APPENDIX A

STREAMFLOW DATA SETS FOR THE STUDY

TABLE A.1 Run-off (x10^6 cu.m) Mae Ping River at Nawarath Bridge, ChiangMai (P.1)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1921	33.610	37.739	45.014	73.310	212.112	391.392	293.242	157.766	112.061	74.995	50.890	29.622	1511.753
1922	40.781	56.419	53.482	93.139	162.864	321.926	230.256	166.493	110.333	72.835	48.989	42.422	1399.939
1923	37.498	63.245	87.350	64.022	251.424	197.492	259.891	121.997	89.856	65.059	43.978	44.237	1326.049
1924	55.382	62.813	100.570	141.696	338.688	396.576	232.762	165.110	129.859	93.139	60.566	47.520	1824.681
1925	49.248	57.888	77.155	108.346	150.768	401.846	225.158	130.810	103.766	86.918	55.987	44.669	1492.559
1926	34.474	37.584	70.114	101.174	245.376	336.355	368.496	280.193	170.294	111.110	72.749	54.950	1882.869
1927	63.936	177.034	169.603	208.397	239.242	199.757	521.165	175.306	114.912	70.589	44.410	38.707	2023.058
1928	40.176	43.459	147.658	303.091	229.478	183.082	170.554	141.178	85.795	59.011	45.360	49.421	1498.263
1929	39.139	48.816	91.238	107.741	329.098	666.835	227.750	124.675	97.891	62.986	39.053	35.770	1870.992
1930	33.178	96.163	85.882	233.712	247.190	335.578	222.739	121.738	83.462	62.813	39.226	33.955	1595.636
1931	29.855	32.227	28.616	33.087	94.954	232.589	73.094	36.374	37.152	33.782	30.067	27.929	689.726
1932	35.126	31.493	103.659	175.824	124.762	391.478	352.858	150.336	104.976	72.144	52.099	46.742	1641.497
1933	43.891	88.992	90.029	299.462	673.747	524.016	254.189	148.262	113.616	87.869	63.491	48.384	2435.948
1934	44.669	43.546	803.352	143.597	231.379	356.659	359.770	130.291	107.568	75.773	49.421	40.694	2386.719
1935	34.128	76.205	88.387	188.784	242.525	454.378	342.403	238.637	159.149	101.779	74.390	54.259	2055.024
1936	49.939	85.018	80.957	227.146	192.326	308.794	136.166	73.699	73.181	55.382	51.926	59.530	1394.064
1937	47.434	92.621	116.899	209.866	200.362	652.838	241.315	127.440	136.685	95.049	56.851	47.779	2025.139
1938	44.237	182.822	328.061	268.618	605.750	554.688	381.456	240.990	179.798	132.797	79.920	77.760	3076.897
1939	61.085	83.290	120.787	192.931	551.405	635.126	384.221	230.688	236.304	141.869	93.139	91.670	2822.515
1940	80.006	109.123	119.059	107.136	388.714	388.109	193.968	128.131	120.900	104.544	96.163	89.251	1925.104
1941	75.514	71.107	99.274	83.376	233.971	416.448	298.685	140.400	130.637	82.944	59.184	56.419	1747.959
1942	47.952	64.282	276.912	184.982	487.642	645.322	250.992	201.917	149.645	102.557	72.576	72.922	2557.701
1943	55.987	62.986	99.101	214.358	469.066	725.069	265.421	245.030	172.109	167.789	122.774	110.333	2710.023
1944	61.949	70.243	68.602	208.138	211.421	221.530	240.538	143.942	124.502	127.440	107.741	148.954	1735.000
1945	125.453	153.274	168.739	220.493	327.024	503.280	485.136	118.973	158.458	81.475	69.120	66.010	2477.435
1946	61.772	109.296	103.421	79.747	273.715	301.018	284.429	127.094	90.288	75.168	43.632	43.373	1592.953
1947	57.802	98.150	134.266	183.427	311.645	486.605	296.179	154.483	100.138	76.118	53.222	41.126	1993.161
1948	41.558	124.502	126.230	116.640	190.598	302.832	535.680	166.061	131.328	109.296	73.094	53.914	1971.733
1949	41.299	69.898	95.126	177.638	439.258	482.976	406.771	313.286	213.322	106.099	99.360	73.526	2518.559
1950	49.680	88.474	155.174	178.330	272.592	468.115	530.582	258.763	188.956	152.323	95.645	74.822	2513.456
1951	54.173	63.072	189.389	217.900	318.816	470.361	506.477	191.894	173.146	113.875	76.810	66.010	2441.923
1952	48.384	57.715	78.192	122.429	349.229	736.646	300.326	196.560	146.180	107.654	104.803	58.752	2306.870

TABLE A.1 (Cont.) Run-off (x10^6 cu.m) Mae Ping River at Nawarath Bridge, ChiangMai (P.1)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1953	51.494	106.790	139.190	146.966	433.642	495.331	345.600	225.158	170.035	103.162	67.306	82.253	2366.927
1954	28.287	121.824	137.808	57.803	190.080	278.294	358.819	86.832	86.400	56.160	32.106	27.994	1462.407
1955	31.285	63.245	162.432	146.362	432.173	419.990	232.589	142.992	89.683	58.752	38.707	25.076	1843.286
1956	28.114	113.685	92.707	189.994	527.558	647.222	273.456	154.397	125.885	63.072	37.152	27.168	2280.410
1957	21.963	29.808	110.678	65.318	207.533	445.046	258.509	101.866	63.763	37.325	36.634	17.314	1395.757
1958	17.202	40.141	52.289	89.942	179.626	313.200	180.749	82.771	55.469	32.918	19.670	14.887	1078.864
1959	11.826	44.993	80.655	95.126	277.776	581.472	292.673	97.978	76.637	46.483	34.819	23.420	1663.858
1960	15.146	31.193	31.647	55.329	177.552	359.770	187.402	104.458	163.296	58.320	34.560	71.008	1289.681
1961	23.763	82.771	101.174	86.054	311.645	599.702	355.795	177.120	130.723	77.069	50.371	40.003	2036.190
1962	27.071	57.197	39.916	94.348	228.614	165.024	303.610	103.766	79.747	37.152	26.507	22.850	1185.802
1963	18.642	19.782	62.217	90.029	387.677	266.371	381.110	413.597	170.381	96.250	47.952	26.310	1980.318
1964	21.561	134.525	119.706	210.211	198.806	472.694	387.850	201.744	141.178	74.650	45.187	26.580	2034.692
1965	10.109	19.613	69.638	29.290	166.493	288.749	252.461	265.507	123.898	44.669	12.269	4.406	1287.102
1966	16.941	50.345	61.475	51.992	322.618	433.296	195.091	153.101	102.384	59.530	26.914	26.663	1500.350
1967	33.182	68.135	96.250	69.090	253.325	646.358	298.339	144.029	97.286	43.027	24.131	16.260	1789.412
1968	47.166	76.464	99.706	132.710	364.435	243.130	221.357	112.061	67.910	38.707	27.367	17.783	1448.796
1969	8.130	72.783	143.251	148.262	579.398	273.110	211.853	155.002	86.227	41.299	23.504	19.744	1762.563
1970	23.928	207.939	275.962	357.005	782.266	757.382	376.186	216.259	270.518	109.555	46.829	32.244	3456.073
1971	18.274	141.566	153.792	642.384	876.787	737.424	586.397	296.093	199.066	108.605	46.915	25.427	3832.730
1972	49.101	27.562	65.785	32.642	381.974	341.194	361.843	325.469	230.515	83.203	34.387	42.967	1976.642
1973	7.279	96.742	217.642	377.482	1158.278	1173.312	571.104	282.096	210.384	99.360	36.288	25.220	4255.187
1974	23.397	115.430	131.587	61.862	440.208	555.984	294.624	393.898	143.683	142.992	31.657	14.809	2350.131
1975	7.754	50.604	331.344	346.896	718.762	894.499	610.330	354.845	233.971	103.075	45.274	23.190	3720.544
1976	20.101	84.499	102.816	33.005	202.349	386.726	353.376	189.821	132.710	96.595	11.033	7.957	1620.988
1977	52.392	89.139	63.279	66.053	141.955	576.029	353.895	237.946	137.117	133.747	48.341	25.747	1925.640

TABLE A.2 Run-off (x10^6 cu.m) Wang River at Ban Hai, Lampang (W.16)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1972	4.537	2.977	6.188	1.664	51.784	43.618	36.579	28.197	11.668	5.146	2.192	2.808	197.358
1973	1.547	6.498	11.106	28.951	227.590	163.987	60.566	21.517	11.421	6.812	3.925	3.427	547.347
1974	3.117	9.722	11.946	13.294	55.870	64.109	26.646	43.533	9.504	15.379	3.804	3.355	260.279
1975	3.700	3.501	20.061	27.121	147.200	146.880	83.549	27.380	14.740	6.171	3.776	2.462	486.541
1976	2.203	6.328	7.959	5.376	20.550	61.465	60.588	33.333	9.286	10.629	2.630	2.148	222.495
1977	4.736	15.375	2.899	9.330	25.033	63.158	72.399	23.045	9.235	8.020	3.767	2.890	239.887
1978	2.562	11.375	5.504	72.166	77.756	79.471	39.394	13.820	6.480	3.508	2.095	1.499	315.630
1979	0.730	7.500	14.949	5.490	22.012	25.672	19.538	4.880	2.424	1.351	0.901	0.665	106.112
1980	1.094	2.106	8.128	12.481	30.516	112.812	25.583	13.586	6.045	2.023	0.920	0.460	215.754
1981	0.382	13.560	5.193	86.995	52.958	28.425	46.478	30.913	9.374	4.232	2.283	1.505	282.298
1982	3.429	2.697	4.333	8.382	12.828	82.218	23.871	7.684	2.781	1.901	0.778	0.283	151.185
1983	0.103	1.153	0.851	2.185	21.645	41.066	30.586	17.220	5.479	1.688	0.787	0.083	122.846
1984	1.126	9.646	17.542	5.352	28.092	78.098	83.195	14.437	5.186	2.462	1.012	0.524	246.672
1985	0.724	12.743	8.274	20.021	15.331	53.417	45.268	54.842	13.397	4.647	1.818	0.981	231.463
1986	0.498	8.041	7.975	14.278	47.583	86.365	16.408	11.694	5.797	4.269	1.751	1.166	205.825
1987	1.738	4.872	9.876	2.326	72.949	63.007	26.080	19.549	5.890	2.271	0.643	0.305	209.506
1988	2.582	33.609	50.648	57.095	48.872	29.473	40.704	18.898	8.482	3.096	1.120	0.662	295.241

TABLE A.3 Run-off (x10^6 cu.m) Yom River at Ban Kaeng Luang, Sukhothai (Y.6)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1952	12.478	63.338	33.340	124.589	555.293	1857.427	367.373	140.573	64.714	33.610	55.814	25.503	3334.052
1953	11.716	84.845	315.947	122.688	624.758	1041.725	524.016	200.016	77.414	33.566	27.790	16.236	3080.717
1954	10.459	52.934	101.779	83.462	190.080	699.754	520.733	64.022	45.533	23.357	13.079	7.776	1812.968
1955	18.835	27.734	178.934	119.577	697.766	901.670	221.184	67.824	31.104	16.675	12.182	9.245	2302.730
1956	5.357	165.542	90.202	300.499	846.461	1555.546	208.224	61.430	34.646	16.246	9.158	5.356	3298.667
1957	16.419	30.134	93.139	101.779	324.173	1386.634	587.520	92.621	40.884	20.269	13.924	7.370	2714.866
1958	6.134	38.750	64.022	60.134	276.394	292.723	114.048	37.152	13.332	5.443	4.234	1.814	914.180
1959	1.348	56.972	56.471	369.792	632.794	1243.555	249.696	50.630	23.509	9.150	6.575	4.234	2704.726
1960	1.635	25.732	62.986	167.417	533.347	1052.093	518.659	102.470	75.859	30.249	16.298	10.123	2596.868
1961	16.191	126.939	304.992	240.538	1065.571	2353.104	874.195	182.045	74.736	44.064	20.131	15.638	5318.144
1962	7.413	32.288	50.198	106.808	226.627	439.862	555.120	69.466	34.783	16.796	8.242	6.955	1554.558
1963	10.973	8.381	46.656	126.576	609.379	804.125	677.635	502.762	94.523	43.805	24.106	29.549	2978.470
1964	11.008	66.390	104.198	166.752	102.384	664.243	750.038	113.184	49.421	26.019	16.412	14.403	2084.452
1965	6.221	11.146	37.498	17.453	173.664	484.358	230.083	119.491	37.930	12.528	7.862	3.024	1141.258
1966	2.773	70.904	76.550	35.044	463.363	776.131	137.203	90.202	32.314	13.634	7.499	4.380	1709.997
1967	16.626	58.975	59.891	22.739	184.896	1186.531	368.237	53.136	30.093	12.143	6.454	5.314	2005.035
1968	23.124	124.330	277.232	79.661	251.510	276.739	200.534	37.601	20.416	12.744	6.273	3.385	1313.549
1969	1.369	18.857	78.637	120.005	488.938	475.891	205.027	133.661	39.174	14.342	5.409	3.326	1584.636
1970	15.051	198.780	263.779	441.763	1507.594	1721.606	461.203	141.610	84.586	31.951	15.712	9.392	4893.027
1971	9.452	115.741	139.968	654.134	1017.965	993.254	747.878	104.544	53.309	19.811	12.597	11.318	3879.971
1972	18.930	17.842	44.988	43.148	655.344	300.240	460.685	122.342	57.629	15.353	7.076	17.176	1760.753
1973	7.214	51.304	161.093	230.074	1501.286	1908.403	802.742	169.949	67.046	22.922	9.435	6.489	4937.957
1974	19.146	123.898	85.069	49.784	1043.280	851.213	306.029	433.641	73.181	67.133	13.599	6.644	3072.617
1975	9.331	22.360	198.979	381.456	1527.552	1090.454	573.782	234.230	95.299	42.422	22.326	11.733	4209.924
1976	9.901	69.103	118.333	40.617	638.841	921.629	644.198	223.430	68.083	66.519	16.528	14.671	2831.853
1977	18.109	62.070	28.512	18.541	234.835	1135.901	422.928	200.534	57.093	23.708	8.277	4.692	2215.200
1978	8.400	68.680	46.410	634.980	1209.150	1345.260	602.930	109.720	54.660	21.420	10.570	8.160	4120.340
1979	6.506	70.096	231.550	70.489	279.380	291.334	124.744	22.844	14.031	8.074	5.197	2.117	1126.362
1980	3.500	17.020	213.880	295.300	376.730	1509.600	325.590	99.980	35.960	10.700	5.320	2.610	2896.190
1981	3.080	262.670	200.650	1137.660	1080.970	490.020	516.840	257.490	93.350	36.630	13.940	5.700	4099.000
1982	82.935	35.882	49.447	56.964	115.206	517.666	410.193	89.951	36.366	15.353	7.966	5.374	1423.303
1983	3.290	38.670	58.970	92.530	374.180	979.860	589.390	225.460	74.330	31.350	14.010	9.050	2491.090

TABLE A.3 (Cont.) Run-off (x10^6 cu.m) Yom River at Ban Kaeng Luang, Sukhothai (Y.6)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1984	9.763	73.120	120.882	130.775	205.364	685.757	568.443	104.501	47.969	18.827	7.646	3.663	1976.710
1985	5.960	62.700	84.790	133.680	307.090	609.770	455.990	388.800	117.390	32.320	14.060	9.410	2221.960
1986	13.933	154.907	115.828	87.337	393.293	724.375	236.373	116.381	58.793	21.940	12.574	14.208	1949.942
1987	5.300	16.340	36.470	13.220	661.380	842.710	435.670	178.880	54.360	15.980	7.570	3.210	2271.090
1988	3.355	175.332	323.103	544.424	656.022	323.715	348.507	106.255	45.039	13.217	5.371	2.065	2546.404

