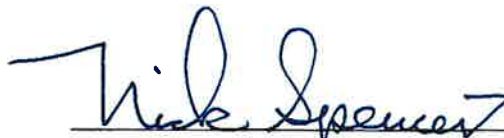


IDWR Concurrence:

 9-21-10

Vicky L. Music Date
Senior Water Resource Agent

 9-21-10

Nicholas B. Spencer Date
Deputy Attorney General
Attorney for IDWR

09/21/2010

IDAHO DEPARTMENT OF WATER RESOURCES
RECOMMENDED WATER RIGHTS ACQUIRED UNDER STATE LAW

RIGHT NUMBER: 63-5067

NAME AND ADDRESS: EDWARDS FAMILY LLC
4106 SAND CREEK
BOISE ID 83703

SOURCE: GROUND WATER

TRIBUTARY:

QUANTITY: 0.170 CFS 0.27
37.35 AFY 77.5

Use of this right with Right No. 63-14 is limited to a total combined diversion rate of ~~0.84~~ 0.33 cfs for outside irrigation.

NBS

PRIORITY DATE: 10/01/1930

VLM

POINT OF
DIVERSION:

T04N R02E S29 SWNE Within ADA County
T04N R02E S29 SWNE Within ADA County

PURPOSE AND
PERIOD OF USE:

<u>PURPOSE OF USE</u>	<u>PERIOD OF USE</u>	<u>QUANTITY</u>
COMMERCIAL	01/01 12/31	0.170 CFS 0.27
		37.35 AFY 77.5
IRRIGATION	01/01 12/31	0.170 CFS
	03/01 11/15	37.35 AFY

~~Commercial use is for a greenhouse business and includes all associated uses including use for retail offices and shop, heating, and irrigation inside and outside of the greenhouses.~~

Commercial use is for all uses within the greenhouses, shop, and apartment including domestic, retail shops and watering of plants. Irrigation use is for areas outside the greenhouses

PLACE OF USE: IRRIGATION in ADA County

T04N R02E S29 SWNE 8.30

COMMERCIAL in ADA County

T04N R02E S29 SWNE

8.3 ACRES TOTAL

Use of this right with Right No. 63-14 is limited to the outside irrigation of a combined total of 8.3 acres.

OTHER PROVISIONS NECESSARY FOR DEFINITION OR ADMINISTRATION OF THIS WATER RIGHT:

This partial decree is subject to such general provisions necessary for the definition of the rights or for the efficient administration of the water rights as may be ultimately determined by the Court at a point in time no later than the entry of a final unified decree. Section 42-1412(6), Idaho Code.

NBS
VLM

EXPLANATORY MATERIAL: BASIS OF CLAIM - Beneficial Use

Right includes accomplished change in purpose of use pursuant to Section 42-1425, Idaho Code.

Right includes accomplished change in point of diversion pursuant to Section 42-1425, Idaho Code.

Right no. 63-5065 is also diverted through point of diversions described above.

11/19/2008

IDAHO DEPARTMENT OF WATER RESOURCES
RECOMMENDED WATER RIGHTS ACQUIRED UNDER STATE LAW

RIGHT NUMBER: 63-5067

NAME AND ADDRESS: EDWARDS FAMILY LLC
4106 SAND CREEK
BOISE ID 83703

SOURCE: GROUND WATER

TRIBUTARY:

QUANTITY: 0.170 CFS
37.35 AFY

Use of this right with Right No. 63-14 is limited to a total combined diversion rate of .84 cfs, for irrigation.

PRIORITY DATE: 10/01/1930

POINT OF
DIVERSION:

T04N R02E S29 SWNE Within ADA County
T04N R02E S29 SWNE Within ADA County

PURPOSE AND
PERIOD OF USE:

<u>PURPOSE OF USE</u>	<u>PERIOD OF USE</u>	<u>QUANTITY</u>
COMMERCIAL	01/01 12/31	0.170 CFS 37.35 AFY
IRRIGATION	01/01 12/31	0.170 CFS 37.35 AFY

Commercial use is for a greenhouse business and includes all associated uses including use for retail offices and shop, heating, and irrigation inside and outside of the greenhouses.

