

**CLAIM OF
BENEFICIAL USE
for Ground Water Permits
claiming 0.1 cfs or less**



Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.oregon.gov/OWRD

**A fee of \$230 must accompany this form for permits
with priority dates of July 9, 1987, or later.**

A separate form shall be completed for each permit.

In cases where a permit has been amended through the permit amendment process, a separate claim for the permit amendment is not required. Incorporate the permit amendment into the claim for the permit.

This form is subject to revision. Begin each new claim by checking for a new version of this form at:
<https://www.oregon.gov/OWRD/Forms/Pages/default.aspx>

The completion of this form is required by OAR 690-014-0100(1) and 690-014-0110(4).

Please type or print in dark ink. If this form is found to contain errors or omissions, it may be returned to you. **Every item must have a response.** If any requested information does not apply to the claim, insert "NA." **Do not delete or alter any section of this form unless directed by the form.** The Department may require the submittal of additional information from any water user or authorized agent.

"Section 8" of this form is intended to aid in the completion of this form and should not be submitted.

If you have questions regarding the completion of this form, please call 503-979-9103.

The Department has a program that allows it to enter into a voluntary agreement with an applicant for expedited services. Under such an agreement, the applicant pays the cost to hire additional staff that would not otherwise be available. This program means a certificate may be issued in about a month.

For more information on this program see

<https://www.oregon.gov/OWRD/programs/WaterRights/RA/Pages/default.aspx>

(See Certificate Resources)

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SECTION 1

GENERAL INFORMATION

1. File Information:

APPLICATION #	PERMIT # (IF APPLICABLE)	PERMIT AMENDMENT # (IF APPLICABLE)
G- 16633	G- 16154	

2. Property Owner (current owner information):

APPLICANT/BUSINESS NAME James P. Estes		PHONE NO. 5035681680	ADDITIONAL CONTACT NO. estes.jim8@gmail.com
ADDRESS 18263 S Windy City Rd			
CITY Mulino	STATE OR	ZIP 97042	E-MAIL estes.jim8@gmail.com

If the current property owner is not the permit holder of record, it is recommended that an assignment be filed with the Department. ***Each*** permit holder of record must sign this form.

3. Permit holder of record (this may, or may not, be the current property owner):

PERMIT HOLDER OF RECORD James P. Estes		
ADDRESS 18263 S Windy City Rd		
CITY Mulino	STATE OR	ZIP 97042

ADDITIONAL PERMIT HOLDER OF RECORD NONE		
ADDRESS		
CITY	STATE	ZIP

4. Date of Site Inspection:

7/19/2022, 8/16/2022

5. Person(s) interviewed and description of their association with the project:

NAME	DATE	ASSOCIATION WITH THE PROJECT
James Estes	7/19/2022	Owner
James Estes	8/16/2022	Owner, during pump test

6. County:

Clackamas

7. If any property described in the place of use of the permit final order is excluded from this report, identify the owner of record for that property (ORS 537.230(5)):

OWNER OF RECORD NONE		
ADDRESS		
CITY	STATE	ZIP

Add additional tables for owners of record as needed

SECTION 2 SIGNATURES

CWRE Statement, Seal and Signature

The facts contained in this Claim of Beneficial Use are true and correct to the best of my knowledge.



CWRE NAME Lynn D. Green	PHONE No. 503-452-5561	ADDITIONAL CONTACT No. 503-849-5895
ADDRESS PO Box 14488		
CITY Portland	STATE OR	ZIP 97293
E-MAIL LYNNG@EVREN-NW.COM		

Permit Holder's of Record Signature or Acknowledgement

Each permit holder of record must sign this form in the space provided below.

The facts contained in this Claim of Beneficial Use are true and correct to the best of my knowledge. I request that the Department issue a water right certificate.