TABLE A.4 Run-off (x10^6 cu.m) Nan River at Amphoe Muang, Nan (N.1)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1969	6.838	16.063	205.286	500.083	774.576	215.914	86.746	78.970	31.596	21.475	13.760	7.962	1959.269
1970	72.058	96.699	592.272	659.405	1130.198	1647.389	293.846	163.814	34.898	23.581	12.264	11.863	4738.287
1971	57.812	91.670	273.629	273.629	1158.710	487.901	272.074	112.493	99.878	70.243	50.285	44.755	2993.079
1972	15.172	21.583	43.927	196.992	1198.282	178.243	117.936	48.038	28.000	14.273	9.439	16.984	1888.869
1973	8.579	26.188	92.912	400.291	907.114	718.157	214.445	61.862	29.404	17.437	9.802	9.478	2495.669
1974	18.534	58.698	96.768	116.208	452.563	315.792	131.501	62.726	36.374	24.521	14.187	13.915	1341.787
1975	6.882	25.265	220.406	477.101	1064.016	1273.536	152.511	77.414	38.776	26.405	14.446	10.372	3387.130
1976	11.508	17.772	115.919	210.989	648.778	537.667	273.715	66.442	41.472	30.100	12.588	11.033	1977.983
1977	16.108	49.354	25.363	244.339	377.598	311.126	120.269	68.170	36.720	20.284	12.417	10.657	1292.405
1978	13.111	25.194	174.213	371.718	693.696	570.550	192.616	41.697	27.471	13.418	9.698	8.027	2141.409
1979	34.435	62.657	239.955	184.891	632.843	270.162	139.261	87.437	64.135	50.846	38.878	44.880	1850.380
1980	54.700	84.000	404.440	917.780	711.640	1272.050	277.740	121.910	85.310	57.370	32.650	23.580	4043.170
1981	31.360	119.460	183.980	1404.420	907.550	675.220	289.530	133.790	77.310	53.640	32.880	24.670	3933.810
1982	52.479	51.788	101.745	453.470	666.420	843.324	506.088	131.967	83.376	59.573	31.251	24.201	3005.682
1983	17.790	61.780	92.360	443.910	941.280	858.950	569.430	221.700	102.490	54.790	30.800	18.010	3413.290
1984	22.080	109.830	186.250	870.360	1203.310	1134.070	391.330	133.160	76.550	40.090	23.240	15.510	4205.780
1985	40.710	44.040	108.410	394.860	1236.210	535.900	188.920	164.600	87.280	51.850	29.720	23.980	2906.480
1986	35.402	184.788	166.722	481.352	461.441	333.223	176.364	96.379	52.57	36.037	25.557	22.581	2072.416
1987	16.315	25.500	56.233	82.866	417.403	283.595	186.615	120.882	64.770	39.757	26.783	23.150	1343.870
1988	21.116	84.257	130.874	394.798	849.230	298.210	158.820	72.874	40.880	26.395	19.578	19.604	2116.637

TABLE A.5 Run-off (x10^6 cu.m) Mae Taeng River at Amphoe Mae Taeng, Chiang Mai (P.4A)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1955	19.984	30.145	80.438	50.198	132.624	142.214	102.730	67.046	44.842	38.069	25.493	18.853	752.636
1956	23.417	32.543	37.106	76.637	242.006	327.110	143.942	88.992	75.168	54.173	27.873	23.881	1152.848
1957	21.113	19.317	47.107	68.947	78.365	165.802	90.029	40.003	34.301	30.318	20.235	13.807	629.344
1958	12.951	22.196	30.274	42.526	82.944	107.654	59.011	38.275	28.045	23.501	15.846	11.284	474.507
1959	10.005	17.962	29.125	49.006	90.893	178.070	107.309	54.086	36.634	26.620	23.915	18.006	641.631
1960	13.625	24.373	22.092	27.613	75.263	97.891	73.008	40.003	55.253	21.626	14.861	11.085	476.693
1961	11.493	27.828	31.906	25.775	101.323	180.230	137.635	69.206	50.630	34.214	23.753	19.450	713.443
1962	14.901	20.382	17.007	37.200	67.359	49.421	83.635	29.462	23.266	15.654	11.740	10.534	380.561
1963	7.949	6.221	119.172	52.854	85.968	70.675	187.142	337.568	75.686	44.237	33.523	29.635	1050.630
1964	21.427	45.792	68.774	69.638	179.971	172.714	143.683	75.427	53.914	39.830	25.315	19.267	915.752
1965	13.565	21.254	40.608	26.352	117.504	67.565	147.571	216.605	22.896	21.168	18.921	18.403	732.412
1966	13.956	22.947	16.757	18.518	60.667	102.816	38.386	17.942	15.829	13.052	9.386	8.623	338.879
1967	6.808	17.208	25.078	28.619	61.344	176.688	99.360	50.717	39.658	29.376	20.022	19.590	574.468
1968	23.129	32.816	40.435	43.373	96.250	52.963	45.187	28.356	26.107	17.798	14.131	6.632	427.177
1969	4.842	26.024	31.194	41.887	170.381	87.782	77.155	57.542	39.312	23.972	9.055	6.935	576.081
1970	6.484	28.015	50.858	81.821	172.454	196.992	73.008	38.686	66.269	28.433	14.591	7.953	765.564
1971	3.542	10.528	11.723	108.893	171.850	142.301	128.131	67.910	63.504	33.549	18.263	8.447	768.641
1972	13.426	11.727	16.076	4.367	80.995	72.835	70.589	68.602	58.838	21.552	6.170	4.100	429.277
1973	1.138	19.571	53.158	82.854	592.358	326.333	167.962	87.350	66.528	24.246	0.606	2.125	1424.229
1974	1.612	26.452	42.468	10.738	93.070	106.448	56.518	85.882	43.025	21.880	4.541	3.384	496.018
1975	2.716	13.803	100.732	45.197	135.043	173.750	119.059	75.427	73.267	34.473	8.115	2.786	784.368
1976	0.774	12.792	32.051	7.042	34.962	74.501	67.433	41.469	40.348	18.777	2.338	2.264	334.751
1977	52.392	89.139	63.279	66.053	141.955	576.029	353.895	237.946	137.117	133.747	48.341	25.747	1925.640
1978	2.068	17.202	22.410	80.793	83.962	119.145	60.743	23.081	35.386	2.898	2.004	1.887	451.579
1979	12.201	32.131	73.614	12.743	37.335	38.368	115.433	22.760	34.305	5.659	4.484	4.975	394.008
1980	0.026	13.774	45.924	22.340	13.003	125.592	42.494	25.717	34.786	2.143	0.000	0.095	325.894
1981	2.198	41.446	42.708	32.530	89.143	50.492	50.466	66.312	51.188	14.213	3.663	2.748	447.107
1982	1.954	21.842	51.415	5.280	18.582	97.261	75.021	46.764	41.001	2.720	0.798	0.887	363.525
1983	0.425	7.498	30.380	1.862	25.855	136.779	77.375	109.949	62.098	6.362	3.337	0.607	462.527
1984	0.664	18.819	33.112	13.680	63.719	102.012	76.444	36.427	29.564	1.753	1.220	1.280	378.694
1985	1.151	25.184	46.947	21.100	39.226	107.826	67.968	120.957	70.349	9.783	1.638	1.159	513.288
1986	0.951	38.529	37.250	46.163	65.592	104.863	26.381	29.739	33.191	9.522	0.895	0.411	393.487
1987	0.839	9.259	28.070	2.740	140.882	62.640	49.912	68.854	39.084	2.213	1.325	1.051	406.869
1988	5.033	29.818	65.073	36.396	43.113	37.519	52.889	59.640	40.756	3.380	1.586	1.382	376.586

TABLE A.6 Run-off (x10^6 cu.m) Nam Mae Chaem at Amphoe Hot, Chiang Mai (P.14)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1954	32.054	91.757	69.293	73.354	94.867	167.098	182.909	73.786	53.222	39.226	23.504	20.311	921.381
1955	25.041	35.851	102.384	73.094	125.712	207.965	118.714	79.142	52.272	37.152	30.594	19.574	907.495
1956	79.073	62.899	46.042	75.514	200.707	473.386	166.406	100.138	79.056	49.507	32.141	25.108	1389.977
1957	14.038	25.571	45.706	54.397	83.722	126.749	102.298	51.408	36.350	32.241	17.933	11.965	602.378
1958	15.828	20.218	38.845	74.563	84.758	133.142	92.534	48.989	33.696	26.023	13.807	11.336	593.739
1959	10.480	23.151	39.917	87.523	183.427	396.230	194.659	75.600	47.002	31.942	22.896	15.021	1127.848
1960	12.408	41.422	57.024	65.664	257.106	189.475	168.566	76.032	74.477	45.965	30.067	22.040	1040.246
1961	24.041	58.752	79.920	100.915	281.146	473.990	338.170	135.994	97.114	70.243	45.965	33.610	1739.860
1962	28.814	43.014	46.483	124.934	177.293	329.962	306.634	106.013	67.306	50.717	33.005	25.328	1339.503
1963	24.395	39.636	127.181	191.462	262.397	268.358	363.485	211.939	138.413	111.024	82.166	74.909	1895.365
1964	66.614	110.765	106.358	180.662	188.870	457.315	576.115	174.874	124.243	101.866	78.278	73.872	2239.832
1965	53.568	56.678	78.451	88.906	211.334	270.086	261.014	187.747	105.764	79.229	58.147	49.766	1500.690
1966	20.382	79.954	43.286	88.560	208.397	373.853	130.464	89.424	61.603	44.150	27.276	24.676	1192.025
1967	22.887	46.224	38.180	65.318	145.757	308.362	187.229	95.990	63.418	47.779	28.780	24.667	1074.591
1968	30.914	50.600	58.018	96.682	163.814	135.389	186.710	96.077	60.739	41.818	29.203	20.313	970.277
1969	16.844	48.505	55.123	85.968	368.755	316.483	199.325	119.837	74.736	54.432	33.696	26.222	1399.926
1970	24.296	97.252	80.871	122.515	313.200	311.990	179.971	111.542	95.126	61.430	39.917	33.696	1471.806
1971	22.308	55.313	77.760	199.238	273.283	255.658	177.725	97.632	71.453	50.285	31.191	23.881	1335.727
1972	28.028	19.523	33.413	59.443	162.346	166.493	144.461	110.851	70.157	44.842	27.161	26.514	893.232
1973	10.963	44.506	65.491	92.707	297.562	323.309	165.802	94.262	65.059	47.002	28.138	18.987	1253.788
1974	21.721	67.178	65.405	64.713	154.397	184.550	122.515	154.656	73.786	68.774	31.968	22.616	1032.279
1975	18.738	36.091	76.637	105.754	274.061	336.701	214.013	119.059	82.771	59.443	39.571	27.589	1390.428
1976	16.589	31.791	35.147	49.857	125.971	244.339	203.558	110.160	54.086	59.357	24.887	18.541	974.283
1977	25.350	37.618	32.244	78.710	152.410	447.984	164.419	104.544	73.958	61.171	31.018	27.250	1236.676
1978	19.621	50.319	41.740	224.687	316.490	298.640	195.721	98.669	68.083	47.278	26.931	18.075	1406.254
1979	17.228	40.375	51.002	53.793	102.626	95.230	132.875	45.585	30.266	22.740	16.088	16.779	624.587
1980	13.848	50.617	76.032	78.935	116.476	268.756	160.920	73.630	53.525	36.642	22.118	14.895	966.394

TABLE A.6 (Cont.) Run-off (x10^6 cu.m) Nam Mae Chaem at Amphoe Hot, Chiang Mai (P.14)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1981	13.608	36.875	41.895	89.277	148.012	130.395	124.615	108.527	65.007	42.630	26.266	18.688	845.795
1982	24.564	44.176	132.564	81.752	151.779	335.880	253.774	99.680	62.450	46.440	28.210	18.827	1280.096
1983	12.666	17.060	32.759	32.296	98.372	125.674	169.970	158.085	75.038	49.118	32.080	18.611	821.729
1984	21.919	25.221	50.640	65.814	110.533	130.773	222.218	80.698	48.844	32.544	19.485	14.027	822.716
1985	19.086	36.209	65.000	106.052	126.922	252.339	208.490	157.583	80.218	54.173	32.975	24.806	1163.853
1986	16.831	39.233	31.004	74.342	125.114	125.199	85.269	55.719	42.239	34.106	20.429	14.687	664.172
1987	15.594	20.474	51.496	39.938	163.382	202.167	202.745	151.751	70.742	45.355	27.358	19.018	1010.020
1988	16.823	46.704	76.509	72.616	123.803	103.961	209.98	127.914	76.627	51.527	27.728	20.391	954.583

TABLE A.7 Run-off (x10^6 cu.m) Nam Mae Rim at Amphoe Mae Rim, Chiang Mai (P.21)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1954	3.313	18.709	20.303	5.527	28.140	35.966	30.508	8.534	10.066	4.185	2.244	2.531	170.026
1955	2.502	3.916	19.103	16.301	29.587	37.697	19.407	12.558	8.533	5.351	2.928	0.941	158.824
1956	2.044	8.249	4.320	18.013	31.120	70.626	18.553	13.352	10.494	6.520	2.861	3.138	189.290
1957	0.494	1.006	12.480	4.265	13.211	15.846	10.230	4.977	3.386	1.922	2.286	0.426	70.529
1958	1.255	1.793	3.166	11.340	19.302	19.293	6.547	3.134	4.160	1.326	1.431	0.134	72.881
1959	0.243	1.734	4.378	11.840	19.302	46.781	18.388	6.170	6.123	2.500	1.944	0.809	120.212
1960	0.593	0.817	4.055	4.295	17.256	28.294	17.055	6.725	15.725	3.903	2.985	2.755	104.458
1961	2.024	6.901	9.551	6.488	28.485	42.269	47.179	9.122	8.801	4.631	2.395	1.578	169.424
1962	1.441	2.461	1.772	7.031	13.935	17.530	25.651	4.411	4.447	1.223	0.991	0.889	81.782
1963	0.736	0.286	2.765	2.331	36.202	13.824	28.598	18.490	9.418	3.802	2.074	1.901	120.427
1964	1.728	11.405	12.096	23.587	13.910	33.350	33.091	16.416	15.120	8.726	6.134	5.098	180.661
1965	3.629	6.566	9.763	2.938	17.971	18.576	28.598	14.083	9.245	3.629	1.901	1.296	118.195
1966	1.144	6.907	7.487	9.307	33.302	32.405	16.881	8.709	6.834	2.951	1.712	1.823	129.462
1967	2.796	8.772	7.951	11.104	28.017	54.106	19.157	11.800	9.648	5.681	2.143	1.671	162.846
1968	2.941	6.349	8.306	15.268	31.378	15.585	25.359	13.123	9.424	4.320	2.405	1.838	136.296
1969	2.456	28.005	13.422	14.690	79.229	112.925	48.246	46.742	23.273	13.666	4.711	5.939	393.304
1970	7.109	29.163	26.432	21.443	59.547	46.703	20.097	15.301	14.989	9.716	3.734	4.400	258.634
1971	2.734	7.766	17.820	44.187	63.279	39.625	35.763	18.229	12.018	7.627	4.677	3.524	257.249
1972	4.902	4.654	9.273	6.281	28.618	32.498	23.438	19.579	11.869	5.811	3.403	3.157	153.483
1973	1.856	7.795	20.887	22.373	72.529	78.797	30.440	18.457	12.608	7.459	4.569	3.039	280.809
1974	2.844	11.636	14.369	19.551	42.446	52.274	32.102	31.999	15.254	19.008	7.591	5.779	254.853
1975	4.759	11.781	30.185	34.650	49.595	47.757	46.797	22.956	16.494	11.064	5.633	3.509	285.180
1976	2.624	6.771	6.757	4.733	17.371	21.115	23.771	13.275	8.505	8.858	3.962	3.169	120.911
1977	5.530	8.629	7.703	12.605	17.068	34.004	23.828	12.816	9.455	8.032	4.396	2.820	146.886
1978	3.132	6.917	7.833	24.589	29.894	27.901	18.877	10.147	7.950	3.993	2.307	1.428	144.968
1979	1.444	6.088	15.827	5.241	13.331	22.245	21.800	7.958	6.478	3.366	2.168	1.944	107.890
1980	2.600	8.294	12.467	17.100	17.206	27.176	15.066	9.596	7.571	3.232	1.892	0.817	123.017

TABLE A.7 (Cont.) Run-off (x10^6 cu.m) Nam Mae Rim at Amphoe Mae Rim, Chiang Mai (P.21)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1981	0.829	13.464	14.062	18.339	30.362	19.545	13.758	21.647	11.302	5.891	3.059	1.810	154.068
1982	4.126	7.717	17.355	8.118	16.936	36.558	23.669	11.770	6.761	3.511	1.977	0.991	139.489
1983	0.473	1.640	4.834	3.586	17.266	32.857	21.514	27.194	10.168	6.107	4.223	1.608	131.470
1984	2.397	8.406	17.849	7.890	19.278	23.228	24.208	9.733	5.700	3.891	1.368	0.569	124.517
1985	1.099	2.481	8.224	10.365	9.879	25.576	19.399	31.862	9.533	4.277	1.749	0.708	125.152
1986	1.692	7.593	10.574	15.566	22.628	28.219	19.129	10.867	8.332	6.057	2.476	1.955	135.088
1987	1.920	3.049	5.449	2.757	27.935	19.426	13.463	17.807	9.146	4.323	0.962	0.633	106.871
1988	2.881	12.129	24.940	36.040	29.980	18.764	18.134	16.593	10.078	3.848	2.195	2.033	177.615

