Model (CAPM)

Barometer Group Criteria

The criteria used for determining the industry barometer groups used to calculate ROEs in this report are as follows:

- 50% or more of the company's assets must be related to the jurisdictional utility industry;
- The company's stock must be publicly traded;
- Companies involved in merger & acquisition activity will be excluded;
- Investment information for the company must be available to the Commission from more than one source; and
- Geographic Regions:
  EDCs: *Value Line* East, Central, and West Group Electric Utility companies;
  NGDCs: *Value Line* Investment Survey's Natural Gas Utility industry group companies;
  Water/Waste water: *Value Line* Investment Survey's Water Utility industry group companies.

The barometer group companies are reviewed by staff on a quarterly basis and make any changes to these companies based upon the criteria above.

ROE Calculations

The Commission consistently uses the DCF model to determine the appropriate cost of equity for utilities. In this report, the DSIC ROE is calculated using two DCF models.

TUS uses the following formula to calculate the current dividend DCF: $K = D_1/P_0 + G$

TUS uses the following formula to calculate the 52-week average dividend DCF: $K = D_0/P_a + G$

Definitions:

K	=	Cost of equity
D_1	=	Dividend expected during the year
	=	$D_0 + \frac{1}{2}g$
D_0	=	Latest indicated dividend, obtained from Yahoo! Finance
g	=	Expected 5-year dividend growth rate of barometer group obtained from Value Line Investment Survey.
P_0	=	Current price of the stock, obtained from Yahoo! Finance
P_a	=	Average of high and low stock price over the latest 52-week period, obtained from Yahoo! Finance
G	=	Average of 5-year expected earnings growth rate forecasts obtained from Value Line Investment Survey, Zacks Investment Survey, Yahoo! Finance, Morningstar and/or Reuters.

effective date, the ROE is from this report. If the base rate proceeding is settled, without a stipulated ROE, the ROE is from this report.

The CAPM uses the yield of a risk-free interest bearing obligation plus a rate of return premium that is proportional to the systematic risk of an investment.

TUS uses the following formula to calculate CAPM: $K = \beta(R_m - R_f)$

Three components are necessary to calculate the CAPM cost of equity:

β	=	Beta, a measure of systematic risk for each stock
R_f	=	The risk-free rate of return, 10-year U.S. Treasury yields are used for R_f. Yields are taken from the previous two quarters and forecasted next four quarters.
R_m	=	Total return of the equity market as determined by the SBBI Yearbook

The Commission determines the ROE used for DSIC purposes based on the range of reasonableness from the DCF barometer group data, CAPM data, recent ROEs adjudicated by the Commission, and informed judgment.

The market indicated common equity cost rate range consists of data used from the barometer groups and is based on a series of calculations to average the DCF methods.

Market Based Returns on Common Equity[1]

August 8, 2019

Electric Company Barometer Group

	Cost Rates %
(1) Current DCF:	8.26
(2) 52-Week Average DCF:	8.40
(3) Overall DCF ((1) + (2)) / 2 :	8.33
(4) Market Indicated Common Equity Cost Rate Range: @ 1 standard deviation around the mean.[2]	7.06-9.61
(5) CAPM Check of DCF Reasonableness:	8.09
(6) Recent Commission Approved ROEs[3]: *UGI Utilities, Inc. - Electric, R-2017-2640058, does not include 0.05% management effectiveness adjustment	9.80*
(7) Distribution System Improvement Charge (DSIC) Return[4]:	**9.55%**