SIGNATURE	PRINT OR TYPE NAME	TITLE	DATE
	James P. Estes	Owner	9/1/2022

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SECTION 3

CLAIM DESCRIPTION

1. Point(s) of Appropriation (POA):

POA NAME OR NUMBER (CORRESPOND TO MAP)	WELL LOG ID # FOR ALL WORK PERFORMED ON THE WELL (IF APPLICABLE)	WELL TAG # (IF APPLICABLE)
POA 1	CLAC 11337	

Attach each well log available for the well (include the log for the original well and any subsequent alterations, reconstructions, or deepenings)

2. Developed use(s), period of use, and rate for each use:

POA NAME OR NUMBER	USES	IF IRRIGATION, LIST CROP TYPE	SEASON OR MONTHS WHEN WATER WAS USED	ACTUAL RATE OR VOLUME USED (CFS, GPM, OR AF)
POA 1	Irrigation	Grapes, vegetable, grass	Spring-Fall	15 GPM
Total Quantity of Water Used				15 GPM

3. Provide a general narrative description of the distribution works. This description must trace the water system from each point of appropriation to the place of use:

POA 1: Zone 1: 8 drip lines-75 foot of drip tape, Zone 2: 17 drip lines- 100 foot of drip tape, Zone 3: 6 drip lines -100 foot of drip tape
Zone 4: 4 Rows of drip line, Zone 6: water reel back field

Reminder: The map associated with this claim must identify the location of the point(s) of diversion, Donation Land Claims (DLC), Government Lots (GLot), and Quarter-Quarters (QQ).

4. Variations:

Was the use developed differently from what was authorized by the permit, permit amendment final order, or extension final order? If yes, describe below.

YES ☒ NO

(e.g. "The permit allowed three points of diversion. The water user only developed one of the points." or "The permit allowed 40.0 acres of irrigation. The water user only developed 10.0 acres.")

5. Claim Summary:

POD / POA NAME OR #	MAXIMUM RATE AUTHORIZED	CALCULATED THEORETICAL RATE BASED ON SYSTEM	AMOUNT OF WATER MEASURED	USE	# OF ACRES ALLOWED	# OF ACRES DEVELOPED
POA 1	0.089 CFS	0.053 CFS	0.033 CFS	Irrigation	4.4	4.3

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SECTION 4
SYSTEM DESCRIPTION

Are there multiple POAs?

YES

NO

If "YES" you will need to copy and complete a separate Section 4 for each POA.

POA Name or Number this section describes (only needed if there is more than one):

POA 1

A. Place of Use

Attach Claim of Beneficial Use map.

Reminder: The map associated with this claim must identify Donation Land Claims (DLC), Government Lots (Gov Lot), Quarter-Quarters (QQ), and if for irrigation, the number of acres irrigated within each projected DLC, Gov Lot, and QQ.

B. Groundwater Source Information (Well)

1. Is the appropriation from a well?

YES

NO

If "NO", items 2 through 4 relating to this section may be deleted.

2. Describe the access port (type and location) or other means to measure the water level in the well:

Observation port in top of casing

3. If well logs are not available, provide as much of the following information as possible:

CASING DIAMETER	CASING DEPTH	TOTAL DEPTH	COMPLETION DATE OF ORIGINAL WELL	COMPLETION DATES OF ALTERATIONS	WHO THE WELL WAS DRILLED FOR	WELL DRILLED BY
see attached well log						

4. In addition to the information requested in item "3" above, provide any other information which may help the Department locate any well logs associated with this appropriation.

CLAC 11337

C. Groundwater Source Information (Sump)

1. Is the appropriation from a dug well (sump)?

YES

NO

If "NO", items 2 through 4 relating to this section may be deleted.

Reminder: Construction standards for sumps can be found in OAR 690-210-0400.

2. If the appropriation involves a SUMP, provide the following information for each SUMP:

LENGTH	WIDTH	AVERAGE DIAMETER	MAXIMUM DEPTH	SURFACE AREA (IN ACRES)	VOLUME IN CUBIC FEET OR ACRE FEET
NA					

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3. If the sump is curbed constructed with watertight surface curbing, describe the curbing:

CURBING MATERIAL (CONCRETE, CONCRETE TILES, OR STEEL)	IF CONCRETE, PROVIDE THE THICKNESS OF THE WALL
NA	

4. Provide sump volume calculations:

NA

D. Appropriation and Delivery System Information

Provide the following information concerning the appropriation and delivery system. Information provided must describe the equipment used to transport and apply the water from the point of appropriation to the place of use.

1. Is a pump used?

YES NO

If "NO" items 2 through item 5 may be deleted.