TABLE A.8 Run-off (x10^6 cu.m) Nam Mae Khan at Amphoe San Pa Tong, Chiang Mai (P.23)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1955	5.108	10.433	38.362	10.627	56.203	101.779	40.694	35.683	22.688	4.622	6.221	0.734	333.154
1956	2.765	33.955	4.320	16.502	49.280	170.122	87.264	44.755	34.819	13.651	12.960	6.048	476.441
1957	3.927	6.023	18.235	13.355	33.320	43.485	39.602	12.610	11.243	0.337	1.469	0.000	183.606
1958	0.000	5.485	5.345	9.994	24.741	36.091	31.324	9.557	9.227	25.276	6.159	0.000	163.199
1959	0.000	11.024	16.922	29.801	22.219	78.164	33.936	18.362	15.536	5.768	5.059	0.544	237.335
1960	0.000	3.283	1.987	2.506	58.147	77.522	66.355	20.218	73.190	7.949	3.283	0.019	314.459
1961	2.074	26.266	11.923	8.468	37.450	71.798	100.829	27.648	17.237	6.826	2.765	0.180	313.464
1962	0.010	3.715	3.888	10.706	17.523	61.765	132.883	60.394	46.527	32.659	1.560	2.678	374.308
1963	3.018	1.642	16.386	17.855	84.694	27.970	27.906	41.904	20.992	5.390	1.192	0.121	249.070
1964	0.152	15.012	7.072	46.140	36.954	146.794	87.005	29.926	4.538	0.010	0.966	0.150	374.719
1965	0.000	0.105	3.283	0.000	21.168	33.955	44.755	25.056	12.096	2.333	0.537	0.000	143.288
1966	0.000	12.658	5.165	8.866	55.930	98.520	30.837	14.448	10.971	4.640	0.202	1.823	244.060
1967	1.585	6.891	10.619	6.033	17.149	99.852	37.211	38.833	15.984	4.745	3.223	1.419	243.544
1968	7.081	14.768	17.848	13.200	21.195	28.244	28.800	18.726	13.162	2.514	0.307	0.000	165.845
1969	0.000	13.739	38.916	12.793	115.493	110.419	48.177	38.984	21.469	8.405	11.306	3.577	423.278
1970	3.551	71.431	49.529	25.531	126.835	115.690	64.973	39.226	60.394	11.953	10.653	21.652	601.418
1971	4.065	17.803	27.860	83.592	114.329	120.787	126.403	47.088	18.273	1.197	3.331	3.607	568.335
1972	13.651	3.287	9.819	11.413	28.339	99.598	50.800	53.633	21.924	0.644	0.501	3.948	297.557
1973	1.261	27.570	57.454	38.390	184.378	252.461	119.578	73.699	49.075	23.155	26.689	13.893	867.603
1974	3.875	29.972	21.056	10.191	50.518	130.378	83.575	158.112	46.483	51.520	7.681	7.707	601.068
1975	5.625	14.113	52.548	49.615	133.574	215.827	128.045	80.438	47.606	23.073	11.720	11.746	773.930
1976	1.119	16.603	17.304	6.495	41.371	88.292	96.703	64.886	31.432	31.059	4.138	2.846	402.248
1977	19.055	26.654	16.680	11.177	44.103	218.506	99.014	57.716	41.818	34.063	15.513	4.788	589.087
1978	1.097	18.334	17.686	102.751	105.525	91.955	74.809	35.286	27.553	10.372	1.426	0.000	486.794
1979	1.028	17.142	46.526	25.255	30.275	78.693	102.496	30.827	24.252	10.999	0.518	0.000	368.011
1980	1.918	35.208	62.649	45.265	53.041	88.975	92.552	55.166	52.462	26.706	13.444	5.944	533.330
1981	2.175	51.735	22.148	27.200	69.401	55.922	47.615	85.608	42.306	8.602	3.332	0.975	417.019
1982	2.965	9.281	55.220	4.398	11.721	110.027	67.991	27.886	8.547	2.036	0.432	0.135	300.639
1983	0.067	0.283	15.807	2.778	33.464	70.905	113.336	106.787	37.276	15.785	1.517	0.286	398.291
1984	3.567	5.867	10.258	7.276	16.411	47.762	67.224	22.886	18.127	6.820	1.573	0.146	207.917
1985	8.306	20.506	7.725	23.213	15.580	73.643	64.187	134.241	33.726	13.395	4.083	1.286	399.891
1986	1.344	25.730	20.625	20.776	49.709	71.219	34.576	23.979	20.000	19.901	5.149	1.125	294.133
1987	0.655	0.625	23.587	2.207	65.218	86.977	53.380	64.137	25.452	22.435	2.090	0.272	347.034

TABLE A.9 Run-off (x10^6 cu.m) Ngao River at Amphoe Ngao,Lampang (Y.13)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1963	0.613	1.545	1.686	20.481	22.903	22.326	31.873	6.762	3.150	1.252	0.890	0.689	114.170
1964	0.503	21.064	3.092	7.034	7.591	29.096	35.357	14.373	3.440	2.225	0.906	0.965	125.646
1965	1.037	5.616	11.405	3.888	7.776	41.558	35.770	2.751	0.857	0.864	0.864	0.573	112.959
1966	5.827	8.667	2.150	4.330	18.702	29.535	30.715	1.683	0.922	0.976	0.452	0.512	104.471
1967	0.543	0.999	0.715	0.769	5.841	17.538	8.769	2.575	1.178	0.924	0.600	0.669	41.120
1968	1.224	4.372	12.037	2.179	13.624	18.963	3.105	1.391	1.680	1.127	0.943	0.922	61.567
1969	0.672	0.557	1.429	3.096	5.080	10.712	14.101	4.345	2.280	0.946	0.732	0.736	44.686
1970	0.137	7.594	11.580	4.969	43.941	35.580	14.176	4.288	3.359	1.751	0.771	0.714	128.860
1971	0.859	5.868	5.727	33.717	24.310	26.948	20.622	5.607	4.101	3.273	1.407	0.988	133.427
1972	2.025	1.799	1.578	9.653	25.685	8.986	12.122	8.597	5.815	3.827	2.702	3.537	86.326
1973	1.301	2.322	4.813	6.730	60.001	69.379	28.856	11.190	5.550	3.676	1.135	1.402	196.355
1974	2.830	7.006	2.688	4.759	18.286	20.521	9.597	32.144	12.027	12.813	5.751	5.838	134.260
1975	4.537	5.452	18.519	10.284	30.716	22.702	16.851	6.893	3.795	2.337	1.035	0.454	123.575
1976	1.659	5.443	4.570	6.972	15.548	29.311	20.215	15.206	10.204	10.917	6.238	5.879	132.162
1977	3.162	5.063	1.650	7.646	13.928	26.283	21.142	11.266	5.106	1.555	1.322	1.400	99.523
1978	0.069	4.908	1.581	35.385	34.383	29.461	9.590	3.953	2.657	2.199	1.693	1.659	127.538
1979	0.614	1.751	3.616	3.930	6.981	8.916	7.285	3.026	1.440	0.897	0.677	0.651	39.784
1980	0.880	2.970	18.936	14.890	20.903	42.455	8.604	0.457	0.499	0.176	0.069	0.060	110.899
1981	0.660	9.228	4.161	20.751	25.459	14.212	20.320	15.369	4.476	1.580	0.515	0.363	117.094
1982	1.204	0.587	1.165	4.899	5.583	14.581	11.577	4.653	2.521	1.381	0.387	0.195	48.733
1983	0.141	0.658	0.521	1.795	11.646	13.695	12.531	4.663	1.515	0.735	0.329	0.302	48.531
1984	0.442	1.368	1.515	1.483	4.919	10.480	21.250	3.286	1.267	0.854	0.506	0.326	47.696
1985	0.312	1.486	2.551	5.668	4.076	10.549	5.326	6.763	1.757	1.329	0.717	0.594	41.128
1986	0.669	4.355	4.693	6.534	29.868	39.494	13.998	5.399	2.547	1.779	1.172	1.034	111.542
1987	0.915	1.823	3.497	2.927	27.476	17.579	12.957	13.433	2.343	0.428	0.000	0.000	83.378

TABLE A. 10 Run-off (x10^6 cu.m) Nam Pat at Amphoe Nam Pat, Uttaradit (N.33)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1966	1.447	13.869	4.469	1.439	38.226	112.978	11.012	4.527	2.703	0.824	0.204	0.109	191.807
1967	12.863	15.391	21.679	14.710	23.778	170.494	41.672	4.300	2.353	1.173	0.629	2.729	311.771
1968	31.203	68.065	47.387	56.461	23.580	58.164	13.449	3.497	1.788	1.027	0.465	0.344	305.430
1969	0.787	9.742	37.821	10.879	41.706	60.365	17.112	13.087	3.309	1.597	0.755	1.175	198.335
1970	4.159	67.477	95.403	110.506	456.538	306.029	77.846	19.550	10.058	6.538	4.463	5.191	1163.758
1971	5.448	19.963	30.083	73.891	112.935	151.978	77.829	11.477	8.049	5.841	4.942	5.096	507.532
1972	4.811	3.141	11.581	9.096	36.602	63.342	73.042	10.323	5.034	2.821	1.616	16.552	237.961
1973	2.331	11.075	20.487	31.536	110.220	161.654	47.282	7.207	3.904	2.605	1.529	2.315	402.145
1974	6.318	20.898	15.926	7.572	118.116	82.853	30.006	13.679	4.639	4.309	0.822	0.793	305.931
1975	0.295	17.319	39.733	54.463	171.283	186.624	64.109	15.986	6.994	3.540	2.980	0.757	564.083
1976	1.752	19.046	9.150	11.022	58.877	210.565	90.266	22.766	5.759	4.271	1.984	2.595	438.053
1977	2.942	10.034	1.979	7.188	17.438	58.266	16.193	4.545	1.997	0.555	0.104	1.229	122.470
1978	8.329	13.254	24.775	213.287	332.925	140.305	58.424	10.083	4.463	1.853	1.040	1.032	809.770
1979	8.851	17.788	40.514	7.870	39.474	32.050	13.799	1.920	1.299	0.838	0.437	0.601	165.441
1980	4.936	19.927	59.054	58.869	77.004	438.156	42.880	12.995	5.594	2.566	1.456	1.244	724.681
1981	4.931	51.307	24.889	248.085	96.740	36.017	26.971	15.085	4.752	2.217	1.180	0.628	512.802
1982	10.005	7.560	22.443	8.169	14.333	98.842	67.418	10.079	3.371	1.545	0.599	0.307	244.671
1983	0.354	6.801	26.388	8.633	50.717	101.460	80.810	17.021	4.748	2.267	1.725	1.331	302.255
1984	5.381	11.894	42.048	24.532	32.822	132.468	90.072	16.691	8.149	2.735	0.524	1.610	368.926
1985	3.256	13.520	6.113	28.845	32.360	118.060	28.257	14.244	4.830	2.070	0.918	0.562	253.035
1986	4.139	35.992	25.689	26.583	30.222	78.223	18.310	7.750	3.300	1.106	0.678	0.778	232.770
1987	2.367	6.288	38.251	5.892	141.004	108.485	45.672	14.132	7.131	3.484	1.928	1.023	375.659
1988	0.764	47.106	44.008	66.230	53.380	47.515	76.612	13.481	6.041	1.942	0.895	1.078	359.052

APPENDIX B

COMPUTER PROGRAM LISTING

File name : GGUBS.FOR / page : 1

```
C   IMSL ROUTINE NAME      - GGUBS
C
C-----------------------------------------------------------------------
C
C   LATEST REVISION        - JUNE 01, 1991
C
C   PURPOSE                - BASIC UNIFORM (0,1) PSEUDO-RANDOM NUMBER
C                            GENERATOR
C
C   ARGUMENTS    DSEED     - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                            ASSIGNED AN INTEGER VALUE IN THE
C                            EXCLUSIVE RANGE (1.D0, 2147483647.D0).
C                            DSEED IS REPLACED BY A NEW VALUE TO BE
C                            USED IN A SUBSEQUENT CALL.
C                 NR       - INPUT NUMBER OF DEVIATES TO BE GENERATED.
C                 R        - OUTPUT VECTOR OF LENGTH NR CONTAINING THE
C                            PSEUDO-RANDOM UNIFORM (0,1) DEVIATES
C
C   REQD. CMU-CE ROUTINES - NONE
C         IMSL   ROUTINES - NONE
C
C   NOTE                  - NONE
C
C
C-----------------------------------------------------------------------
C
      SUBROUTINE GGUBS (DSEED,NR,R)
C                                     SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 NR
      REAL                    R(NR)
      DOUBLE PRECISION        DSEED
C                                     SPECIFICATIONS FOR LOCAL VARIABLES
      INTEGER                 I
      DOUBLE PRECISION        D2P31M,D2P31
C                                       D2P31M=(2**31) - 1
C                                       D2P31 =(2**31)(OR AN ADJUSTED VALUE)
      DATA                    D2P31M/2147483647.D0/
      DATA                    D2P31/2147483648.D0/
C                                       FIRST EXECUTABLE STATEMENT
      DO 5 I=1,NR
        DSEED = DMOD(16807.D0*DSEED,D2P31M)
    5 R(I) = DSEED / D2P31
      RETURN
      END
```

File Size = 3163 Bytes

```
C   IMSL ROUTINE NAME   - GGNPM
C
C-----------------------------------------------------------------------
C
C   LATEST REVISION     - JUNE 01, 1991
C
C   PURPOSE             - NORMAL RANDOM DEVIATE GENERATOR VIA THE POLAR
C                         METHOD
C
C   ARGUMENTS    DSEED  - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                         ASSIGNED AN INTEGER VALUE IN THE
C                         EXCLUSIVE RANGE (1.D0, 2147483647.D0).
C                         DSEED IS REPLACED BY A NEW VALUE TO BE
C                         USED IN A SUBSEQUENT CALL.
C                 NR    - INPUT.  THE NUMBER OF NORMAL DEVIATES TO BE
C                         GENERATED.  NR MUST BE 2 OR GREATER.  IF NR
C                         IS ODD, NR-1 DEVIATES ARE GENERATED.
C                 R     - OUTPUT VECTOR OF LENGTH NR CONTAINING THE
C                         NORMAL DEVIATES. IF NR IS ODD, R(NR) IS NOT
C                         USED.
C
C   REQD. CMU-CE ROUTINES - NONE
C         IMSL   ROUTINES - NONE
C
C   NOTE                  - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE GGNPM (DSEED,NR,R)
C                                     SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 NR
      REAL                    R(NR)
      DOUBLE PRECISION        DSEED
C                                     SPECIFICATIONS FOR LOCAL VARIABLES
      INTEGER                 I,NN,M
      REAL                    U,V,SUM,SLN
      DOUBLE PRECISION        D2P31M,D2PN31
C                                     D2P31M = (2**31)-1
C                                     D2PN31 = (2**31)
      DATA                    D2P31M/2147483647.D0/
      DATA                    D2PN31/2147483648.D0/
C                                     FIRST EXECUTABLE STATEMENT
      NN = NR
C                                     TEST FOR NR ODD
      M = MOD(NR,2)
      IF (M .NE. 0) NN = NN-1
      DO 10 I = 1,NN,2
    5    DSEED = DMOD(16807.D0*DSEED,D2P31M)
         U = DSEED/D2PN31
         DSEED = DMOD(16807.D0*DSEED,D2P31M)
```

```
      V = DSEED/D2PN31
      U = U+U-1.0
      V = V+V-1.0
      SUM = U*U+V*V
      IF(SUM .GE. 1.0) GO TO 5
      SLN = ALOG(SUM)
      SLN = SQRT((-SLN-SLN)/SUM)
      R(I) = U*SLN
      R(I+1) = V*SLN
   10 CONTINUE
      RETURN
      END
```

File Size = 4474 Bytes

File name : GGMSS.FOR / page : 1

```
C     CMU-CE ROUTINE NAME     - GGMSS
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION         - JULY 08, 1991
C
C     PURPOSE                 - COMPUTED THE MEAN, STANDARD DEVIATION
C                               AND SKEWNESS BY THE METHOD OF MOMENTS.
C
C     ARGUMENTS      Q        - INPUT THE ELEMENTS OF DATA
C                    N        - INPUT THE NUMBER OF DATA
C                    QM       - OUTPUT THE MEAN
C                    QSD      - OUTPUT THE STANDARD DEVIATION
C                    QSK      - OUTPUT THE SKEWNESS COEFFICIENT
C
C     REQD. CMU-CE ROUTINES   - NONE
C           IMSL   ROUTINES   - NONE
C
C     NOTE                    - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE GGMSS(Q,N,QM,QSD,QSK)
C                               SPECIFICATIONS FOR ARGUMENTS
      INTEGER                  N
      REAL                     Q(N)
C                               SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                  I
      REAL                     CORR,FN,SUM1,SUM2,SUM3,QM,QSD,QSK,VAR
C
      DATA                     SUM1/0.0/,SUM2/0.0/SUM3/0.0/
C                               FIRST EXECUTABLE STATEMENT
      FN = N
      DO 10 I=1,N
         SUM1  = SUM1+Q(I)
   10 CONTINUE
      QM = SUM1/FN
      DO 15 I=1,N
         SUM2 = SUM2+(Q(I)-QM)**2
         SUM3 = SUM3+(Q(I)-QM)**3
   15 CONTINUE
      VAR = SUM2/(FN-1.0)
      QSD = SQRT(VAR)
      CORR= FN/((FN-2.0)*(FN-1.0))
      QSK = CORR*SUM3/SQRT(VAR**3)
      RETURN
      END
```

File Size = 1603 Bytes

File name : AUTOC.FOR / page : 1

```
C     CMU-CE ROUTINE NAME    - AUTOC
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JULY 08, 1991
C
C     PURPOSE                - COMPUTED THE AUTOCORRELATION LAG KL
C
C     ARGUMENTS      X       - INPUT THE ELEMENTS OF DATA
C                    N       - INPUT THE NUMBER OF DATA
C                    RR      - OUTPUT THE AUTOCORRELATION
C
C     REQD. CMU-CE ROUTINES  - NONE
C           IMSL   ROUTINES  - NONE
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE AUTOC(X,N,RR)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N
      REAL                    X(N),RR(20)
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,K,KL
      REAL                    XM,SUM1,SUM2,SUM3
C
      DATA                    KL/15/,SUM1/0.0/,SUM2/0.0/
C
C                               FIRST EXECUTABLE STATEMENT
      DO 5 I = 1,N
         SUM1 = SUM1 + X(I)
5     CONTINUE
      XM = SUM1/N
      DO 10 I =1,N
         SUM2 = SUM2 + (X(I)-XM)**2
10    CONTINUE
      DO 20 K = 0,KL
         SUM3 = 0.
         DO 30 I = 1,N-K
            SUM3 = SUM3 + (X(I+K)-XM)*(X(I)-XM)
30       CONTINUE
      RR(K) = SUM3/SUM2
20    CONTINUE
      RETURN
      END
```