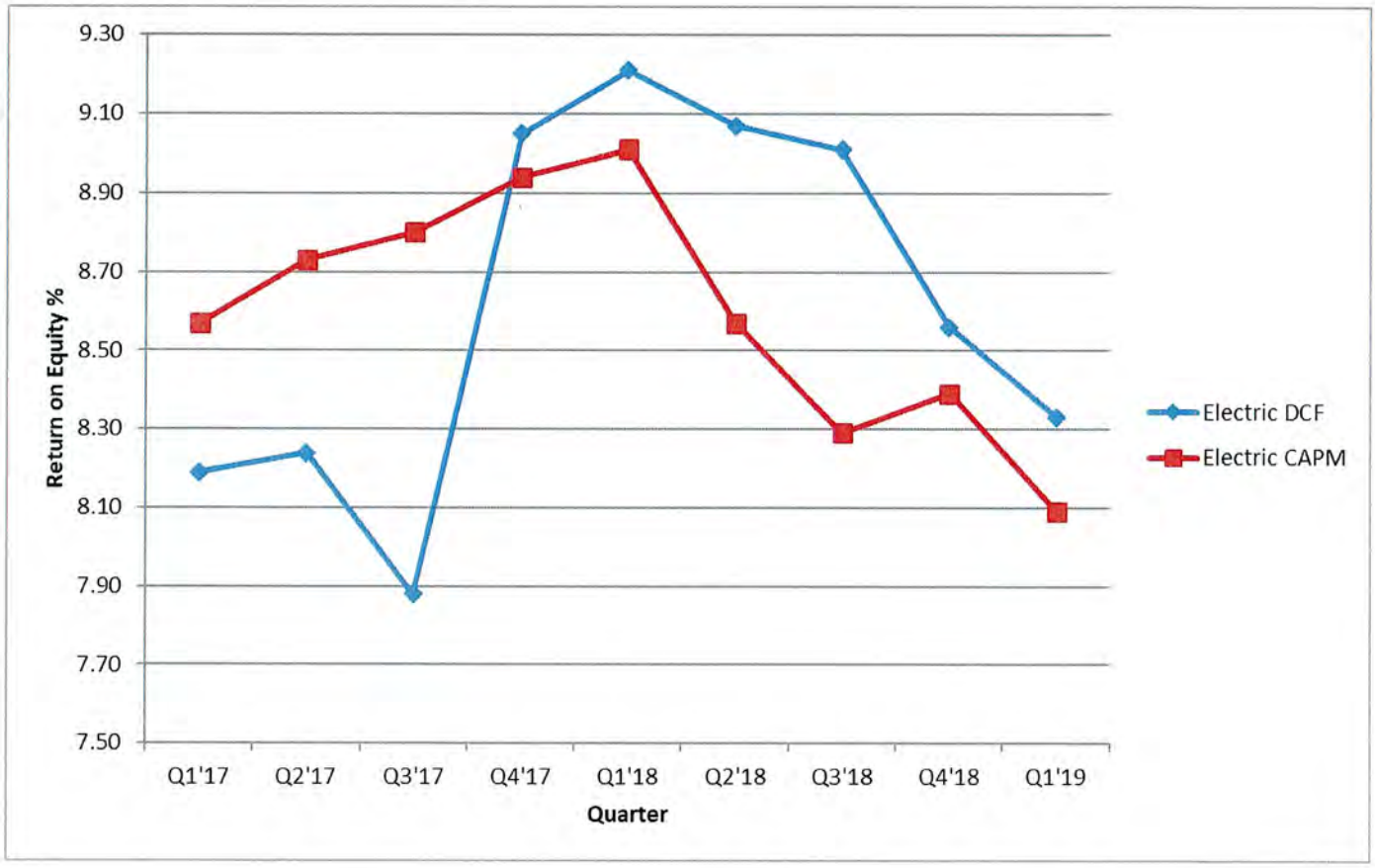
[1] As calculated by the Bureau of Technical Utility Services
[2] Standard Deviation of 54 DCF observations
[3] Base rate case ROEs within last two years, fully litigated or stipulated for DSIC purposes
[4] Commission authorized Return on Equity (ROE) for DSIC purposes

Any questions concerning DSIC should be directed to Andrew Herster of the Bureau of Technical Utility Services at (717) 783-5392.

Historic Electric Industry Barometer Group DCF and CAPM Average ROEs

	Electric	
	DCF	CAPM
Q1'17	8.19	8.57
Q2'17	8.24	8.73
Q3'17	7.88	8.80
Q4'17	9.05	8.94
Q1'18	9.21	9.01
Q2'18	9.07	8.57
Q3'18	9.01	8.29
Q4'18	8.56	8.39
Q1'19	8.33	8.09

Chart of Historic Electric Industry DCF and CAPM Average ROEs



Barometer electric companies are used to calculate a current DCF in the first chart. The second chart demonstrates the companies 52 week average DCF. A final average of the two calculations is also shown at the bottom.