2. Pump Information:

MANUFACTURER	MODEL	SERIAL NUMBER	TYPE (CENTRIFUGAL, TURBINE OR SUBMERSIBLE)
Berkeley pump	NA	NA	1.5 HP submersible

3. Theoretical Pump Capacity:

HORSEPOWER	OPERATING PSI	LIFT FROM SOURCE TO PUMP *If A WELL, THE WATER LEVEL DURING PUMPING	LIFT FROM PUMP TO PLACE OF USE	TOTAL PUMP OUTPUT (IN CFS)
1.5	30-60	37.43	~40 ft	0.0549

4. Provide pump calculations:

(hp)(efficiency) / (lift + psi head) = capacity in cfs
efficiency factor = 7.04, HP = 135, lift = 40 ft, PSI = 60

5. Measured Pump Capacity (using meter if meter was present and system was operating):

INITIAL METER READING	ENDING METER READING	DURATION OF TIME OBSERVED	TOTAL PUMP OUTPUT (IN CFS)
66490.77	69997	4 hours	0.033

Reminder: For pump calculations use the reference information at the end of this document.

6. Sprinkler Information: Zone 4 and 5 use adjustable nozzles set at 14.7 GPH. Zone 6 uses a water reel sprinkler that operates at the maximum pump output, which averaged 14.5 GPM during the well test

	SIZE	OPERATING PSI	SPRINKLER OUTPUT (GPM)	TOTAL NUMBER OF SPRINKLERS	MAXIMUM NUMBER USED	TOTAL SPRINKLER OUTPUT (CFS)
Zone 4	NA	50	0.245	50	2	0.001
Zone 5	NA	50	0.245	30	2	0.001
Zone 6	NA	50	14.5	1	1	0.032

Reminder: For sprinkler output determination use the reference information at the end of this document.

7. Drip Emitter Information:

SIZE	OPERATING PSI	EMITTER OUTPUT (GPM)	TOTAL NUMBER OF EMITTERS	MAXIMUM NUMBER USED	TOTAL EMITTER OUTPUT (CFS)

8. Drip Tape Information:

	DRIPPER SPACING IN INCHES	GPM PER 100 FEET	TOTAL LENGTH OF TAPE	MAXIMUM LENGTH OF TAPE USED	TOTAL TAPE OUTPUT (CFS)	ADDITIONAL INFORMATION
Zone 1	6	1.1	600	600	0.0147	
Zone 2	6	1.1	1700	1700	0.042	
Zone 3	6	1.1	600	600	0.0147	

E. Storage

1. Does the distribution system include in-system storage (i.e. storage tank, bulge in system / reservoir)?

YES ☒ NO

If "NO", item 2 and 3 relating to this section may be deleted.

If "YES" is it a: Storage Tank
 Bulge in System / Reservoir

YES NO
YES NO

Complete appropriate table(s), unused table may be deleted.

2. Storage Tank:

MATERIAL (CONCRETE, FIBERGLASS, METAL, ETC.)	CAPACITY (IN GALLONS)	ABOVE GROUND OR BURIED
NA		

3. Bulge in System / Reservoir:

RESERVOIR NAME OR NUMBER (CORRESPOND TO MAP)	APPROXIMATE DAM HEIGHT	APPROXIMATE CAPACITY (IN ACRE FEET)
NA		

F. Gravity Flow Pipe

(THE DEPARTMENT TYPICALLY USES THE HAZEN-WILLIAM'S FORMULA FOR A GRAVITY FLOW PIPE SYSTEM)

1. Does the system involve a gravity flow pipe?

YES ☒ NO

If "NO", items 2 through 4 relating to this section may be deleted.

2. Complete the table:

PIPE SIZE	PIPE TYPE	"C" FACTOR	AMOUNT OF FALL	LENGTH OF PIPE	SLOPE	COMPUTED RATE OF WATER FLOW (IN CFS)
NA						

3. Provide calculations:

NA

4. If an actual measurement was taken, provide the following:

DATE OF MEASUREMENT	WHO MADE THE MEASUREMENT	MEASUREMENT METHOD	MEASURED QUANTITY OF WATER (IN CFS)
NA			

Attach measurement notes.

G. Gravity Flow Canal or Ditch

(THE DEPARTMENT TYPICALLY USES MANNING'S FORMULA FOR CANALS AND DITCHES)

1. Is a gravity flow canal or ditch used to convey the water as part of the distribution system?

YES ☒ NO

If "NO", items 2 through 4 relating to this section may be deleted.