File Size = 1399 Bytes

File name : HURST.FOR / page : 1

```
C     CMU-CE ROUTINE NAME     - HURST
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION         - JULY 08, 1991
C
C     PURPOSE                 - COMPUTED THE HURST COEFFICIENT.
C
C     ARGUMENTS       X       - INPUT THE ELEMENTS OF DATA
C                     N       - INPUT THE NUMBER OF DATA
C                     XM      - INPUT THE MEAN
C                     XSD     - INPUT THE STANDARD DEVIATION
C                     HUR     - OUTPUT THE HURST COEFFICIENT
C
C     REQD. CMU-CE ROUTINES   - NONE
C           IMSL   ROUTINES   - NONE
C
C     NOTE                    - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE HURST(X,N,XM,XSD,HUR)
C                               SPECIFICATIONS FOR ARGUMENTS
      INTEGER                  N
      REAL                     X(N),XM,XSD,HUR
C                               SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                  I
      REAL                     XVAR,SUM1,D(1000),DMAX,DMIN,RD
C
      DATA                     SUM1/0.0/
C
C                                FIRST EXECUTABLE STATEMENT
      DO 10 I = 1,N
         SUM1 = SUM1+(X(I)-XM)
         D(I) = SUM1
   10 CONTINUE
         DMAX = D(1)
      DO 20 I = 2,N
         IF (DMAX-D(I)) 25,20,20
   25       DMAX = D(I)
   20 CONTINUE
      DMIN = D(1)
      DO 30 I = 2,N
         IF (DMIN-D(I)) 30,30,35
   35       DMIN = D(I)
   30 CONTINUE
      RD = DMAX-DMIN
      HUR = ALOG(RD/SQRT(XVAR))/(ALOG(N/2.0))
      RETURN
      END
```

File Size = 1574 Bytes

File name : PARAU.FOR / page : 1

```
C     CMU-CE ROUTINE NAME     - PARAU
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION         - JULY 08, 1991
C
C     PURPOSE                 - COMPUTED THE PARTIAL AUTOCORRELATION
C
C     ARGUMENTS       RR      - INPUT THE AUTOCORRELATION (LAG KL)
C                     PHI     - OUTPUT THE PARTIAL AUTOCORRELATION
C
C     REQD. CMU-CE ROUTINES   - NONE
C           IMSL   ROUTINES   - NONE
C
C     NOTE                    - KL IS NUMBER OF LAG
C
C-----------------------------------------------------------------------
C
      SUBROUTINE PARAU(RR,PHI)
C                               SPECIFICATIONS FOR ARGUMENTS
      REAL                     RR,PHI
C                               SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                  I,J,KL
      REAL                     SUM1,SUM2,RR(20),PHI(20,20)
C
      DATA                     KL/15/
C
C                               FIRST EXECUTABLE STATEMENT
      PHI(1,1) = RR(1)
      DO 10 I = 2,KL
         SUM1 = 0.
         SUM2 = 0.
         DO 20 J = 1,I-1
            SUM1 = SUM1 + PHI(I-1,J)*RR(I-J)
            SUM2 = SUM2 + PHI(I-1,J)*RR(J)
   20    CONTINUE
         PHI(I,I) = (RR(I)-SUM1)/(1.-SUM2)
         DO 30 J = 1,I-1
         IF (I .NE. J) THEN
            PHI(I,J) = PHI(I-1,J)-PHI(I,I)*PHI(I-1,I-J)
         ENDIF
   30    CONTINUE
   10 CONTINUE
      RETURN
      END
```

File Size = 1433 Bytes

File name : GAMMA.FOR / page : 1

```
C      CMU-CE ROUTINE NAME     - GAMMA
C
C-----------------------------------------------------------------------
C
C      LATEST REVISION         - JULY 08, 1991
C
C      PURPOSE                 - COMPUTED THE VARLUE OF GAMMA FUNCTION
C
C      ARGUMENTS       X       - INPUT THE VALUE OF DATA
C                      GM      - OUTPUT THE VALUE OF GAMMA FUNCTION
C
C      REQD. CMU-CE ROUTINES   - NONE
C            IMSL   ROUTINES   - NONE
C
C      NOTE                    - THE VARLUE OF X MUST BE INTERVAL [1,2]
C
C-----------------------------------------------------------------------
C
      SUBROUTINE GAMMA(X,GM)
C                               SPECIFICATIONS FOR ARGUMENTS
      REAL                     X,GM
C                               SPECIFICATION FOR LOCAL VARIABLES
      REAL                     B1,B2,B3,B4,B5,B6,B7,B8
C
      DATA                     B1/-0.577191652/,B2/0.988205891/
     $                         B3/-0.897056937/,B4/0.918206857/
     $                         B5/-0.756704078/,B6/0.482199394/
     $                         B7/-0.193527818/,B8/0.035868343/
C
C                               FIRST EXECUTABLE STATEMENT
      X  = X-1.0
      GM = 1.0+B1*X+B2*X**2+B3*X**3+B4*X**4+B5*X**5+B6*X**6
     $       +B7*X**7+B8*X**8
      RETURN
      END
```

File Size = 1279 Bytes

File name : KIRBY.FOR / page : 1

```
C     CMU-CE ROUTINE NAME    - KIRBY
C
C-----------------------------------------------------------------
C
C     LATEST REVISION        - JULY 08, 1991
C
C     PURPOSE                - COMPUTED RANDOM NUMBER WHICH HAVE
C                              SKEWNESS MORE THAN 3.0.
C
C     ARGUMENTS      NP      - INPUT THE NUMBER OF DATA
C                    CS      - INPUT THE VALUE OF SKEWNESS
C                    R       - INPUT THE RANDOM NUMBERS
C                    RK      - OUTPUT THE RANDOM NUMBERS
C
C     REQD. CMU-CE ROUTINES  - NONE
C           IMSL   ROUTINES  - NONE
C
C     NOTE                   - THIS METHOD MODIFIED FROM WILSON HILFERTY
C
C-----------------------------------------------------------------
C
      SUBROUTINE KIRBY(NP,CS,R,RK)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 NP
      REAL                    CS,R(NP),RK(NP)
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 K
      REAL                    A,B,G,H,XKA,XKB,XKBB,XKG,XKGG,XG,XGG
C
C                              FIRST EXECUTABLE STATEMENT
      XKA = 2.0/CS
      A   = AMAX1(XKA,0.40)
      XKBB = CS-2.25
      XKB  = AMAX1(XKBB,0.0)
      B    = 1.0+0.0144*XKB**2
      XKGG = CS-1.0
      XKG  = AMAX1(XKGG,0.0)
      G    = CS-0.063*XKG**1.85
      H    = (B-2./(CS*A))**(1/3.)
      DO 10 K = 1,NP
         XGG  = 1.0+G*R(K)/6.0-(G/6.0)**2
         XG   = AMAX1(H,XGG)
         RK(K)= A*(XG**3-B)
10    CONTINUE
      RETURN
      END
```

File Size = 1576 Bytes

File name : ARWHT.FOR / page : 1

```
C     CMU-CE ROUTINE NAME    - ARWHT
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 21, 1991
C
C     PURPOSE                - GENERATED STREAMFLOWS BY USING THE LAG-
C                              ONE MARKOV MODEL AR(1) WITH WILSON-
C                              HILFERTY TRANSFORMATION FOR PRESERVE
C                              SKEWNESS
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                      X       - INPUT HISTORICAL ANNUAL FLOWS
C                      N       - INPUT THE NUMBER OF HISTORICAL ANNUAL
C                              FLOWS.
C                      NP      - INPUT THE NUMBER OF GENERATION ANNUAL
C                              FLOWS
C                      XP      - OUTPUT GENERATION ANNUAL FLOWS.
C
C     REQD. CMU-CE ROUTINES  - AUTOC,GGMSS,KIRBY
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - RR(1) MUST BE BETWEEN -1.0 AND 1.0. NO
C                              PROGRAM CHECK IS MADE FOR THIS CONDITION.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE ARWHT(DSEED,X,N,NP,XP)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                NP
      REAL                   X(0:N),XP(0:NP)
      DOUBLE PRECISION       DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                I,J,K
      REAL                   SKR,XM,XSD,XSK,RR(20),R(1000),RK(1000)
     $                       ,XG(100,10)
C
      DATA                   K/0/
C                              FIRST EXECUTABLE STATEMENT
      CALL AUTOC(X,N,RR)
      CALL GGMSS(X,N,XM,XSD,XSK)
      XP(0) = XM
      SKR   = (1.-RR(1)**3)*XSK/((1.-RR(1)**2)**1.5)
      CALL GGNPM(DSEED,NP,R)
      IF (ABS(SKR) .LE. 3.0) THEN
```

```
51:           DO 5 I = 1,NP
52:              RK(I) = 2./SKR*((1.+SKR*R(I)/6.-SKR**2/36.)**3-1.)
53:     5     CONTINUE
54:        ELSE
55:           CALL KIRBY(NP,SKR,R,RK)
56:        ENDIF
57:        DO 10 I = 1,NP/10
58:        DO 10 J = 1,10
59:           K = K+1
60:           XG(I,J) = XM+RR(1)*(XP(K-1)-XM)+RK(K)*XSD*
61:       $             SQRT(1.-RR(1)**2)
62:           XP(K) = XG(I,J)
63:           IF (XP(K) .LT. 0.0) THEN
64:              XP(K) = 0.0
65:           ENDIF
66:    10  CONTINUE
67:        DO 20 I = 1,NP/10
68:           WRITE(2,30) I,(XG(I,J),J=1,10)
69:    30     FORMAT(1X,I3,10F9.2)
70:    20  CONTINUE
71:        RETURN
72:        END
```

File Size = 2727 Bytes

```
1:
2: C     CMU-CE ROUTINE NAME    - ARLT
3: C
4: C-------------------------------------------------------------------
5: C
6: C     LATEST REVISION        - JUNE 21, 1991
7: C
8: C     PURPOSE                - GENERATED STREAMFLOWS BY USING THE LAG-
9: C                              ONE MARKOV MODEL AR(1) WITH 2 OR 3
10: C                             PARAMETER LOG NORMAL DISTRIBUTION FOR
11: C                             PRESERVE SKEWNESS.
12: C
13: C     ARGUMENTS      STYPE   - INPUT TYPE OF MODIFICATION PRESERVE
14: C                             SKEWNESS ,STYPE = '1' IS TWO-PARAMETER
15: C                             LOG NORMAL AND STYPE ='2' IS THREE-
16: C                             PARAMETER LOG NORMAL.
17: C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
18: C                             ASSIGNED AN INTEGER VALUE IN THE
19: C                             EXCLUSIVE RANG (1.D0,2147483647.D0).
20: C                             DSEED IS REPLACED BY A NEW VALUE TO
21: C                             BE USED IN A SUBSEQUENT CALL.
22: C                      X      - INPUT HISTORICAL ANNUAL FLOWS
23: C                      N      - INPUT THE NUMBER OF HISTORICAL ANNUAL
24: C                             FLOWS.
25: C                      NP     - INPUT THE NUMBER OF GENERATION ANNUAL
26: C                             FLOWS
27: C                      XP     - OUTPUT GENERATION ANNUAL FLOWS.
28: C
29: C     REQD. CMU-CE ROUTINES   - AUTOC,GGMSS
30: C           IMSL   ROUTINES   - GGNPM
31: C
32: C     NOTE                    - RR(1) MUST BE BETWEEN -1.0 AND 1.0. NO
33: C                             PROGRAM CHECK IS MADE FOR THIS CONDITION.
34: C
35: C-------------------------------------------------------------------
36: C
37:       SUBROUTINE ARLT(STYPE,DSEED,X,N,NP,XP)
38: C                               SPECIFICATIONS FOR ARGUMENTS
39:       INTEGER                  N,NP
40:       REAL                     X(0:N),XP(0:NP)
41:       DOUBLE PRECISION         DSEED
42:       CHARACTER*10             STYPE
43: C                               SPECIFICATION FOR LOCAL VARIABLES
44:       INTEGER                  I,J,K
45:       REAL                     A,XM,YM,XSD,XSK,XVAR,YVAR,RHO,PHEE,RR(20)
46:      $                        ,R(1000),XG(100,10)
47: C
48:       DATA                     K/0/
49: C                               FIRST EXECUTABLE STATEMENT
50:       CALL AUTOC(X,N,RR)
```

```
      CALL GGMSS(X,N,XM,XSD,XSK)
      XP(0) = XM
      XVAR = XSD**2
      CALL GGNPM(DSEED,NP,R)
      IF (STYPE .EQ. '1') THEN
          YVAR = ALOG(1.0+XVAR/XM**2)
          YM   = ALOG(XM)-YVAR/2.0
          RHO  = (1.0/YVAR)*ALOG(RR(1)*(EXP(YVAR)-1.0)+1.0)
          DO 50 I = 1,NP/10
          DO 50 J = 1,10
             K = K+1
             XG(I,J) = (EXP(YM*(1.-RHO)))*XP(K-1)**RHO
     $                 *(EXP(SQRT(YVAR*(1.0-RHO**2))*R(K)))
             XP(K)   = XG(I,J)
50        CONTINUE
      ELSEIF (STYPE .EQ. '2') THEN
          PHEE = ((1.+0.5*XSK**2)+SQRT(XSK**2+0.25*XSK**4))
     $           **(1./3.)+((1.+0.5*XSK**2)-SQRT(XSK**2+0.25
     $           *XSK**4))**(1./3.)-1.0
          YVAR = ALOG(PHEE)
          YM   = 0.5*ALOG(XVAR/(PHEE**2-PHEE))
          A    = XM-SQRT(XVAR/(PHEE-1.0))
          RHO  = (ALOG(RR(1)*(PHEE-1.)+1.0))/ALOG(PHEE)
          DO 60 I = 1,NP/10
          DO 60 J = 1,10
             K = K+1
             XG(I,J) = A+(EXP(YM*(1.-RHO)))*(XP(K-1)-A)**RHO*
     $                  EXP(SQRT(YVAR*(1.-RHO**2))*R(K))
             XP(K) = XG(I,J)
60        CONTINUE
      ENDIF
      DO 70 I = 1,NP/10
         WRITE(2,80) I,(XG(I,J),J=1,10)
80       FORMAT(1X,I3,10F9.2)
70    CONTINUE
      RETURN
      END
```

```
1:
2: C     CMU-CE ROUTINE NAME     - ARBP
3: C
4: C-------------------------------------------------------------------
5: C
6: C     LATEST REVISION         - JUNE 22, 1991
7: C
8: C     PURPOSE                 - GENERATED STREAMFLOWS BY USING THE LAG-
9: C                               ONE MARKOV MODEL AR(1) WITH BREAD'S
10: C                              PROCEDURE FOR PRESERVE SKEWNESS
11: C
12: C    ARGUMENTS      DSEED    - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
13: C                              ASSIGNED AN INTEGER VALUE IN THE
14: C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
15: C                              DSEED IS REPLACED BY A NEW VALUE TO
16: C                              BE USED IN A SUBSEQUENT CALL.
17: C                    X       - INPUT HISTORICAL ANNUAL FLOWS
18: C                    N       - INPUT THE NUMBER OF HISTORICAL ANNUAL
19: C                              FLOWS.
20: C                    NP      - INPUT THE NUMBER OF GENERATION ANNUAL
21: C                              FLOWS
22: C                    XP      - OUTPUT GENERATION ANNUAL FLOWS.
23: C
24: C    REQD. CMU-CE ROUTINES   - AUTOC,GGMSS
25: C          IMSL   ROUTINES   - GGNPM
26: C
27: C    NOTE                    - RR(1) MUST BE BETWEEN -1.0 AND 1.0. NO
28: C                              PROGRAM CHECK IS MADE FOR THIS CONDITION.
29: C
30: C-------------------------------------------------------------------
31: C
32:       SUBROUTINE ARBP(DSEED,X,N,NP,XP)
33: C                               SPECIFICATIONS FOR ARGUMENTS
34:       INTEGER                  N,NP
35:       REAL                     X(0:N),XP(0:NP)
36:       DOUBLE PRECISION         DSEED
37: C                               SPECIFICATION FOR LOCAL VARIABLES
38:       INTEGER                  I,J,K
39:       REAL                     XAML,XSDL,XSKL,RR(20),T(100),XL(0:100)
40:      $                        ,EE(0:1000),RT(1000),HK(0:100),R(1000)
41:      $                        ,XG(100,10)
42: C
43:       DATA                     K/0/,EE(0)/0.0/
44: C                               FIRST EXECUTABLE STATEMENT
45:       DO 10 I = 1,N
46:          XL(I) = ALOG(X(I)+0.01)
47: 10    CONTINUE
48:       CALL GGMSS(XL,N,XAML,XSDL,XSKL)
49:       DO 20 I = 1,N
50:          T(I) = (XL(I)-XAML)/XSDL
```

```
51:            HK(I) = 6.0/XSKL*((XSKL/2.*T(I)+1.0)**(1./3.)-1.0)+XSKL/6.0
52: 20      CONTINUE
53:         CALL AUTOC(HK,N,RR)
54:         CALL GGNPM(DSEED,NP,R)
55:         DO 30 I = 1,NP
56:            EE(I) = RR(1)*EE(I-1)+R(I)*SQRT(1.-RR(1)**2)
57: 30      CONTINUE
58:         DO 40 I = 1,NP/10
59:         DO 40 J = 1,10
60:            K = K+1
61:            RT(K) =  ((XSKL/6.0*(EE(K)-XSKL/6.0)+1.)**3-1.0)*2.0/XSKL
62:            XG(I,J) =  EXP(XAML+RT(K)*XSDL)-.01
63:            XP(K) = XG(I,J)
64:            IF (XP(K) .LT. 0.0) THEN
65:               XP(K) = 0.0
66:            ENDIF
67: 40      CONTINUE
68:         DO 50 I = 1,NP/10
69:            WRITE(2,60) I,(XG(I,J),J=1,10)
70: 60         FORMAT(1X,I3,10F9.2)
71: 50      CONTINUE
72:         RETURN
73:         END
```