Electric Company Barometer Group
Calculation of a Current Dividend Yield

	Closing Market Price (Po) 8/7/2019 ($)	Latest Indicated Dividend Do ($)	Ind. Div. Plus 1/2 Div. Growth Rate (D1) ($)	Current Dividend Yield(D1/Po) (%)	DCF (%)
Allete, Inc.	85.21	2.35	2.41	2.83	8.89
Alliant Energy Corp	50.69	1.42	1.46	2.88	8.64
American Electric Power	89.47	2.68	2.76	3.09	8.54
AVANGRID, Inc.	50.08	1.76	1.79	3.57	11.79
Avista Corp	45.68	1.55	1.58	3.46	6.86
CMS Energy Corp	59.11	1.53	1.58	2.68	9.56
Consolidated Edison	87.06	2.96	3.01	3.46	7.27
DTE Energy Company	128.18	3.78	3.89	3.04	8.22
Duke Energy Company	88.84	3.78	3.84	4.32	10.13
El Paso Electric Co	66.53	1.54	1.59	2.39	6.89
Eversource Energy	77.89	2.14	2.20	2.82	8.63
Exelon Corp	45.01	1.45	1.49	3.31	7.11
FirstEnergy Corp	43.57	1.52	1.55	3.55	8.95
IDACORP, Inc.	103.63	2.52	2.60	2.50	6.18
MGE Energy, Inc.	73.71	1.35	1.38	1.87	8.37
NextEra Energy, Inc.	212.87	5.00	5.25	2.47	9.66
NorthWestern Corp	68.96	2.30	2.35	3.41	6.36
OGE Energy Corp	42.36	1.46	1.51	3.58	8.18
Otter Tail Corp	52.14	1.40	1.43	2.74	9.74
Pinnacle West Capital Corp	93.01	2.95	3.04	3.27	8.75
PNM Resources, Inc.	49.52	1.16	1.20	2.42	8.39
Portland General Electric Co.	54.70	1.54	1.59	2.91	7.11
PPL Corporation	29.80	1.65	1.67	5.59	6.64
Public Service Enterprise Group	57.17	1.88	1.93	3.37	7.87
Southern Company	57.45	2.48	2.52	4.38	8.08
WEC Energy Group, Inc.	88.25	2.36	2.43	2.75	8.86
Xcel Energy Inc.	60.79	1.62	1.67	2.74	8.19
Group Average	72.65	2.15	2.21	3.16	8.29
Group Average G				5.10	
DCF				**8.26**	

Electric Company Barometer Group
52-week Average Dividend Yield Calculation

	High	Low	Average (Pa)	Latest Indicated Dividend (Do)	Average Dividend Yield (Do/Pa)	DCF
	($)	($)	($)	($)	(%)	(%)
Allete, Inc.	88.58	72.42	80.50	2.35	2.92	8.99
Alliant Energy Corp	51.46	40.68	46.07	1.42	3.08	8.84
American Electric Power	91.99	68.92	80.46	2.68	3.33	8.78
AVANGRID, Inc.	53.47	45.81	49.64	1.76	3.55	11.77
Avista Corp	52.70	39.75	46.23	1.55	3.35	6.75
CMS Energy Corp	60.17	47.63	53.90	1.53	2.84	9.72
Consolidated Edison	90.51	73.30	81.91	2.96	3.61	7.42
DTE Energy Company	132.09	106.41	119.25	3.78	3.17	8.36
Duke Energy Company	91.67	78.00	84.84	3.78	4.46	10.27
El Paso Electric Co	66.83	47.99	57.41	1.54	2.68	7.18
Eversource Energy	78.65	60.15	69.40	2.14	3.08	8.89
Exelon Corp	51.18	42.19	46.69	1.45	3.11	6.91
FirstEnergy Corp	44.75	35.33	40.04	1.52	3.80	9.20
IDACORP, Inc..	106.13	89.31	97.72	2.52	2.58	6.25
MGE Energy, Inc.	76.44	56.64	66.54	1.35	2.03	8.53
NextEra Energy, Inc.	215.87	164.25	190.06	5.00	2.63	9.83
NorthWestern Corp	74.47	56.23	65.35	2.30	3.52	6.47
OGE Energy Corp	44.41	35.29	39.85	1.46	3.66	8.26
Otter Tail Corp	54.51	44.22	49.37	1.40	2.84	9.84
Pinnacle West Capital Corp	99.81	77.19	88.50	2.95	3.33	8.81
PNM Resources, Inc.	52.10	37.67	44.89	1.16	2.58	8.55
Portland General Electric Co.	55.98	43.73	49.86	1.54	3.09	7.29
PPL Corporation	32.89	27.31	30.10	1.65	5.48	6.53
Public Service Enterprise Group	61.63	49.23	55.43	1.88	3.39	7.89
Southern Company	58.21	42.50	50.36	2.48	4.93	8.62
WEC Energy Group, Inc.	87.64	64.96	76.30	2.36	3.09	9.20
Xcel Energy Inc.	62.03	46.01	54.02	1.62	3.00	8.45
Group Average	75.41	59.00	67.21	2.15	3.30	8.43
Group Average G					5.10	
DCF					**8.40**	

Average of Current and 52-Week **8.33**

Multiple sources of the Barometer companies projected 5 year Earnings Per Share are used to calculate the Group Average Dividend Growth Estimate.