2. Complete the table:

CANAL OR DITCH TYPE (MATERIAL)	TOP WIDTH OF CANAL OR DITCH	BOTTOM WIDTH OF CANAL OR DITCH	DEPTH	"N" FACTOR	AMOUNT OF FALL	LENGTH OF CANAL / DITCH	SLOPE	COMPUTED RATE (IN CFS)
NA								

3. Provide calculations:

NA

4. If an actual measurement was taken, provide the following:

DATE OF MEASUREMENT	WHO MADE THE MEASUREMENT	MEASUREMENT METHOD	MEASURED QUANTITY OF WATER (IN CFS)
NA			

Attach measurement notes.

H. Additional notes or comments related to the system:

--

Zone 4 and 5 use adjustaoozles rated at 14.7 GPH. Zone 6 uses a water reel sprinkler that operates at the maximum pump output, which averaged 14.5 GPM during the well test

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SECTION 5 CONDITIONS

All conditions contained in the permit, permit amendment, or any extension final order shall be addressed. Reports that do not address all performance related conditions will be returned.

1. Time Limits:

Permits and any extension final orders contain any or all of the following dates: the date when the actual construction work was to begin, the date when the construction was to be completed, and the date when the complete application of water to the proposed use was to be completed. These dates may be referred to as ABC dates. Describe how the water user has complied with each of the development timelines established in the permit or extension final order:

	DATE FROM PERMIT	DATE ACCOMPLISHED*	DESCRIPTION OF ACTIONS TAKEN BY WATER USER TO COMPLY WITH THE TIME LIMITS
ISSUANCE DATE	2/1/2007		
BEGIN CONSTRUCTION (A)		9/21/1975	Well installed
COMPLETE CONSTRUCTION (B)		8/26/2022	Water meter installed, pump test submitted
COMPLETE APPLICATION OF WATER (C)	10/15/2022	9/1/2022	COBU

* MUST BE WITHIN PERIOD BETWEEN PERMIT OR ANY EXTENSION FINAL ORDER ISSUANCE AND THE DATE TO COMPLETELY APPLY WATER

2. Is there an extension final order(s)?

YES **NO**

If "NO", items a and b relating to this section may be deleted.

a. Did the Extension Final Order require the submittal of Progress Reports?

YES **NO**

If "NO", item b relating to this section may be deleted.

b. Were the Progress Reports submitted?

YES **NO**

If the reports have not been submitted, attach a copy of the reports if available.

3. Initial Water Level Measurements:

a. Was the water user required to submit an initial static water level measurement?

YES **NO**

If "NO", items b through d relating to this section may be deleted.

b. What month was the initial measurement to be taken in?

NA

c. Was the measurement submitted to the Department?

YES **NO**

d. If the initial measurement was not submitted, provide that measurement now, if available:

DATE OF MEASUREMENT	MEASUREMENT MADE BY	METHOD	MEASUREMENT
8/16/2022	EVREN Northwest, Inc.	eTape	37.43 ft BTOC

4. Annual Static Water Level Measurements:

a. Was the water user required to submit annual static water level measurements?

YES **NO**

If "NO", items b through e relating to this section may be deleted.

- b. Provide the month, or months, in which the static water level measurement(s) were to be made:

NA

- c. Were the static water level measurements taken in the month(s) required? **YES** **NO**
- d. If "YES", were those measurements submitted to the Department? **YES** **NO**
- e. If the annual measurements were not submitted, provide the measurements now:

DATE OF MEASUREMENT	MEASUREMENT MADE BY	METHOD	MEASUREMENT
8/16/2022	EVREN Northwest, Inc.	eTape	37.43 ft BTOC

5. Pump Test:

- a. Is a pump test required? **YES** **NO**

Ground water permits with priority dates on or after December 20, 1988, require the submittal of a pump test prior to issuance of a certificate. In some cases, the permit holder may qualify for a multiple well exemption or an unreasonable burden exemption.

For additional information regarding pump tests see:

<https://www.oregon.gov/OWRD/programs/GWWL/GW/Pages/PumpTestProgram.aspx>

If "NO", items b through e relating to this section may be deleted.