File Size = 2793 Bytes

```
1:
2: C     CMU-CE ROUTINE NAME     - ARMAWHT
3: C
4: C-----------------------------------------------------------------
5: C
6: C     LATEST REVISION         - JUNE 22, 1991
7: C
8: C     PURPOSE                 - GENERATED STREAMFLOWS BY USING ARMA(1,1)
9: C                               MODEL WITH WILSON-HILFERTY TRANFORMATION
10: C                              PROCEDURE FOR PRESERVE SKEWNESS
11: C
12: C    ARGUMENTS       DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
13: C                              ASSIGNED AN INTEGER VALUE IN THE
14: C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
15: C                              DSEED IS REPLACED BY A NEW VALUE TO
16: C                              BE USED IN A SUBSEQUENT CALL.
17: C                    X      - INPUT HISTORICAL ANNUAL FLOWS
18: C                    N      - INPUT THE NUMBER OF HISTORICAL ANNUAL
19: C                              FLOWS.
20: C                    NP     - INPUT THE NUMBER OF GENERATION ANNUAL
21: C                              FLOWS
22: C                    XP     - OUTPUT GENERATION ANNUAL FLOWS.
23: C
24: C    REQD. CMU-CE ROUTINES   - AUTOC,GGMSS,KIRBY
25: C          IMSL   ROUTINES   - GGNPM
26: C
27: C    NOTE                    - THE VALUES PARAMETER (P1,Z1) MUST BE
28: C                              UNDER STATIONARITY AND INVERTIBILITY
29: C                              CONDITION. THIS PROGRAM IS NOT CHECK
30: C                              FOR THIS CONDITION.
31: C
32: C-----------------------------------------------------------------
33: C
34:      SUBROUTINE ARMAWHT(DSEED,X,N,NP,XP)
35: C                              SPECIFICATIONS FOR ARGUMENTS
36:      INTEGER                 N,NP
37:      REAL                    X(0:N),XP(0:NP)
38:      DOUBLE PRECISION        DSEED
39: C                              SPECIFICATION FOR LOCAL VARIABLES
40:      INTEGER                 I,J,K
41:      REAL                    A,XM,XSD,XSK,SKR,P1,QQ1,Q1,Q2,Z1
42:     $                       ,STDR,RR(20),RT(0:1000),R(1000)
43:     $                       ,XG(100,10)
44: C
45:      DATA                    K/0/,RT(0)/0.0/
46: C                              FIRST EXECUTABLE STATEMENT
47:      CALL AUTOC(X,N,RR)
48:      CALL GGMSS(X,N,XM,XSD,XSK)
49:      P1 = RR(2)/RR(1)
50:      A  = (P1**2-2.*RR(1)*P1+1.)/(RR(1)-P1)
```

```
      QQ1   = A**2-4.
      IF (QQ1 .GT. 0.0) THEN
          Q1 = (-A+SQRT(QQ1))/2.
          Q2 = (-A-SQRT(QQ1))/2.
          IF ((Q1 .LT. 1.0) .AND. (Q1 .GT. -1.0)) THEN
              Z1 = Q1
          ELSEIF ((Q2 .LT. 1.0) .AND. (Q2 .GT. -1.0)) THEN
              Z1 = Q2
          ENDIF
      ELSE
          WRITE(*,10)
10        FORMAT(5X,'I am sorry ! No solution')
      ENDIF
      STDR  = SQRT((1.-P1**2)/(1.+Z1**2-2.*P1*Z1))
      SKR   = XSK*(((1.+Z1**2-2.*P1*Z1)/(1.-P1**2))**1.5)
     $      /((1.-Z1**3+3.*P1*Z1**2-3.*P1**2*Z1)/(1.-P1**3))
      CALL GGNPM(DSEED,NP,R)
      IF (ABS(SKR) .LE. 3.0) THEN
        DO 20 I = 1,NP
          RT(I) = 2./SKR*((1.+SKR*R(I)/6.-SKR**2/36.)**3-1.)
20      CONTINUE
      ELSE
        CALL KIRBY(NP,SKR,R,RT)
      ENDIF
      XP(0) = XM
      DO 30 I = 1,NP/10
      DO 30 J = 1,10
         K = K+1
         XG(I,J) = XM+P1*(XP(K-1)-XM)+(RT(K)-Z1*RT(K-1))*STDR*XSD
         XP(K) = XG(I,J)
         IF (XP(K) .LT. 0.0) THEN
             XP(K) = 0.0
         ENDIF
30    CONTINUE
      DO 50 I = 1,NP/10
         WRITE(2,40) I,(XG(I,J),J=1,10)
40       FORMAT(1X,I3,10F9.2)
50    CONTINUE
      RETURN
      END
```

File Size = 3418 Bytes

```
1:
2: C     CMU-CE ROUTINE NAME     - ARMALT
3: C
4: C-------------------------------------------------------------------
5: C
6: C     LATEST REVISION         - JUNE 23, 1991
7: C
8: C     PURPOSE                 - GENERATED STREAMFLOWS BY USING ARMA(1,1)
9: C                               MODEL WITH 2- AND 3-PARAMETER LOG NORMAL
10: C                              TRANFORMATION FOR PRESERVE SKEWNESS.
11: C
12: C     ARGUMENTS      STYPE    - INPUT TYPE OF MODIFICATION PRESERVE
13: C                               SKEWNESS, STYPE = '1' IS TWO-PARAMETER
14: C                              LOG NORMAL AND STYPE = '2' IS THREE-
15: C                              PARAMETER LOG NORMAL.
16: C                     DSEED    - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
17: C                              ASSIGNED AN INTEGER VALUE IN THE
18: C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
19: C                              DSEED IS REPLACED BY A NEW VALUE TO
20: C                              BE USED IN A SUBSEQUENT CALL.
21: C                     X        - INPUT HISTORICAL ANNUAL FLOWS
22: C                     N        - INPUT THE NUMBER OF HISTORICAL ANNUAL
23: C                              FLOWS.
24: C                     NP       - INPUT THE NUMBER OF GENERATION ANNUAL
25: C                              FLOWS
26: C                     XP       - OUTPUT GENERATION ANNUAL FLOWS.
27: C
28: C     REQD. CMU-CE ROUTINES   - AUTOC,GGMSS
29: C           IMSL   ROUTINES   - GGNPM
30: C
31: C     NOTE                    - THE VALUES PARAMETER (P1,Z1) MUST BE
32: C                               UNDER STATIONARITY AND INVERTIBILITY
33: C                              CONDITION. THIS PROGRAM IS NOT CHECK
34: C                              FOR THIS CONDITION.
35: C
36: C-------------------------------------------------------------------
37: C
38:       SUBROUTINE ARMALT(STYPE,DSEED,X,N,NP,XP)
39: C                              SPECIFICATIONS FOR ARGUMENTS
40:       INTEGER                 N,NP
41:       REAL                    X(0:N),XP(0:NP)
42:       DOUBLE PRECISION        DSEED
43:       CHARACTER*10            STYPE
44: C                              SPECIFICATION FOR LOCAL VARIABLES
45:       INTEGER                 I,J,K
46:       REAL                    A,A1,XM,YM,XSD,XSK,STDR,Ry,QQ1,Q1,Q2,Py
47:      $                       ,Zy,XVAR,YVAR,RR(20),EE(0:1000),R(0:1000)
48:      $                       ,XG(100,10)
49: C
50:       DATA                    K/0/,R(0)/0.0/,EE(0)/0.0/
```

```
C                                   FIRST EXECUTABLE STATEMENT
      CALL AUTOC(X,N,RR)
      CALL GGMSS(X,N,XM,XSD,XSK)
      CALL GGNPM(DSEED,NP,R)
      XVAR = XSD**2
      IF (STYPE .EQ. '1') THEN
          YVAR = ALOG(1.0+XVAR/XM**2)
          YM = ALOG(XM)-YVAR/2.0
          Ry   = (1.0/YVAR)*ALOG(RR(1)*(EXP(YVAR)-1.0)+1.0)
          Py   = (ALOG(1.+RR(2)*(EXP(YVAR)-1)))/(ALOG(1.+RR(1)
     $              *(EXP(YVAR)-1)))
          A1    = (Py**2-2.*Ry*Py+1.)/(Ry-Py)
          QQ1   = A1**2-4.
          IF (QQ1 .GT. 0.0) THEN
              Q1 = (-A1+SQRT(QQ1))/2.
              Q2 = (-A1-SQRT(QQ1))/2.
              IF ((Q1 .LT. 1.0) .AND. (Q1 .GT. -1.0)) THEN
                 Zy = Q1
              ELSEIF ((Q2 .LT. 1.0) .AND. (Q2 .GT. -1.0)) THEN
                 Zy = Q2
              ENDIF
          ELSE
              WRITE(*,70)
              FORMAT(5X,'I am sorry ! No solution')
          ENDIF
      STDR  = SQRT((1.-Py**2)/(1.+Zy**2-2.*Py*Zy))
      DO 80 I = 1,NP/10
      DO 80 J = 1,10
         K = K+1
         EE(K)    = Py*EE(K-1)+(R(K)-Zy*R(K-1))*STDR
         XG(I,J) = EXP(EE(K)*SQRT(YVAR)+YM)
         XP(K)    = XG(I,J)
   80 CONTINUE
      ELSEIF (STYPE .EQ. '2') THEN
         PHEE = ((1.+0.5*XSK**2)+SQRT(XSK**2+0.25*XSK**4))**(1./3.)
     $     +((1.+0.5*XSK**2)-SQRT(XSK**2+0.25*XSK**4))**(1./3.)-1.0
         YVAR = ALOG(PHEE)
         YM = 0.5*ALOG(XVAR/(PHEE**2-PHEE))
         A  = XM-SQRT(XVAR/(PHEE-1.0))
         Ry = (ALOG(RR(1)*(PHEE-1.)+1.0))/ALOG(PHEE)
         Py = (ALOG(1.+RR(2)*(EXP(YVAR)-1)))/(ALOG(1.+RR(1)
     $        *(EXP(YVAR)-1)))
         A1    = (Py**2-2.*Ry*Py+1.)/(Ry-Py)
         QQ1   = A1**2-4.
         IF (QQ1 .GT. 0.0) THEN
             Q1 = (-A1+SQRT(QQ1))/2.
             Q2 = (-A1-SQRT(QQ1))/2.
             IF ((Q1 .LT. 1.0) .AND. (Q1 .GT. -1.0)) THEN
                Zy = Q1
             ELSEIF ((Q2 .LT. 1.0) .AND. (Q2 .GT. -1.0)) THEN
```

```
101:                    Zy = Q2
102:                ENDIF
103:            ELSE
104:                WRITE(*,90)
105: 90            FORMAT(5X,'I am sorry ! No solution')
106:            ENDIF
107:            STDR  = SQRT((1.-Py**2)/(1.+Zy**2-2.*Py*Zy))
108:            DO 100 I = 1,NP/10
109:            DO 100 J = 1,10
110:              K = K+1
111:              EE(K) = Py*EE(K-1)+(R(K)-Zy*R(K-1))*STDR
112:              XG(I,J) = A+EXP(EE(K)*SQRT(YVAR)+YM)
113:                XP(K) = XG(I,J)
114: 100        CONTINUE
115:          ENDIF
116:          DO 110 I = 1,NP/10
117:            WRITE(2,120) I,(XG(I,J),J=1,10)
118: 120        FORMAT(1X,I3,10F9.2)
119: 110    CONTINUE
120:          RETURN
121:          END
```

File Size = 4882 Bytes

```
C     CMU-CE ROUTINE NAME    - ARMABP
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 23, 1991
C
C     PURPOSE                - GENERATED STREAMFLOWS BY USING ARMA(1,1)
C                              MODEL WITH BEARD'S PROCEDURE FOR
C                              PRESERVE SKEWNESS
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                     X        - INPUT HISTORICAL ANNUAL FLOWS
C                     N        - INPUT THE NUMBER OF HISTORICAL ANNUAL
C                              FLOWS.
C                     NP       - INPUT THE NUMBER OF GENERATION ANNUAL
C                              FLOWS
C                     XP       - OUTPUT GENERATION ANNUAL FLOWS.
C
C     REQD. CMU-CE ROUTINES  - AUTOC,GGMSS
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - THE VALUES PARAMETER (P1,Z1) MUST BE
C                              UNDER STATIONARITY AND INVERTIBILITY
C                              CONDITION. THIS PROGRAM IS NOT CHECK
C                              FOR THIS CONDITION.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE ARMABP(DSEED,X,N,NP,XP)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    X(0:N),XP(0:NP)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,K
      REAL                    A,XML,XSDL,XSKL,STDR,P1,QQ1,Q1,Q2,Z1
     $                        ,RR(20),EE(0:1000),R(0:1000),T(100)
     $                        ,XG(100,10),XL(0:100),HK(0:100),RT(1000)
C
      DATA                     K/0/,R(0)/0.0/,EE(0)/0.0/
C                              FIRST EXECUTABLE STATEMENT
      DO 10 I = 1,N
         XL(I) = ALOG(X(I)+0.01)
10    CONTINUE
      CALL GGMSS(XL,N,XML,XSDL,XSKL)
```

```
      DO 20 I = 1,N
         T(I) = (XL(I)-XML)/XSDL
         HK(I) = 6.0/XSKL*((XSKL/2.*T(I)+1.0)**(1./3.)-1.0)
     $           +XSKL/6.0
20    CONTINUE
      CALL AUTOC(HK,N,RR)
      P1 = RR(2)/RR(1)
      A    = (P1**2-2.0*RR(1)*P1+1.0)/(RR(1)-P1)
      QQ1  = A**2-4.0
      IF (QQ1 .GT. 0.0) THEN
         Q1 = (-A+SQRT(QQ1))/2.
         Q2 = (-A-SQRT(QQ1))/2.
         IF ((Q1 .LT. 1.0) .AND. (Q1 .GT. -1.0)) THEN
              Z1 = Q1
         ELSEIF ((Q2 .LT. 1.0) .AND. (Q2 .GT. -1.0)) THEN
              Z1 = Q2
         ENDIF
      ELSE
         WRITE(*,30)
30       FORMAT(5X,'I am sorry ! No solution')
      ENDIF
      STDR  = SQRT((1.-P1**2)/(1.+Z1**2-2.*P1*Z1))
      CALL GGNPM(DSEED,NP,R)
      DO 40 I = 1,NP/10
      DO 40 J = 1,10
         K = K+1
         EE(K) = P1*EE(K-1)+(R(K)-Z1*R(K-1))*STDR
         RT(K) = ((XSKL/6.0*(EE(K)-XSKL/6.0)+1.)**3-1.0)*2.0/XSKL
         XG(I,J)  = EXP(XML+RT(K)*XSDL)-0.01
         XP(K) = XG(I,J)
         IF (XP(K) .LT. 0.0) THEN
            XP(K) = 0.0
         ENDIF
40    CONTINUE
      DO 50 I = 1,NP/10
         WRITE(2,60) I,(XG(I,J),J=1,10)
60       FORMAT(1X,I3,10F9.2)
50    CONTINUE
      RETURN
      END
```

