Estimating Water Flow From Pipes

Cooperative Extension Service
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Guide A-104

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In recent years, there have been increased demands upon our limited water supply by industry, cities and towns, recreation, and agriculture. So irrigators should use the available water supply more wisely than ever before.

Proper management takes the guesswork out of the application of irrigation water to the land. Times and amounts of water applied are just as important as the times and amounts of seed and fertilizer used.

Irrigation management involves measuring water at delivery points to determine exact amounts going to the field.

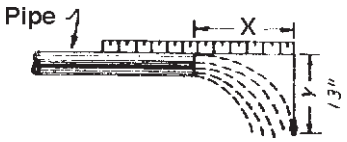
The standard term for rate of flow of irrigation water is cubic feet per second (cfs). A cubic foot per second of water is flowing when a cubic foot volume of water (equal to one foot wide, one foot long, and one foot high) passes a given point every second.

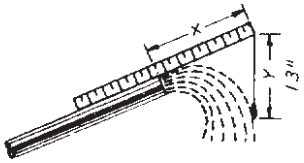
A cubic foot of water equals:

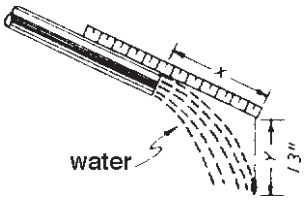
- Approximately 405 gallons per minute (gpm).
- Approximately 1 acre-inch per hour.
- Approximately 1 acre-foot per 12 hours.
- Approximately 2 acre-feet per 24 hours.

An acre-inch is the volume of water required to cover an acre of land one inch deep. An acre-foot is the volume of water required to cover an acre one foot deep.

The following tables will be helpful to the irrigator in determining the amount of water being applied to the land with nothing more than a carpenter's rule:







DISCHARGE FROM PIPES FLOWING FULL
In Gallons Per Minute
with
Vertical Drop "Y" = 13 Inches

Pipe size		Horizontal distance "X"												
Inside diameter	Area (Sq. In.)	12"	14"	16"	18"	20"	22"	24"	26"	28"	30"	32"	34"	36"
2"	3.14	38	44	50	57	63	69	75	82	88	94	100	107	113
2.5"	4.91	59	69	79	88	98	108	118	128	137	147	157	167	177
3"	7.07	85	99	113	127	141	156	170	184	198	212	226	240	255
4"	12.57	151	176	201	226	251	277	302	327	352	377	402	427	453
5"	19.64	236	275	314	354	393	432	471	511	550	589	628	668	707
6"	28.27	339	396	452	509	565	622	678	735	792	848	905	961	1013
7"	38.48	462	539	616	693	770	847	924	1000	1077	1154	1231	1308	1385
8"	50.27	603	704	804	905	1005	1106	1206	1307	1408	1508	1609	1709	1810
9"	63.62	763	891	1018	1145	1272	1400	1527	1654	1781	1909	2036	2163	2290
10"	78.54	942	1100	1257	1414	1571	1728	1885	2042	2199	2356	2513	2670	2827
11"	95.03	1140	1330	1520	1711	1901	2091	2281	2471	2661	2851	3041	3231	3421
12"	113.10	1357	1583	1809	2036	2262	2488	2714	2941	3167	3393	3619	3845	4072

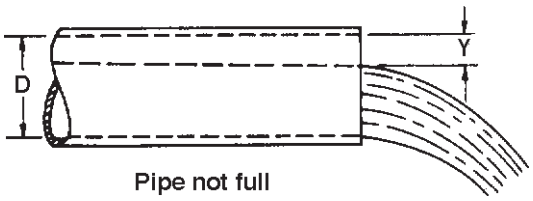
$$Q = \frac{3.61\,AX}{\sqrt{}}$$ Where: A = Cross-sectional area of discharge pipe in square inches

X = Horizontal distances in inches
Y = Vertical distances in inches

AN APPROXIMATE METHOD OF ESTIMATING DISCHARGE FROM PIPES FLOWING PARTIALLY FULL

Rate of flow in gallons per minute

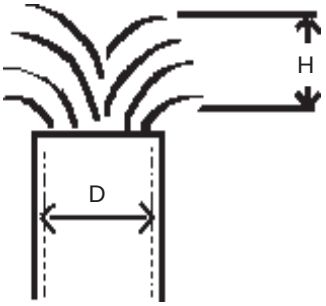
Y	Inside diameter of pipe - "D" in inches				
D	4	6	8	10	12
0.1	142	334	579	912	1310
0.2	128	302	524	825	1185
0.3	112	264	457	720	1034
0.4	94	222	384	605	868
0.5	75	176	305	480	689
0.6	55	130	226	355	510
0.7	37	88	152	240	345
0.8	21	49	85	134	194
0.9	8	17	30	52	74
1.0	0	0	0	0	0



ESTIMATING FLOW FROM VERTICAL PIPE OR CASING

The approximate flow from vertical pipes or casings can be determined by measuring the maximum height(h) in inches to which the water jet rises above the pipe, and inside diameter of the pipe (d) in inches.

The flow in gallons per minute is given in the following table for different sizes of standard pipe and for different heights of the water jets.



Height (H)	NOMINAL DIAMETER (D) OF STANDARD PIPE (INCHES)										
(Inches)	2	3	4	5	6	7	8	10	12	14	16
2	29	65	113	180	269	352	460	797	1148	1583	2042
2.5	32	72	126	202	291	396	517	898	1293	1760	2299
3	35	77	135	217	311	425	569	950	1416	1928	2518
3.5	38	85	149	238	341	465	626	1055	1530	2083	2720
4	41	92	161	252	369	503	687	1115	1636	2227	2908
4.5	44	98	172	270	396	540	733	1200	1735	2362	3085
5	47	104	182	286	420	575	779	1270	1829	2489	3251
5.5	49	109	192	301	444	606	825	1332	1918	2611	3410
6	52	115	202	316	469	638	872	1391	2003	2727	3562
6.5	54	121	211	331	490	667	913	1448	2085	2838	3707
7	57	126	219	345	509	700	949	1503	2164	2945	3847
8	61	135	236	370	548	751	1025	1606	2313	3149	4113
9	65	144	251	396	585	802	1091	1704	2454	3340	4362
10	69	153	265	418	621	850	1150	1796	2586	3520	4598
12	76	169	294	463	685	933	1259	1967	2833	3856	5037
14	83	184	319	502	740	1020	1360	2125	3060	4165	5440
16	89	197	342	540	796	1090	1454	2272	3272	4453	5816
18	95	209	364	575	845	1160	1542	2410	3470	4723	6169
20	101	221	386	607	890	1225	1626	2540	3658	4979	6503
25	113	249	433	680	998	1375	1818	2840	4090	5566	7270
30	124	273	476	746	1095	1505	1991	3111	4480	6098	7964
35	134	298	516	810	1175	1630	2151	3360	4839	6586	8602
40	144	318	551	865	1270	1745	2299	3592	5173	7041	9196

For other pipe sizes and heights of jets. Use the formulae:

$$\text{Gal. per min.} = 5.68\ CD^2\sqrt{H}$$

$$\text{Cu. ft. per sec.} = 0.0126\ CD^2\sqrt{H}$$

Where D = inside pipe diameter in inches.
H = jet height in inches.
C = a constant varying from 0.87 to 0.97 for pipes of 2 to 6 inches in diameter and heights of 6 to 224 inches.

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