- b. Has the pump test been previously submitted to the Department? **YES** **NO**
- c. Is the pump test attached to this claim? **YES** **NO**
- d. Has the pump test been approved by the Department? **YES** **NO**
- e. Has a pump test exemption been approved by the Department? **YES** **NO**

****The Claim will not be reviewed until a pump test or exemption has been approved by the Department.**

6. Measurement Conditions:

- a. Does the permit, permit amendment, or any extension final order require the installation of a meter or approved measuring device? **YES** **NO**

If "NO", items b through f relating to this section may be deleted.

Reminder: If a meter or approved measuring device was required, the COBU map must indicate the location of the device in relation to the point of appropriation.

- b. Has a meter been installed? **YES** **NO**

c. Meter Information

POA NAME OR #	MANUFACTURER	SERIAL #	CONDITION (WORKING OR NOT)	CURRENT METER READING	DATE INSTALLED
POA 1	DAE	22012833	Working	66906	7/7/2022

If a meter has been installed, items d through f relating to this section may be deleted.

- d. If a meter has not been installed, has a suitable measuring device been installed and approved by the Department? **YES** **NO**

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e. If "YES", provide a copy of the letter approving the device, if available. If the letter is not available provide the name and title of the Water Resources Department employee approving the measuring device, and the approximate date of the approval:

NAME	TITLE	APPROXIMATE DATE
NA		

f. Measurement Device Description

DEVICE DESCRIPTION	CONDITION (WORKING OR NOT)	DATE INSTALLED
Totalizing meter	Working	7/7/2022

7. Recording and reporting conditions:

a. Is the water user required to report the water use to the Department?

☒ YES ☐ NO

If "NO", item b relating to this section may be deleted.

b. Have the reports been submitted?

YES ☒ NO

If the reports have not been submitted, attach a copy of the reports if available. (ATTACHED)

8. Other conditions required by permit, permit amendment final order, or extension final order:

a. Were there special well construction standards?

YES ☒ NO

b. Was submittal of a ground water monitoring plan required?

YES ☒ NO

c. Was a Well Identification Number (Well ID tag) assigned and attached to the well?

YES ☒ NO

WELL ID #	DATE ATTACHED TO WELL

d. Other conditions?

YES ☒ NO

If "YES" to any of the above, identify the condition and describe the water user's actions to comply with the condition(s):

--

SECTION 6 ATTACHMENTS

Provide a list of any additional documents you are attaching to this report:

ATTACHMENT NAME	DESCRIPTION
WELL USE LOG	Water use log since July 2022

SECTION 7

CLAIM OF BENEFICIAL USE MAP

The Claim of Beneficial Use Map must be submitted with this claim. Claims submitted without the Claim of Beneficial Use map will be returned. The map shall be submitted on poly film at a scale of 1" = 1320 feet, 1" = 400 feet, or the original full-size scale of the county assessor map for the location.

Provide a general description of the survey method used to prepare the map. Examples of possible methods include, but are not limited to, a traverse survey, GPS, or the use of aerial photos. If the basis of the survey is an aerial photo, provide the source, date, series and the aerial photo identification number.

Combination of GPS with aerial photographic interpretation (Google Maps, 2021)

Map Checklist

Please be sure that the map you submit includes ALL the items listed below.

(Reminder: Incomplete maps and/or claims may be returned.)

- ☒ Map on polyester film.
- ☒ Appropriate scale (1" = 400 feet, 1" = 1320 feet, or the original full-size scale of the county assessor map)
- ☒ Township, Range, Section, Donation Land Claims, and Government Lots
- ☒ If irrigation, number of acres irrigated within each projected Donation Land Claims, Government Lots, Quarter-Quarters
- ☒ Locations of meters and/or measuring devices in relationship to point of diversion or appropriation.
- ☒ Conveyance structures illustrated (pumps, reservoirs, pipelines, ditches, etc.)
- ☒ Point(s) of diversion or appropriation (illustrated and coordinates)
- ☒ Tax lot boundaries and numbers
- ☐ Source illustrated if surface water
- ☒ Disclaimer ("This map is not intended to provide legal dimensions or locations of property ownership lines")
- ☒ Application and permit number or transfer number
- ☒ North arrow
- ☒ Legend
- ☒ CWRE stamp and signature

SECTION 8
REFERENCE INFORMATION FOR CWRE USE
(Please DO NOT submit these pages.)