File name : FFGN.FOR / page : 1

```
C     CMU-CE ROUTINE NAME    - FFGN
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 24, 1991
C
C     PURPOSE                - GENERATED STREAMFLOWS BY USING FAST
C                              FRACTION GAUSSIAN NOISE MODEL WITH
C                              SOME MODIFIED FOR PRESERVE SKEWNESS.
C
C     ARGUMENTS      STYPE   - INPUT TYPE OF MODIFICATION PRESERVE
C                              SKEWNESS, STYPE = '1' IS MODIFIED
C                              HIGH FREQUENCY TERM, STYPE = '2' IS
C                              MODIFIED LOW FREQUENCY TERM AND
C                              STYPE = '3' IS MODIFIED BOTH TERM.
C                    DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                    X       - INPUT HISTORICAL ANNUAL FLOWS
C                    N       - INPUT THE NUMBER OF HISTORICAL ANNUAL
C                              FLOWS.
C                    NP      - INPUT THE NUMBER OF GENERATION ANNUAL
C                              FLOWS
C                    XP      - OUTPUT GENERATION ANNUAL FLOWS.
C
C     REQD. CMU-CE ROUTINES  - AUTOC,GGMSS,GAMMA,HURST
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - THE VALUES L AND B CAN ADJUSTED FOR
C                              SUITABLE MODEL.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE FFGN(STYPE,DSEED,X,N,NP,XP)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    X(0:N),XP(0:NP)
      DOUBLE PRECISION        DSEED
      CHARACTER*10            STYPE
C                               SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,K,L,M,N
      REAL                    B,H,HUR,XM,XSD,XSK,STDH,FR(20),WM2(20)
     $                       ,GM,Ph,SKH,SKL,SKHL,SUM1,SUM2,SUM3,SUML
     $                       ,GL(0:1000,10),RR(20),R(0:1000),RT(1000)
     $                       ,GH(1000),XL(0:1000,10),XH(0:1000)
     $                       ,XG(100,10)
C
```

```
      DATA                    K/0/,L/8/,B/3.0/,SUM1/0.0/,SUM2/0.0/
     $                       ,SUM3/0.0/,XH(0)/0.0/
C                              FIRST EXECUTABLE STATEMENT
      CALL GGMSS(X,N,XM,XSD,XSK)
      CALL HURST(X,N,XM,XSD,HUR)
      CALL AUTOC(X,N,RR)
      H = 3.0-2.0*HUR
      CALL GAMMA(H,GM)
      DO 10 N = 1,L
         WM2(N) = HUR*(2.0*HUR-1.0)*(B**(1.0-HUR)-B**(HUR-1.))
     $             /GM*B**(2.*(HUR-1.)*N)
         FR(N)  = EXP(-B**(-N))
         SUM1   = SUM1+WM2(N)
         SUM2   = SUM2+WM2(N)*FR(N)
         SUM3   = SUM3+WM2(N)**1.5*(1.-FR(N)**2)**1.5/(1.-FR(N)**3)
10    CONTINUE
      STDH  = SQRT(1.0-SUM1)
      Ph    = (RR(1)-SUM2)/(1.0-SUM1)
      SKH   = (1.0-Ph**3)*XSK/(STDH**3*(1.0-Ph**2)**1.5)
      SKL   = XSK/SUM3
      SKHL  = XSK/(SUM3+1.0/SKH)
      DO 20 M = 0,NP
         CALL GGNPM(DSEED,L,R)
         IF (STYPE .EQ. '2') THEN
            IF (ABS(SKL) .GE. 3.0) THEN
               CALL KIRBY(L,SKL,R,RT)
            ENDIF
         ELSEIF (STYPE .EQ. '3') THEN
            IF (ABS(SKHL) .GE. 3.0) THEN
               CALL KIRBY(L,SKHL,R,RT)
            ENDIF
         ENDIF
         DO 30 N = 1,L
         IF (STYPE .EQ. '1') THEN
                GL(M,N) = R(N)
         ELSEIF (STYPE .EQ. '2') THEN
            IF (ABS(SKL) .LT. 3.0) THEN
               GL(M,N)= ((1.0+R(N)*SKL/6.-SKL**2/36)**3
     $                   -1.0)*2.0/SKL
            ELSE
               GL(M,N) = RT(N)
            ENDIF
         ELSEIF (STYPE .EQ. '3') THEN
            IF (ABS(SKHL) .LT. 3.0) THEN
               GL(M,N)= ((1.0+R(N)*SKHL/6.-SKHL**2/36)**3
     $                   -1.0)*2.0/SKHL
            ELSE
               GL(M,N) = RT(N)
            ENDIF
         ENDIF
```

```
101: 30     CONTINUE
102: 20    CONTINUE
103:       CALL GGNPM(DSEED,NP,R)
104:              IF (STYPE .EQ. '1') THEN
105:                 IF (ABS(SKH) .LT. 3.0) THEN
106:                   DO 25 M = 1,NP
107:                 GH(M)= ((1.0+R(M)*SKH/6.-SKH**2/36)**3-1.0)
108:      $                    *2.0/SKH
109: 25              CONTINUE
110:                ELSE
111:                   CALL KIRBY(NP,SKH,R,GH)
112:                 ENDIF
113:              ELSEIF (STYPE .EQ. '2') THEN
114:                   DO 45 M = 1,NP
115:                     GH(M) = R(M)
116: 45              CONTINUE
117:              ELSEIF (STYPE .EQ. '3') THEN
118:                 IF (ABS(SKHL) .LT. 3.0) THEN
119:                   DO 35 M = 1,NP
120:                 GH(M)= ((1.0+R(M)*SKHL/6.-SKHL**2/36)**3+1.0)
121:      $                    *2.0/SKHL
122: 35              CONTINUE
123:                ELSE
124:                   CALL KIRBY(NP,SKHL,R,GH)
125:                 ENDIF
126:              ENDIF
127:       DO 40 M = 1,NP/10
128:       DO 40 J = 1,10
129:          K = K+1
130:          SUML = 0.0
131:          DO 50 N = 1,L
132:             XL(0,N) = GL(0,N)
133:             XL(K,N) = FR(N)*XL(K-1,N)+SQRT(1.0-FR(N)**2)*GL(K,N)
134:             SUML = SUML+SQRT(WM2(N))*XL(K,N)
135: 50       CONTINUE
136:          XH(K) = Ph*XH(K-1)+SQRT(1.0-Ph**2)*GH(K)
137:          XG(M,J)  = XM+(SUML+STDH*XH(K))*XSD
138:          XP(K) = XG(M,J)
139: 40    CONTINUE
140:       DO 60 I = 1,NP/10
141:          WRITE(2,70) I,(XG(I,J),J=1,10)
142: 70       FORMAT(1X,I3,10F9.2)
143: 60    CONTINUE
144:       RETURN
145:       END
```

```
C     CMU-CE ROUTINE NAME     - BLMD
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION         - JUNE 28, 1991
C
C     PURPOSE                 - GENERATED STREAMFLOWS BY USING
C                               BLOKEN LINE MODEL WITH SOME MODIFIED
C                               FOR PRESERVE SKEWNESS.
C
C     ARGUMENTS      STYPE    - INPUT TYPE OF MODIFICATION PRESERVE
C                               SKEWNESS, STYPE = '1' IS MODIFIED
C                               HIGH FREQUENCY TERM, STYPE = '2' IS
C                               MODIFIED BOTH TERM.
C                    DSEED    - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                               ASSIGNED AN INTEGER VALUE IN THE
C                               EXCLUSIVE RANG (1.D0,2147483647.D0).
C                               DSEED IS REPLACED BY A NEW VALUE TO
C                               BE USED IN A SUBSEQUENT CALL.
C                    X        - INPUT HISTORICAL ANNUAL FLOWS
C                    N        - INPUT THE NUMBER OF HISTORICAL ANNUAL
C                               FLOWS.
C                    NP       - INPUT THE NUMBER OF GENERATION ANNUAL
C                               FLOWS
C                    XP       - OUTPUT GENERATION ANNUAL FLOWS.
C
C     REQD. CMU-CE ROUTINES   - AUTOC,GGMSS,HURST
C           IMSL   ROUTINES   - GGNPM,GGUBS
C
C     NOTE                    - THE VALUES A(1),B AND L CAN ADJUSTED
C                               FOR SUITABLE MODEL.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE BLMD(STYPE,DSEED,X,N,NP,XP)
C                               SPECIFICATIONS FOR ARGUMENTS
      INTEGER                  N,NP
      REAL                     X(0:N),XP(0:NP)
      DOUBLE PRECISION         DSEED
      CHARACTER*10             STYPE
C                               SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                  I,J,K,KK,L,M,N,NR
      REAL                     B,BL,HUR,XM,XSD,XSK,STDH,A(20),VM2(20)
     $                        ,RL,Rh,SKH,SKHL,SUM1,SUM2,SUM3,U(20)
     $                        ,GL(10,1001),RR(20),R(0:1001),RT(0:1001)
     $                        ,G(0:1001),BR(10,0:1001),XH(0:1000),SUML
     $                        ,XG(100,10)
C
      DATA                     KK/0/,L/8/,B/3.0/,SUM1/0.0/,SUM2/0.0/
```

```
     $                          ,SUM3/0.0/,A(1)/2.0/
C                                 FIRST EXECUTABLE STATEMENT
      CALL GGMSS(X,N,XM,XSD,XSK)
      CALL HURST(X,N,XM,XSD,HUR)
      CALL AUTOC(X,N,RR)
      BL    = (HUR*(2.0*HUR-1)*(2.0*HUR-2.0)*(2.0*HUR-3.0)*(2.*HUR-4.)
     $      *(2.*HUR-5.))/(6.*(2.**(3.-2.*HUR)-1.0))
      DO 10 M = 1,L
         A(M)    = A(1)*B**(M-1)
         VM2(M) = A(1)**(2.*HUR-2.)*BL*(B**(HUR-1.)-B**(1.-HUR))
     $           *B**(2.*(HUR-1.)*(M-1))/(2.*(HUR-1.))
         SUM1    = SUM1+VM2(M)
         SUM2    = SUM2+(1.-3./(4.*A(1)**2*B**(2.*(M-1)))*(2.-1./(A(1)
     $           *B**(M-1))))*B**(2.*(HUR-1.)*(M-1))
         SUM3    = SUM3+VM2(M)**1.5
10    CONTINUE
      STDH = SQRT(1.0-SUM1)
      RL    = A(1)**(2*HUR-2)*BL*(B**(HUR-1.)-B**(1.-HUR))*SUM2
     $        /(2.*(HUR-1.))
      Rh    = (RR(1)-RL)/(1.0-SUM1)
      SKH   = (1.0-Rh**3)*XSK/(STDH**3*(1.0-Rh**2)**1.5)
      SKHL = XSK/(0.5*1.5**1.5*SUM3+XSK/SKH)
      NR = NP+1
C                                      GENERATED RANDOM NUMBER
      DO 20 M = 1,L
         CALL GGNPM(DSEED,NR,R)
         IF (STYPE .EQ. '2') THEN
            IF (ABS(SKHL) .GE. 3.0) THEN
               CALL KIRBY(NR,SKHL,R,RT)
            ENDIF
         ENDIF
      DO 20 N = 0,NR
         IF (STYPE .EQ. '1') THEN
            BR(M,N) = R(N)
         ELSE
            IF (ABS(SKHL) .LT. 3.0) THEN
               BR(M,N)= ((1.0+R(N)*SKHL/6.-SKHL**2/36.)**3
     $                -1.0)*2.0/SKHL
            ELSE
               BR(M,N) = RT(N)
            ENDIF
         ENDIF
20    CONTINUE
      CALL GGNPM(DSEED,NR,R)
       IF (STYPE .EQ. '1') THEN
           IF (ABS(SKH) .LT. 3.0) THEN
              DO 30 N = 0,NR
                 G(N)= ((1.0+R(N)*SKH/6.-SKH**2/36)**3-1.0)
     $                    *2.0/SKH
30            CONTINUE
```

```
101:              ELSE
102:                 CALL KIRBY(NR,SKH,R,G)
103:              ENDIF
104:           ELSEIF (STYPE .EQ. '2') THEN
105:              IF (ABS(SKHL) .LT. 3.0) THEN
106:                 DO 35 N = 0,NR
107:                    G(N)= ((1.0+R(N)*SKHL/6.-SKHL**2/36)**3-1.0)
108:        $                 *2.0/SKHL
109:  35             CONTINUE
110:              ELSE
111:                 CALL KIRBY(NR,SKHL,R,G)
112:              ENDIF
113:           ENDIF
114:           CALL GGUBS(DSEED,L,U)
115:  C                                  GENERATED STREAMFLOWS
116:           XH(0) = G(0)
117:           DO 40 N = 1,NP/10
118:           DO 40 J = 1,10
119:              KK = KK+1
120:              SUML = 0.0
121:              DO 50 M =1,L
122:                 TDAS   = KK+U(M)*A(M)
123:                   DO 45 K = 0,NP
124:                 IF ((TDAS .GT. K*A(M)) .AND. (TDAS .LT. (K+1)*A(M))) THEN
125:                    GL(M,KK) = BR(M,K)+(TDAS-K*A(M))/A(M)*
126:        $                       (BR(M,K+1)-BR(M,K))
127:                    GOTO 46
128:                 ENDIF
129:  45               CONTINUE
130:  46             SUML = SUML+SQRT(VM2(M))*GL(M,KK)*SQRT(1.5)
131:  50     CONTINUE
132:              XH(KK)   = Rh*XH(KK-1)+SQRT(1.0-Rh**2)*G(KK)
133:              XG(N,J)  = XM+(SUML+STDH*XH(KK))*XSD
134:              XP(KK)   = XG(N,J)
135:  40     CONTINUE
136:           DO 55 I = 1,NP/10
137:           WRITE(2,65) I,(XG(I,J), J=1,10)
138:  65       FORMAT(1X,I3,10F9.2)
139:  55     CONTINUE
140:           RETURN
141:           END
```

```
C     CMU-CE ROUTINE NAME    - THOMAS
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 28, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              THOMAS-FIERING MODEL AND SOME MODIFIED
C                              FOR PRESERVE SKEWNESS.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                     QD       - INPUT HISTORICAL MONTHLY FLOWS
C                     N        - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                     NP       - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                     QG       - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - GGMSS,KIRBY
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE THOMAS(DSEED,QD,N,NP,QG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,13),QG(NP,12)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,JJ
      REAL                    T1,T2,T3,XM,XSD,XSK,B(12),SKR(12),QBA(12)
     $                        ,QSD(12),QSK(12),XR(12),Y(100),R(1000)
     $                        ,RT(1000),V(1000,12)
C
      DO 10 J=1,12
         DO 20 I=1,N
            Y(I)=QD(I,J)
20       CONTINUE
         CALL GGMSS(Y,N,XM,XSD,XSK)
         QBA(J)=XM
         QSD(J)=XSD
         QSK(J)=XSK
10    CONTINUE
```

```
      DO 40 J=1,12
         T1=0.0
         T2=0.0
         T3=0.0
         JJ=J-1
         IF (JJ .EQ. 0) THEN
            JJ=12
               XM1 = (N*QBA(J)-QD(1,J))/(N-1)
               XM2 = (N*QBA(JJ)-QD(N,JJ))/(N-1)
            DO 45 I=2,N
               T1=T1+(QD(I-1,JJ)-XM2)*(QD(I,J)-XM1)
               T2=T2+(QD(I-1,JJ)-XM2)**2
               T3=T3+(QD(I,J)-XM1)**2
45          CONTINUE
         ELSE
            DO 50 I=1,N
               T1=T1+(QD(I,JJ)-QBA(JJ))*(QD(I,J)-QBA(J))
               T2=T2+(QD(I,JJ)-QBA(JJ))**2
               T3=T3+(QD(I,J)-QBA(J))**2
50          CONTINUE
         ENDIF
            XR(J) =T1/SQRT(T2*T3)
            B(J)  =XR(J)*QSD(J)/QSD(JJ)
            SKR(J)=(QSK(J)-QSK(JJ)*XR(J)**3)/SQRT((1.0-XR(J)**2)**3)
40    CONTINUE
C                                  GENERATED RANDOM NUMBER
      DO 41 I =1,NP
         CALL GGNPM(DSEED,12,R)
      DO 41 J =1,12
         V(I,J) = R(J)
41    CONTINUE
      DO 42 J =1,12
         CS = SKR(J)
         IF (ABS(SKR(J)) .LT. 3.0) THEN
            DO 43 I = 1,NP
               V(I,J) = 2.*((1.+V(I,J)*SKR(J)/6.-SKR(J)**2/36.)**3
     $                -1.)/SKR(J)
43          CONTINUE
         ELSE
            DO 44 I = 1,NP
                  R(I) = V(I,J)
44          CONTINUE
            CALL KIRBY(NP,CS,R,RT)
              DO 46 I = 1,NP
                 V(I,J) = RT(I)
46          CONTINUE
          ENDIF
42    CONTINUE
C                                  GENERATED MONTHLY STREAMFLOWS
      QG(1,1) = V(1,1)*QSD(1)+QBA(1)
```

```
101:        DO 60 J=2,12
102:           QG(1,J)=QBA(J)+B(J)*(QG(1,J-1)-QBA(J-1))+QSD(J)*
103:       $           SQRT(1.0-XR(J)**2)*V(1,J)
104:           IF (QG(I,J) .LT. 0.0) QG(1,J) = 0.0
105: 60     CONTINUE
106:        DO 70 I =2,NP
107:           QG(I,1)=QBA(1)+B(1)*(QG(I-1,12)-QBA(12))+
108:       $           QSD(1)*SQRT(1.0-XR(1)**2)*V(I,1)
109:           IF (QG(I,1) .LT. 0.0) QG(I,1) = 0.0
110:           DO 80 J=2,12
111:              QG(I,J)=QBA(J)+B(J)*(QG(I,J-1)-QBA(J-1))+
112:       $                 QSD(J)*SQRT(1.0-XR(J)**2)*V(I,J)
113:              IF (QG(I,J) .LT. 0.0) QG(I,J) = 0.0
114: 80        CONTINUE
115: 70     CONTINUE
116:        RETURN
117:        END
```