Development of a Representative Dividend Growth Rate
for the Barometer Group of Electric Companies
5 Year Forecast

	Value Line DPS (%)	Value Line EPS (%)	Zack's EPS (%)	Yahoo EPS (%)	Morningstar EPS (%)	Avgerage Earnings Growth (%)	Growth Estimate (%)
Allete, Inc.	5.00	5.00	7.20	6.00		6.07	6.07
Alliant Energy Corp	5.50	6.50	5.50	5.05	6.00	5.76	5.76
American Electric Power	6.00	4.00	5.70	6.10	6.00	5.45	5.45
AVANGRID, Inc.	3.00	10.00	7.50	6.60	8.80	8.23	8.23
Avista Corp	4.00	3.50	3.30	3.40		3.40	3.40
CMS Energy Corp	7.00	7.00	6.40	7.14	7.00	6.89	6.89
Consolidated Edison	3.50	3.00	2.00	3.44	6.80	3.81	3.81
DTE Energy Company	6.00	5.50	6.00	4.45	4.80	5.19	5.19
Duke Energy Company	3.00	6.00	4.90	7.26	5.10	5.82	5.82
El Paso Electric Co	6.50	3.00	5.50	4.50	5.00	4.50	4.50
Eversource Energy	5.50	5.50	5.60	5.63	6.50	5.81	5.81
Exelon Corp	5.50	10.50	3.80	-1.76	3.80	4.09	3.80
FirstEnergy Corp	3.50	8.00	6.00	-6.60	2.20	2.40	5.40
IDACORP, Inc..	6.00	3.50	3.80	2.40	5.00	3.68	3.68
MGE Energy, Inc.	4.50	9.00		4.00		6.50	6.50
NextEra Energy, Inc.	10.00	10.00	8.00	7.99	2.80	7.20	7.20
NorthWestern Corp	4.50	3.00	2.60	3.24		2.95	2.95
OGE Energy Corp	7.50	6.50	4.60	3.80	3.50	4.60	4.60
Otter Tail Corp	4.00	5.00	7.00	9.00		7.00	7.00
Pinnacle West Capital Corp	6.00	5.50	5.10	5.32	6.00	5.48	5.48
PNM Resources, Inc.	7.00	7.00	5.50	6.18	5.20	5.97	5.97
Portland General Electric Co.	6.50	4.50	4.80	5.20	2.30	4.20	4.20
PPL Corporation	2.00	1.50		0.59	-4.60	-0.84	1.05
Public Service Enterprise Group	5.00	6.00	2.30	2.30	7.40	4.50	4.50
Southern Company	3.00	3.50	4.50	2.18	4.60	3.70	3.70
WEC Energy Group, Inc.	6.00	6.00	5.90	5.91	6.60	6.10	6.10
Xcel Energy Inc.	6.00	5.50	4.90	5.80	5.60	5.45	5.45
Group Average	5.26	5.70	5.14	4.26	4.84	4.96	5.13
USE							5.10

Sources: Morningstar, August 8, 2019 (http://financials.morningstar.com)
Value Line Investment Survey, August 8, 2019
Zacks, August 8, 2019 (www.zacks.com)
Yahoo!, August 8, 2019 (http://finance.yahoo.com/)

The market indicated common equity cost rate range consists of data used from the barometer groups and is based on a series of calculations to average the DCF methods.

Market Based Returns on Common Equity[1]
August 8, 2019

Gas Distribution Company Barometer Group

	Cost Rates %
(1) Current DCF:	8.65
(2) 52-Week Average DCF:	8.74
(3) Overall DCF ((1) + (2)) / 2 :	8.69
(4) Market Indicated Common Equity Cost Rate Range: @ 1 standard deviation around the mean.[2]	7.38-10.00
(5) CAPM Check of DCF Reasonableness:	8.78
(6) Recent Commission Approved ROEs[3]: *None within last two years	*
(7) Distribution System Improvement Charge (DSIC) Return[4]:	**10.00%**

[1] As calculated by the Bureau of Technical Utility Services
[2] Standard Deviation of 18 DCF observations
[3] Base rate case ROEs within last two years, fully litigated or stipulated for DSIC
[4] Commission authorized Return on Equity (ROE) for DSIC purposes

Any questions concerning DSIC should be directed to Andrew Herster of the Bureau of Technical Utility Services at (717) 783-5392.

Historic Gas Industry DCF and CAPM Average ROEs

	Gas	
	DCF	CAPM
Q1'17	9.37	9.37
Q2'17	9.42	9.53
Q3'17	9.27	9.44
Q4'17	9.51	9.32
Q1'18	9.65	9.61
Q2'18	9.93	9.02
Q3'18	9.96	8.88
Q4'18	8.53	9.04
Q1'19	8.69	8.78

Graph of Historic Gas Industry DCF and CAPM Average ROEs