Additional information is available at:

<https://www.oregon.gov/OWRD/programs/WaterRights/COBU/Pages/default.aspx>

Go to page "Resources for Certified Water Right Examiners"

^{8A}
MS Word Hints

To add rows to a table, click outside the table on the far right and hit enter.

← Place cursor here and
hit return to add a row

To resolve page numbering issues, go to print preview. Page through the entire document (while in print preview), then print from print preview.

Type text POA

DATE

Well Log CLAG 11337 2022

Water Rights Permit G-16154

Date End meter reading Gals pumped

Date	End meter reading	Gals pumped
June	46,607	46,607
July	95,966	49,359
August		

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Common Calculations

The Department typically uses the following calculations to determine system capacities; many of which are available to download from the Department's Web Site.

Pumps:

$$\text{Q Pump} = \frac{(\text{horsepower})(\text{pump efficiency})}{(\text{total head in feet})} = \text{Q in cfs}$$

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Efficiency factors:

NOTE: Pump efficiency factor for centrifugal pump (75%) = 6.61
Pump efficiency factor for turbine pump (80%) = 7.04

Centrifugal Pump, 75% eff. $\frac{(550 \text{ ft lb/sec/Hp})(.75)}{(62.4 \text{ lb/cu ft})} = 6.61 \text{ ft}^4/\text{sec/Hp}$

Turbine & Submersible Pumps, 80% eff. $\frac{(550 \text{ ft lb/sec/Hp})(.80)}{(62.4 \text{ lb/cu ft})} = 7.04 \text{ ft}^4/\text{sec/Hp}$

Total head is the sum of suction lift, pressure head, and discharge lift.

If the operating pressure is not measured, varying the assumed operational pressure in the above formulas until the calculated outputs are equal, or nearly so, will generally give the most correct theoretical capacity of the system.

Efficiencies have been assumed to be 75% for centrifugal pump installations and 80% for turbine or submersible pumps. See the list below of converted psi's to feet of head. These figures account for minor friction losses. If the system involves unusually long pipelines friction losses should be accounted for by using standard charts and formulas.

Refer to the conversion table below to compute PSI to head for pump pressure in feet.

$$[(\text{psi}/.433)(1.1) = \text{head (in feet/psi)} = 2.54 \text{ feet head/psi}]$$

PSI	HEAD	PSI	HEAD
25	63.5	55	139.7
30	76.2	60	152.4
35	88.9	65	165.1
40	101.6	70	177.8
45	114.3	75	190.5
50	127.0	80	203.2

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Ditches/Canals:

Manning's Formula:

$$v = \frac{1.486}{n} r^{2/3} s^{1/2}$$

v = mean velocity of flow in feet per second

r = hydraulic radius in feet

s = slope of the energy gradient

n = coefficient of roughness

Type of Conduit and Description Pipe	Coefficient of Roughness	
	Minimum	Maximum
Cast Iron, Coated	0.01	0.014
Cast Iron, Uncoated	0.011	0.015
Wrought Iron, Galvanized	0.013	0.017
Wrought Iron, Black	0.012	0.015
Steel, Riveted and Spiral	0.013	0.017
Corrugated	0.021	0.0255
Wood Stave	0.01	0.014
Neat Cement Surface	0.01	0.013
Concrete	0.01	0.017
Vitrified Sewer Pipe	0.01	0.017
Clay, Common Drainage Tile	0.011	0.017
Lined Channels		
Metal, Smooth Semicircular	0.011	0.015
Metal, Corrugated	0.0228	0.0244
Wood, Planed	0.01	0.015
Wood, Unplaned	0.011	0.015
Neat Cement-Lined	0.01	0.013
Concrete	0.012	0.018
Cement Rubble	0.017	0.03
Vegetated, Small Channels, Shallow Depths		
Bermuda Grass; Long - 13", Green	0.042	
Bermuda Grass; Long - 13", Dormant	0.035	
Bermuda Grass; Short - 3", Green	0.034	
Bermuda Grass; Short - 3", Dormant	0.034	
Unlined Channels		
Earth; Straight and Uniform	0.017	0.025
Dredged	0.025	0.033
Winding and Sluggish	0.0225	0.03
Stoney Bed, Weeds on Bank	0.025	0.04
Earth Bottom, Rubble Sides	0.028	0.035
Rock Cuts; Smooth and Uniform	0.025	0.035
Rock Cuts; Jagged and Irregular	0.035	0.045