File Size = 4078 Bytes

```
1:
2: C     CMU-CE ROUTINE NAME    - DISAG
3: C
4: C-----------------------------------------------------------------
5: C
6: C     LATEST REVISION        - JULY 03, 1991
7: C
8: C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
9: C                              DISAGGREGATION MODEL AND SOME MODIFIED
10: C                             FOR PRESERVE SKEWNESS.
11: C
12: C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
13: C                             ASSIGNED AN INTEGER VALUE IN THE
14: C                             EXCLUSIVE RANG (1.D0,2147483647.D0).
15: C                             DSEED IS REPLACED BY A NEW VALUE TO
16: C                             BE USED IN A SUBSEQUENT CALL.
17: C                    QD      - INPUT HISTORICAL MONTHLY FLOWS
18: C                    X       - INPUT HISTORICAL ANNUAL FLOWS
19: C                    N       - INPUT THE NUMBER OF HISTORICAL MONTHLY
20: C                              FLOWS.
21: C                    NP      - INPUT THE NUMBER OF GENERATION MONTHLY
22: C                              FLOWS
23: C                    QG      - OUTPUT GENERATION MONTHLY FLOWS.
24: C
25: C     REQD. CMU-CE ROUTINES  - ARWHT,GGMSS,KIRBY
26: C           IMSL   ROUTINES  - GGNPM
27: C
28: C     NOTE                   - NONE
29: C
30: C-----------------------------------------------------------------
31: C
32:       SUBROUTINE DISAG(DSEED,QD,X,N,NP,QG)
33: C                              SPECIFICATIONS FOR ARGUMENTS
34:       INTEGER                N,NP
35:       REAL                   QD(1000,13),QG(NP,13),X(N)
36:       DOUBLE PRECISION       DSEED
37: C                            SPECIFICATION FOR LOCAL VARIABLES
38:       INTEGER                I,IV,IY,J,K
39:       REAL                   XM,XSD,XSK,SUMXX,SXX,SUMB,SUMBB,CS
40:      $                       ,XY(1,12),SUMXY(1,12),SXY(1,12),YX(12,1)
41:      $                       ,X(100),Y(100),SUMYX(12,1),SYX(12,1)
42:      $                       ,YT(1,12),AA(12,1),SY(12,12),SUMYY(12,12)
43:      $                       ,SYY(12,12),XA(12,1),BB(12,12),BT(12,12)
44:      $                       ,BBT(12,12),BX(12,12),SKV(12),QBA(13)
45:      $                       ,QSK(13),VX(12,1),CX(12,1),AP(12,1)
46:      $                       ,XP(1000),V(1000,12),R(1000),QSD(13)
47:      $                       ,RT(1000)
48: C
49: C                                FIRST EXECUTABLE STATEMENT
50:       CALL ARWHT(DSEED,X,N,NP,XP)
```

```
      DO 10 J=1,12
         DO 20 I=1,N
            Y(I)=QD(I,J)
20       CONTINUE
         CALL GGMSS(Y,N,XM,XSD,XSK)
         QBA(J)=XM
         QSD(J)=XSD
         QSK(J)=XSK
10    CONTINUE
         DO 30 I=1,N
            X(I)= QD(I,13)
30       CONTINUE
         CALL GGMSS(X,N,XM,XSD,XSK)
         QBA(13)=XM
         QSD(13)=XSD
         QSK(13)=XSK
C                                  COMPUTE COEFFICIENT A,B
C                                    MATRIX SXX (1 X 1)
      SUMXX = 0.0
      DO 40 IY = 1,N
            SUMXX = SUMXX+X(IY)**2
40    CONTINUE
      SXX = SUMXX/N
C                                      MATRIX SXY (1 X 12)
      DO 50 IY = 1,N
         DO 60 J = 1,12
            XY(1,J) = X(IY)*QD(IY,J)
60       CONTINUE
         DO 70 J = 1,12
            SUMXY(1,J) = SUMXY(1,J)+XY(1,J)
70       CONTINUE
50    CONTINUE
      DO 80 J = 1,12
         SXY(1,J) = SUMXY(1,J)/N
80    CONTINUE
C                                     MATRIX SYX (12 X 1)
      DO 90 IY = 1,N
         DO 100 J = 1,12
            YX(J,1) = X(IY)*QD(IY,J)
100   CONTINUE
      DO 110 J = 1,12
         SUMYX(J,1) = SUMYX(J,1)+YX(J,1)
110   CONTINUE
90    CONTINUE
      DO 120 J = 1,12
         SYX(J,1) = SUMYX(J,1)/N
120   CONTINUE
C                                      MATRIX SYY (12 X 12)
      DO 130 IY = 1,N
         DO 140 J= 1,12
```

```
101:                YT(1,J) = QD(IY,J)
102:                AA(J,1) = QD(IY,J)
103: 140         CONTINUE
104:           DO 150 I=1,12
105:              DO 150 K =1,12
106:                 SY(I,K) = AA(I,1)*YT(1,K)
107: 150      CONTINUE
108:           DO 160 I=1,12
109:              DO 160 J=1,12
110:                 SUMYY(I,J) = SUMYY(I,J)+SY(I,J)
111: 160      CONTINUE
112: 130      CONTINUE
113:           DO 170 I=1,12
114:              DO 170 J=1,12
115:                 SYY(I,J) = SUMYY(I,J)/N
116: 170      CONTINUE
117: C                                      COMPUTED COEF. OF A
118:           DO  180 J =1,12
119:             XA(J,1) = SYX(J,1)/SXX
120: 180      CONTINUE
121: C                                      COMPUTED COEF. OF B
122:           DO 190 I=1,12
123:              DO 190 K =1,12
124:                 BB(I,K) = SYX(I,1)*SXY(1,K)
125: 190      CONTINUE
126:           DO 200 I =1,12
127:              DO 200 J =1,12
128:                 BT(I,J) = BB(I,J)/SXX
129:                 BBT(I,J) = SYY(I,J)-BT(I,J)
130: 200         CONTINUE
131:           DO 210 I = 1,12
132:              DO 220 J =1,12
133:                 IF (J .GT. I) THEN
134:                     BX(I,J) = 0.0
135:                 ELSEIF (I .EQ. J) THEN
136:                    IF ((I .EQ. 1) .AND. (J .EQ. 1)) THEN
137:                       BX(1,1) = SQRT(BBT(1,1))
138:                    ELSE
139:                       SUMB = 0.0
140:                    DO 230 K = 1,J-1
141:                       SUMB = SUMB+BX(J,K)**2
142: 230                CONTINUE
143:                       IF ((BBT(J,J)-SUMB) .LE. 0.0) THEN
144:                          BX(I,J) =0.0
145:                       ELSE
146:                          BX(J,J) = SQRT(BBT(J,J)-SUMB)
147:                       ENDIF
148:                 ENDIF
149:                ELSEIF (J .LT. I) THEN
150:                     SUMBB = 0.0
```

```
151:                    DO 240 K = 1,J-1
152:                       SUMBB = SUMBB+BX(I,K)*BX(J,K)
153: 240                CONTINUE
154:                    BX(I,J) = (BBT(I,J)-SUMBB)/BX(J,J)
155:                ENDIF
156: 220        CONTINUE
157: 210     CONTINUE
158: C                                      COMPUTED SKEWNESS OF RANDOM
159:         DO 250 J = 1,12
160:            SUMBX = 0.0
161:            SKV(0) =0.0
162:            IF (J .NE. 12) THEN
163:               DO 260 K = 1,J-1
164:                  SUMBX = SUMBX+BX(J,K)**3*SKV(K)
165: 260           CONTINUE
166:               SKV(J) = (QSD(J)**3*QSK(J)-(XA(J,1)*QSD(13))**3
167:      $                  *QSK(13)-SUMBX)/(BX(J,J))**3
168:            ELSE
169:               DO 270 K = 1,J-1
170:                  SUMBX = SUMBX+BX(12,K)*SKV(K)
171: 270           CONTINUE
172:               SKV(12) = (QSD(13)*XA(12,1)/QSD(12))**3*QSK(13)
173:      $                   +(1./QSD(12)**3)*SUMBX
174:            ENDIF
175: 250     CONTINUE
176: C                                      GENERATED RANDOM
177:         DO 251 I =1,NP
178:         CALL GGNPM(DSEED,12,R)
179:         DO 251 J =1,12
180:            V(I,J) = R(J)
181: 251     CONTINUE
182:         DO 252 J =1,12
183:            CS = SKV(J)
184:            IF (ABS(SKV(J)) .LT. 3.0) THEN
185:               DO 253 I = 1,NP
186:                  V(I,J) = 2.*((1.+V(I,J)*SKV(J)/6.-SKV(J)**2/36.)**3
187:      $                     -1.)/SKV(J)
188: 253              CONTINUE
189:            ELSE
190:               DO 254 I = 1,NP
191:                  R(I) = V(I,J)
192: 254              CONTINUE
193:               CALL KIRBY(NP,CS,R,RT)
194:               DO 256 I = 1,NP
195:                  V(I,J) = RT(I)
196: 256              CONTINUE
197:            ENDIF
198: 252     CONTINUE
199: C                                      GENERATED STREAMFLOW
200:         DO 280 IV = 1,NP
```

```
201:            DO 290 J = 1,12
202:               VX(J,1) = V(IV,J)
203: 290        CONTINUE
204: 320    CONTINUE
205:            DO 330 I =1,12
206:               CX(I,1) = 0.0
207:            DO 330 J=1,12
208:               CX(I,1) = CX(I,1)+BX(I,J)*VX(J,1)
209: 330        CONTINUE
210:            DO 340 J=1,12
211:              AP(J,1)= XP(IV)*XA(J,1)
212: 340        CONTINUE
213:            DO 350 J=1,12
214:               QG(IV,J) = AP(J,1)+CX(J,1)
215: 350        CONTINUE
216: 280    CONTINUE
217:        RETURN
218:        END
```

File Size = 7282 Bytes

```
1:
2: C     CMU-CE ROUTINE NAME    - TWOT
3: C
4: C-----------------------------------------------------------------------
5: C
6: C     LATEST REVISION        - JULY 03, 1991
7: C
8: C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
9: C                              TWO-TIER MODEL.
10: C
11: C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
12: C                              ASSIGNED AN INTEGER VALUE IN THE
13: C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
14: C                              DSEED IS REPLACED BY A NEW VALUE TO
15: C                              BE USED IN A SUBSEQUENT CALL.
16: C                     QD       - INPUT HISTORICAL MONTHLY FLOWS
17: C                     X        - INPUT HISTORICAL ANNUAL FLOWS
18: C                     N        - INPUT THE NUMBER OF HISTORICAL MONTHLY
19: C                              FLOWS.
20: C                     NP       - INPUT THE NUMBER OF GENERATION MONTHLY
21: C                              FLOWS
22: C                     XG       - OUTPUT GENERATION MONTHLY FLOWS.
23: C
24: C     REQD. CMU-CE ROUTINES  - ARWHT,THOMAS
25: C
26: C     NOTE                   - NONE
27: C
28: C-----------------------------------------------------------------------
29: C
30:       SUBROUTINE TWOT(DSEED,QD,X,N,NP,XG)
31: C                              SPECIFICATIONS FOR ARGUMENTS
32:       INTEGER                N,NP
33:       REAL                   QD(1000,13),XG(NP,13),X(N)
34:       DOUBLE PRECISION       DSEED
35: C                              SPECIFICATION FOR LOCAL VARIABLES
36:       INTEGER                I,J
37:       REAL                   SUM1,XP(1000),QG(1000,13)
38: C
39: C                               FIRST EXECUTABLE STATEMENT
40:       CALL ARWHT(DSEED,X,N,NP,XP)
41:       CALL THOMAS(DSEED,QD,N,NP,QG)
42:       DO 10 I=1,NP
43:          SUM1 = 0.0
44:          DO 20 J=1,12
45:             SUM1 = SUM1+QG(I,J)
46: 20       CONTINUE
47:          DO 30 J=1,12
48:             XG(I,J)= XP(I)*QG(I,J)/SUM1
49: 30       CONTINUE
50: 10    CONTINUE
```

```
      RETURN
      END
```

File Size = 1954 Bytes

```
C     CMU-CE ROUTINE NAME    - TWOTM
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JULY 03, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              MODIFIED TWO-TIER MODEL.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                     QD       - INPUT HISTORICAL MONTHLY FLOWS
C                     X        - INPUT HISTORICAL ANNUAL FLOWS
C                     N        - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                     NP       - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                     XG       - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - ARWHT,THOMAS
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE TWOTM(DSEED,QD,X,N,NP,XG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,13),XG(NP,13),X(N)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,K,L,M
      REAL                    SAVE,SUM1,Y1(1000),Y2(1000),QG(1000,13)
C
C                               FIRST EXECUTABLE STATEMENT
      CALL ARWHT(DSEED,X,N,NP,XP)
      CALL THOMAS(DSEED,QD,N,NP,QG)
      DO 10 I=1,NP
         Y1(I) = 0.0
         DO 20 J=1,12
            Y1(I) = Y1(I)+QG(I,J)
20       CONTINUE
10    CONTINUE
      DO 30 I = 1,NP
         Y2(I) = Y1(I)
30    CONTINUE
```

```
      DO 40 I = 1,NP-1
      L = NP-I
      DO 40 M = 1,L
         IF (XP(M) .GT. XP(M+1)) THEN
            SAVE    = XP(M)
              XP(M)   = XP(M+1)
              XP(M+1) = SAVE
         ENDIF
         IF (Y2(M) .GT. Y2(M+1)) THEN
            SAVE    = Y2(M)
              Y2(M)   = Y2(M+1)
              Y2(M+1) = SAVE
         ENDIF
40    CONTINUE
      DO 50 K = 1,NP
      DO 50 I = 1,NP
         IF (Y2(K) .EQ. Y1(I)) THEN
            DO 60 J= 1,12
               QG(K,J) = QG(I,J)
60          CONTINUE
         ENDIF
50    CONTINUE
      DO 70 I = 1,NP
      DO 70 J=1,12
            QG(I,J)= XP(I)*QG(I,J)/Y2(I)
70    CONTINUE
      RETURN
      END
```

File Size = 2533 Bytes

```
C     CMU-CE ROUTINE NAME    - FRAG
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JULY 03, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              FRAGMENT METHOD MODEL.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                     QD       - INPUT HISTORICAL MONTHLY FLOWS
C                     Y        - INPUT HISTORICAL ANNUAL FLOWS
C                     N        - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                     NP       - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                     QG       - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - ARWHT
C           IMSL   ROUTINES  - GGUBS
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE FRAG(DSEED,QD,Y,N,NP,QG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,13),QG(NP,13),Y(N)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,K
      REAL                    X(0:100),XP(1000),XF(100,13),R(1000)
C
C                              FIRST EXECUTABLE STATEMENT
      CALL ARWHT(DSEED,Y,N,NP,XP)
      DO 10 I = 1,N
      DO 10 J = 1,12
         XF(I,J) = QD(I,J)/Y(I)
10    CONTINUE
      CALL GGUBS(DSEED,NP,R)
      DO 20 I = 1,NP
      K = INT(R(I)*N)
      IF (K .EQ. 0) K = N
      DO 20 J = 1,12
```

```
51:           QG(I,J) = XP(I)*XF(K,J)
52: 20     CONTINUE
53:        RETURN
54:        END
```

File Size = 1991 Bytes

```
C     CMU-CE ROUTINE NAME    - FRAGM
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JULY 03, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              MODIFIED FRAGMENT METHOD MODEL.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                     QD       - INPUT HISTORICAL MONTHLY FLOWS
C                     Y        - INPUT HISTORICAL ANNUAL FLOWS
C                     N        - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                     NP       - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                     QG       - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - ARWHT
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE FRAGM(DSEED,QD,Y,N,NP,QG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,13),QG(NP,13),Y(N)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,M,L,K,KR
      REAL                    X(0:100),XP(1000),XF(100,13)
C
      DATA                    X(0)/0.0/
C                              SPECIFICATIONS FOR ARGUMENTS
      CALL ARWHT(DSEED,Y,N,NP,XP)
      DO 10  I = 1,N
         X(I) = Y(I)
10    CONTINUE
      DO 20 I = 1,N
      DO 20 J = 1,12
         XF(I,J) = QD(I,J)/Y(I)
20    CONTINUE
      DO 30 I = 1,N-1
      L = N-I
```

```
      DO 30 M = 1,L
         IF (X(M) .GT.X(M+1)) THEN
            SAVE = X(M)
            X(M) = X(M+1)
            X(M+1) = SAVE
         ENDIF
30    CONTINUE
      DO 40 K = 1,N
      DO 40 I = 1,N
         IF (X(K) .EQ. Y(I)) THEN
            DO 50 J = 1,12
                 XF(K,J) = XF(I,J)
50          CONTINUE
         ENDIF
40    CONTINUE
      DO 60 I = 1,N-1
      X(I) = (X(I)+X(I+1))/2
60    CONTINUE
      DO 70 I = 1,NP
         DO 80 M = 1,N
            IF ((XP(I) .LT. X(M)) .AND. (XP(I) .GT. X(M-1))) THEN
               KR = M
            ELSEIF (XP(I) .GT. X(N)) THEN
               KR = N
            ENDIF
80       CONTINUE
      DO 70 J = 1,12
      QG(I,J) = XP(I)*XF(KR,J)
70    CONTINUE
      RETURN
      END
```

File name : FSCM.FOR / page : 1

```
C     CMU-CE ROUTINE NAME    - FSCM
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 30, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              FIRST SPOLIA-CHANDER MODEL AND SOME
C                              MODIFIED FOR PRESERVE SKEWNESS.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                     QD       - INPUT HISTORICAL MONTHLY FLOWS
C                     N        - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                     NP       - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                     QG       - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - GGMSS,KIRBY,AUTOC
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE FSCM(DSEED,QD,N,NP,QG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,12),QG(NP,12)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,JJ
      REAL                    XM,XSD,XSK,SKR(12),QBA(12),RT(1000),RR(20)
     $                       ,QSD(12),QSK(12),Y(100),R(1000),QT(100,12)
     $                       ,UT(1200),V(1000,12),QE(1000,12)
      DATA                    K/0/
C                              FIRST EXECUTABLE STATEMENT
      DO 10 J=1,12
         DO 20 I=1,N
            Y(I)=QD(I,J)
20       CONTINUE
         CALL GGMSS(Y,N,XM,XSD,XSK)
         QBA(J)=XM
         QSD(J)=XSD
         QSK(J)=XSK
```

```
 10    CONTINUE
       DO 40 I=1,N
       DO 40 J=1,12
          QT(I,J) = (QD(I,J)-QBA(J))/QSD(J)
 40    CONTINUE
       DO 50 I =1,N
       DO 50 J =1,12
          K = 12*(I-1)+J
          UT(K) = QT(I,J)
 50    CONTINUE
       CALL AUTOC(UT,K,RR)
       DO 60 J = 1,12
          JJ = J-1
          IF (JJ .EQ. 0) JJ = 12
          SKR(J)=(QSK(J)-QSK(JJ)*RR(1)**3)/((1.0-RR(1)**2)**1.5)
 60    CONTINUE
 C                              GENERATED RANDOM NUMBER
       DO 41 I =1,NP
          CALL GGNPM(DSEED,12,R)
       DO 41 J =1,12
          V(I,J) = R(J)
 41    CONTINUE
       DO 42 J =1,12
          CS = SKR(J)
          IF (ABS(SKR(J)) .LT. 3.0) THEN
             DO 43 I = 1,NP
                V(I,J) = 2.*((1.+V(I,J)*SKR(J)/6.-SKR(J)**2/36.)**3
      $                -1.)/SKR(J)
 43          CONTINUE
          ELSE
             DO 44 I = 1,NP
                R(I) = V(I,J)
 44          CONTINUE
             CALL KIRBY(NP,CS,R,RT)
               DO 46 I = 1,NP
                  V(I,J) = RT(I)
 46          CONTINUE
          ENDIF
 42    CONTINUE
 C                                    GENERATED STREAMFLOWS
       QE(1,1)= V(1,1)
       DO 70 J=2,12
          QE(1,J)=RR(1)*QE(1,J-1)+SQRT(1.0-RR(1)**2)*V(1,J)
          TQ =QE(1,J)*QSD(J)+QBA(J)
          IF (TQ .LT. 0.0) THEN
             QE(1,J) = -QBA(J)/QSD(J)
          ENDIF
 70    CONTINUE
       DO 90 I =2,NP
          QE(I,1)=RR(1)*QE(I-1,12)+SQRT(1.0-RR(1)**2)*V(I,1)
```

```
101:            TQ = QE(I,1)*QSD(1)+QBA(1)
102:            IF (TQ .LT. 0.0) THEN
103:              QE(I,1) = -QBA(1)/QSD(1)
104:            ENDIF
105:            DO 100 J=2,12
106:               QE(I,J)=RR(1)*QE(I,J-1)+SQRT(1.0-RR(1)**2)*V(I,J)
107:               TQ = QE(I,J)*QSD(J)+QBA(J)
108:               IF (TQ .LT. 0.0) THEN
109:                    QE(I,J) = -QBA(J)/QSD(J)
110:               ENDIF
111: 100         CONTINUE
112: 90      CONTINUE
113:         DO 110 I =1,NP
114:         DO 110 J =1,12
115:            QG(I,J) = QE(I,J)*QSD(J)+QBA(J)
116: 110     CONTINUE
117:         RETURN
118:         END
```

File Size = 3969 Bytes

```
C     CMU-CE ROUTINE NAME    - SSCM
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 30, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              SECOND SPOLIA-CHANDER MODEL AND SOME
C                              MODIFIED FOR PRESERVE SKEWNESS.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                    QD      - INPUT HISTORICAL MONTHLY FLOWS
C                    N       - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                    NP      - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                    QG      - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - GGMSS,KIRBY
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE SSCM(DSEED,QD,N,NP,QG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,12),QG(NP,12)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,JJ,L,LL,NN,K
      REAL                    XM,XSD,XSK,SKR(12),QBA(12),RT(1000)
     $                        ,CS,QSUM,QSD(12),QSK(12),Y(100),R(1000)
     $                        ,V(1000),VC(12),SUM1,SUM2,SUM3,SUM4
     $                        ,VQ(12),XG(12,1000),EC3(12),B(12,12)
     $                        ,COV(12,12),QT(12,1000),EQ3(12),U(1000)
C                              FIRST EXECUTABLE STATEMENT
      DO 10 J=1,12
         DO 20 I=1,N
            Y(I)=QD(I,J)
20       CONTINUE
         CALL GGMSS(Y,N,XM,XSD,XSK)
         QBA(J)=XM
```

```
 51:            QSD(J)=XSD
 52:            QSK(J)=XSK
 53: 10      CONTINUE
 54:         DO 40 I=1,N
 55:         DO 40 J=1,12
 56:            QT(J,I) = QD(I,J)
 57: 40      CONTINUE
 58:         DO 50 J =1,12
 59:            DO 60 I=1,N
 60:               QT(J,I) = QT(J,I)-QBA(J)
 61: 60         CONTINUE
 62:            VQ(J) = QSD(J)**2
 63: 50      CONTINUE
 64:         DO 70 I=2,12
 65:            JJ = I-1
 66:            DO 70 J=1,JJ
 67:               QSUM = 0.0
 68:                 DO 80 NN=1,N
 69:                    QSUM =QSUM+QT(I,NN)*QT(J,NN)
 70: 80              CONTINUE
 71:               COV(I,J) = QSUM/N
 72: 70         CONTINUE
 73:         VC(1) = VQ(1)
 74:         DO 90 J=1,12
 75:            DO 100 K=1,12
 76:               IF (K.GT.J) THEN
 77:                  B(J,K) = 0.0
 78:                ELSEIF (K .EQ. J) THEN
 79:                  B(J,K) = 1.0
 80:                ELSEIF (K .EQ. 1) THEN
 81:                  B(J,1) = COV(J,1)/VC(1)
 82:              ELSEIF (K .LE. J) THEN
 83:                   SUM1 = 0.0
 84:                   LL  = K-1
 85:                   DO 110 L = 1,LL
 86:                      SUM1 = SUM1+B(J,L)*B(K,L)*VC(L)
 87: 110             CONTINUE
 88:                 B(J,K) = (COV(J,K)-SUM1)/VC(K)
 89:               ENDIF
 90: 100        CONTINUE
 91:            IF (J .EQ. 1) GOTO 90
 92:               JJ =J-1
 93:               SUM2 = 0.0
 94:               DO 120 K = 1,JJ
 95:                  SUM2 = SUM2+B(J,K)**2*VC(K)
 96: 120           CONTINUE
 97:               VC(J) = VQ(J)-SUM2
 98: 90      CONTINUE
 99: C       COMPUTE SKEWNESS COEFFICIENT OF C ,SKR(I)
100:         DO 130 J =1,12
```

```
101:            SUM3 = 0.0
102:            DO 140 I = 1,N
103:               SUM3 = SUM3+QT(J,I)**3
104: 140        CONTINUE
105:            EQ3(J) = SUM3/N
106: 130     CONTINUE
107:         EC3(1) = EQ3(1)
108:         SKR(1) = EC3(1)/VC(1)**1.5
109:         DO 150 I=2,12
110:            JJ = I-1
111:            SUM4 = 0.0
112:            DO 160 J =1,JJ
113:               SUM4 = SUM4+B(I,J)**3*EC3(J)
114: 160        CONTINUE
115:            EC3(I) = EQ3(I)-SUM4
116:            SKR(I) = EC3(I)/VC(I)**1.5
117: 150     CONTINUE
118: C                                  GENERATED STREAMFLOWS
119:         DO 170 I= 1,NP
120:            CALL GGNPM(DSEED,12,R)
121:         DO 170 J =1,12
122:            CS = SKR(J)
123:            V(1) = R(J)
124:            IF (ABS(SKR(J)) .LT. 3.0) THEN
125:               RT(J) = 2.*((1.+R(J)*SKR(J)/6.-SKR(J)**2/36.)**3
126:        $              -1.)/SKR(J)
127:            ELSE
128:               CALL KIRBY(1,CS,V,RT)
129:                 RT(J) = RT(1)
130:            ENDIF
131:            JJ = J-1
132:            XG(J,I) = RT(J)*SQRT(VC(J))
133:            IF (J .EQ. 1) GOTO 190
134:            CALL GGNPM(DSEED,JJ,U)
135:            IF (ABS(SKR(J)) .LT. 3.0) THEN
136:              DO 53 L =1,JJ
137:               RT(L) = 2.*((1.+U(L)*SKR(J)/6.-SKR(J)**2/36.)**3
138:        $              -1.)/SKR(J)
139: 53            CONTINUE
140:            ELSE
141:               CALL KIRBY(JJ,CS,U,RT)
142:            ENDIF
143:            DO 180 L = 1,JJ
144:               XG(J,I) = XG(J,I)+B(J,L)*RT(L)*SQRT(VC(L))
145: 180        CONTINUE
146: 190        XG(J,I) = XG(J,I)+QBA(J)
147:            IF (XG(J,I) .LT. 0.0) XG(J,I) = 0.0
148: 170     CONTINUE
149:         DO 200 I = 1,NP
150:         DO 200 J = 1,12
```

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151:          QG(I,J) = XG(J,I)
152: 200    CONTINUE
153:        RETURN
154:        END
```

File Size = 4783 Bytes

```
C     CMU-CE ROUTINE NAME    - SEN
C
C-----------------------------------------------------------------------
C
C     LATEST REVISION        - JUNE 29, 1991
C
C     PURPOSE                - GENERATED MONTHLY STREAMFLOWS BY USING
C                              SEN MODEL AND SOME MODIFIED FOR PRESERVE
C                              SKEWNESS.
C
C     ARGUMENTS      DSEED   - INPUT/OUTPUT DOUBLE PRECISION VARIABLE
C                              ASSIGNED AN INTEGER VALUE IN THE
C                              EXCLUSIVE RANG (1.D0,2147483647.D0).
C                              DSEED IS REPLACED BY A NEW VALUE TO
C                              BE USED IN A SUBSEQUENT CALL.
C                    QD      - INPUT HISTORICAL MONTHLY FLOWS
C                    N       - INPUT THE NUMBER OF HISTORICAL MONTHLY
C                              FLOWS.
C                    NP      - INPUT THE NUMBER OF GENERATION MONTHLY
C                              FLOWS
C                    QG      - OUTPUT GENERATION MONTHLY FLOWS.
C
C     REQD. CMU-CE ROUTINES  - GGMSS,KIRBY,AUTOC
C           IMSL   ROUTINES  - GGNPM
C
C     NOTE                   - NONE
C
C-----------------------------------------------------------------------
C
      SUBROUTINE SEN(DSEED,QD,N,NP,QG)
C                              SPECIFICATIONS FOR ARGUMENTS
      INTEGER                 N,NP
      REAL                    QD(1000,12),QG(NP,12)
      DOUBLE PRECISION        DSEED
C                              SPECIFICATION FOR LOCAL VARIABLES
      INTEGER                 I,J,JJ
      REAL                    T1,T2,T3,XM,XSD,XSK,B(12),SKR(12),QBA(12)
     $                        ,QSD(12),QSK(12),Y(100),R(0:1000),XM1,XM2
     $                        ,RT(0:1000),V(0:1000,12),A(12),RC0(12)
     $                        ,RC1(12),R1(12),STDR(12),T4,T5,T6,RR(20)
     $                        ,XM3,XM4
C
      DO 10 J=1,12
         DO 20 I=1,N
            Y(I)=QD(I,J)
20       CONTINUE
         CALL GGMSS(Y,N,XM,XSD,XSK)
         CALL AUTOC(Y,N,RR)
         QBA(J)=XM
```

```
      QSD(J)=XSD
      QSK(J)=XSK
      R1(J) =RR(1)
10    CONTINUE
      DO 40 J=1,12
      T1=0.0
      T2=0.0
      T3=0.0
      T4=0.0
      T5=0.0
      T6=0.0
      JJ=J-1
      IF (JJ .EQ. 0) JJ =12
      IF (JJ .EQ. 12) THEN
            XM1 = (N*QBA(J)-QD(1,J))/(N-1)
            XM2 = (N*QBA(JJ)-QD(N,JJ))/(N-1)
         DO 45 I=2,N
            T1=T1+(QD(I-1,JJ)-XM2)*(QD(I,J)-XM1)
            T2=T2+(QD(I-1,JJ)-XM2)**2
            T3=T3+(QD(I,J)-XM1)**2
45       CONTINUE
      ELSE
         DO 50 I=1,N
            T1=T1+(QD(I,JJ)-QBA(JJ))*(QD(I,J)-QBA(J))
            T2=T2+(QD(I,JJ)-QBA(JJ))**2
            T3=T3+(QD(I,J)-QBA(J))**2
50       CONTINUE
      ENDIF
      IF (JJ .EQ. 12) THEN
         XM3 = (QBA(J)*N-QD(N,J))/(N-1)
          XM4 = (QBA(JJ)*N-QD(N,JJ))/(N-1)
          DO 61 I = 2,N
           T4 = T4+(QD(I-1,JJ)-XM4)**2
             T5 = T5+(QD(I-1,J)-XM3)*(QD(I-1,JJ)-XM4)
             T6 = T6+(QD(I-1,J)-XM3)**2
61       CONTINUE
      ELSE
         XM3 = (QBA(J)*N-QD(N,J))/(N-1)
           XM4 = (QBA(JJ)*N-QD(1,JJ))/(N-1)
           DO 62 I = 2,N
            T4 = T4+(QD(I,JJ)-XM4)**2
              T5 = T5+(QD(I-1,J)-XM3)*(QD(I,JJ)-XM4)
              T6 = T6+(QD(I-1,J)-XM3)**2
62       CONTINUE
       ENDIF
           RC0(J)=T1/SQRT(T2*T3)
             RC1(J)=T5/SQRT(T4*T6)
             A(J)  =QSD(J)*(RC0(J)-R1(J)*RC1(J))/
     $            (QSD(JJ)*(1.0-RC1(J)**2))
           B(J)  =R1(J)-RC0(J)*RC1(J)/(1.0-RC1(J)**2)
```

```
101:                    STDR(J) = SQRT(QSD(J)**2-QSD(J)**2*(RC0(J)**2-2*R1(J)
102:         $                      *RC0(J)*RC1(J)+R1(J)**2)/(1.0-RC1(J)**2))
103:                  SKR(J) = (QSK(J)*QSD(J)**3-A(J)**3*QSD(JJ)**3*QSK(JJ)
104:         $                   -B(J)**3*QSD(J)**3*QSK(J))/STDR(J)**3
105: 40      CONTINUE
106: C                                    GENERATED RANDOM NUMBER
107:         DO 41 I =0,NP
108:            CALL GGNPM(DSEED,12,R)
109:         DO 41 J =1,12
110:            V(I,J) = R(J)
111: 41      CONTINUE
112:         DO 42 J =1,12
113:            CS = SKR(J)
114:            IF (ABS(SKR(J)) .LT. 3.0) THEN
115:               DO 43 I = 0,NP
116:                  V(I,J) = 2.*((1.+V(I,J)*SKR(J)/6.-SKR(J)**2/36.)**3
117:         $                   -1.)/SKR(J)
118: 43               CONTINUE
119:            ELSE
120:               DO 44 I = 0,NP
121:                  R(I) = V(I,J)
122: 44            CONTINUE
123:               CALL KIRBY(NP,CS,R,RT)
124:                 DO 46 I = 0,NP
125:                    V(I,J) = RT(I)
126: 46            CONTINUE
127:            ENDIF
128: 42      CONTINUE
129: C                                          GENERATED STREAMFLOWS
130:         QG(1,1)=QBA(1)+V(1,1)*QSD(1)
131:         DO 51 J=2,12
132:            QG(0,J) = QBA(J)+V(0,J)*QSD(J)
133:            QG(1,J)=QBA(J)+A(J)*(QG(1,J-1)-QBA(J-1))+B(J)*(QG(0,J)
134:        $          -QBA(J))+STDR(J)*V(1,J)
135:            IF (QG(1,J) .LT. 0.0) QG(1,J) =0.0
136: 51      CONTINUE
137:         DO 90 I =2,NP
138:            QG(I,1)=QBA(1)+A(1)*(QG(I-1,12)-QBA(12))+B(1)*
139:        $          (QG(I-1,1)-QBA(1))+STDR(1)*V(I,1)
140:            IF (QG(I,1) .LT. 0.0) QG(I,1) = 0.0
141:         DO 130 J=2,12
142:            QG(I,J)=QBA(J)+A(J)*(QG(I,J-1)-QBA(J-1))+B(J)*
143:        $          (QG(I-1,J)-QBA(J))+STDR(J)*V(I,J)
144:            IF (QG(I,J) .LT. 0.0) QG(I,J) = 0.0
145: 130     CONTINUE
146: 90      CONTINUE
147:         RETURN
148:         END
149:
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File Size = 5158 Bytes

VITA

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