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Gravity flow pipe systems

Hazen-William's Formula:

$$v = 1.31(c)(r^{0.63})(s^{0.54})$$

v = mean velocity of flow in feet per second

c = coefficient of roughness

r = hydraulic radius in feet

s = slope of energy gradient

Material	Coefficient of Roughness
Asbestos Cement	140
Brass	135
Brick sewer	100
Cast-Iron - new unlined (CIP)	130
Cast-Iron 10 years old	110
Cast-Iron 20 years old	95
Cast-Iron 30 years old	82
Cast-Iron 40 years old	74
Concrete	130
Copper	135
Ductile Iron Pipe (DIP)	140
Galvanized iron	120
Glass	140
Lead	135
Plastic	145
PVC, CPVC	150
Smooth Pipes	140
Steel new unlined	145
Steel	130
Steel riveted	110
Tin	130
Wood Stave	120

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SPRINKLER CAPACITIES BY NOZZLE SIZE IN GALLONS PER MINUTE

This chart is comprised of information gathered from a number of sources and may differ slightly from the manufacturer's specifications.

$$Q \text{ Sprinklers} = \frac{(\text{number of heads})(\text{rate in gallons per minute})}{(448.8 \text{ gpm per cfs})} = Q \text{ in cfs}$$

		P.S.I. ("**" designates computed capacity)																	
NOZZLE SIZE		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
	3/32				1.1	1.3	1.4	1.5	1.6	1.7	1.8								
	7/64				1.5	1.7	1.9	2	2.2										
	1/8				1.9	2.2	2.4	2.7	2.9	3	3.2								
	9/64				2.3	2.6	2.9	3.1	3.4	3.7	4								
	5/32				3	3.4	3.8	4.1	4.4	4.7	5								
	11/64	1.9	2.7	3.3	3.7	4.2	4.6	5	5.4	5.7	6	6.3	6.6						
	3/16	2.2	3.2	3.9	4.3	5	5.5	6	6.4	6.8	7.2	7.5	7.8						
	13/64	2.9	3.6	4.5	5.1	5.9	6.5	7.1	7.6	8.1	8.5	8.9	9.2						
	7/32		4.1	5.1	5.8	6.8	7.6	8.3	8.9	9.4	9.9	10.3	10.6						
	15/64							8.8		10		11.2		12.4					
	1/4		5.2	6.4	7.4	8.9	9.8	10.6	11.4	12.1	12.8	13.4	13.9	14.8*	15.3*	15.9*	16.4*	16.9*	17.4*
	17/64								12.5		14		15.6		17.1				
	9/32					11.2	12.3	13.3	14.3	15.2	16	16.8	17.5	18.1	18.9	19.7	20.7*	21.4*	22*
	19/64									16.6		18.3		19.9		21.4			
	5/16					13.1	15.2	16.5	17.7	18.9	20	21	22	23	23.9	24.8	25.7	26.4*	27.1*
	21/64										20.8		22.7		24.6		26.4		
	11/32					16.5	18	19.7	21.1	22.5	23.8	25	26.2	27.4	28.5	29.6	30.6	31.9*	32.8*
	23/64										24.5		26.8		29.1		31.4		
	3/8					19	21	22.8	24.4	26	27.5	29.1	30.6	32	33.2	34.5	35.7	38*	39*
	13/32								29*	30.9*	32.7*	34.5*	36.2*	37.4*	38.9*	40.4*	41.9*	43.3*	44.7*
	7/16								33.5*	35.6*	37.7*	39.7*	41.7*	43.6*	45.3*	46.9*	48.4*	50.1*	51.6*
	1/2								42.5*	45.2*	47.7*	50.2*	52.5*	54.7*	56.8*	58.6*	60.6*	63.6*	66.7*

NOTE: Use the maximum number heads operating at any one time.

Rate per head in gpm comes from either manufacturer's specifications using orifice size and operating pressure or from OWRD chart.