PLACE OF USE: IRRIGATION in ADA County

T04N R02E S29 SWNE 8.30

COMMERCIAL in ADA County

T04N R02E S29 SWNE

8.3 ACRES TOTAL

Use of this right with Right No. 63-14 is limited to the irrigation of a combined total of 8.3 acres.

OTHER PROVISIONS NECESSARY FOR DEFINITION OR ADMINISTRATION OF THIS WATER RIGHT:

This partial decree is subject to such general provisions necessary for the definition of the rights or for the efficient administration of the water rights as may be ultimately determined by the Court at a point in time no later than the entry of a final unified decree. Section 42-1412(6), Idaho Code.

EXPLANATORY MATERIAL: BASIS OF CLAIM - Beneficial Use

Right includes accomplished change in purpose of use pursuant to Section 42-1425, Idaho Code.

Right includes accomplished change in point of diversion pursuant to Section 42-1425, Idaho Code.

watering
of
plants

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Recommendation Report 63-5067 V1

WATER RIGHT NUMBER: 63-5067 V1

<u>Owner Type</u>	<u>Name and Address</u>
Original Owner	PAUL W EDWARDS 4106 SAND CREEK BOISE, ID 83703 (208)342-7548
Current Owner	EDWARDS FAMILY LLC 4106 SAND CREEK BOISE , ID 83703 (208)342-7548
Attorney	HOFSTETTER LAW OFFICE LLC C/O DANA L HOFSTETTER 608 W FRANKLIN ST BOISE, ID 83702 (208)424-7800

Priority Date: 10/01/1930

Basis: Beneficial Use

Status: Active

SourceTributary

GROUND WATER

<u>Beneficial Use</u>	<u>From To</u>	<u>Diversion Rate</u>	<u>Annual Volume</u>
COMMERCIAL	01/01 to 12/31	0.170 CFS	37.35 AF
IRRIGATION	01/01 to 12/31	0.170 CFS	
	<u>Total Diversion:</u>	0.330 CFS	37.35 AF

Location of Point(s) of Diversion

GROUND WATER	SW1/4NE1/4	Sec. 29, Twp 04N, Rge 02E, B.M.
ADA County		

Place of UseCOMMERCIAL Within ADA County

T04N R02E S29 SWNE

IRRIGATION Within ADA County

T04N R02E S29 SWNE 8.3

Total Acres: 8.3

Conditions of Approval:

1. C04 Right includes accomplished change in purpose of use pursuant to Section 42-1425, Idaho Code.
2. C18 This partial decree is subject to such general provisions necessary for the definition of the rights or for the efficient administration of the water rights as may be ultimately determined by the Court at a point in time no later than the entry of a final unified decree. Section 42-1412(6), Idaho Code.

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Recommendation Report 63-5067 V1

3. E51 Use of this right with Right No. ~~64~~¹⁴ is limited to a total combined diversion rate of .33 cfs for irrigation.
4. Commercial use is for a greenhouse business and includes all associated uses including use for retail offices and shop, heating, and irrigation inside and outside of the greenhouses.
5. E55 Use of this right with Right No. 63-14 is limited to the irrigation of a combined total of 8.3 acres.

Remarks:Comments:

1. vmusic 5/24/2005 QUANTITY

Comment: CLAIMED 2 INCHES PER ACRE WHICH IS WHAT SILKEY V TIEG DECREE DECREED FOR THE GEOTHERMAL WELLS. THIS RIGHT WAS NOT DECREED SO REDUCED QUANTITY TO STANDARD DIVERSION RATE OF .02 CFS PER ACRE.

2. vmusic 5/24/2005 USES

Comment: DELETED DOMESTIC BECAUSE THERE IS ONE DOMESTIC USE CLAIMED UNDER 63-5063. COMMERCIAL USE COVERS ALL OTHER USES. COMMERCIAL CLAIMED PER 1979 IDWR MEMO. CHANGE MEMORIALIZES HISTORICAL USES FOR YEAR ROUND IRRIGATION AND HEATING IN GREENHOUSES.

Verification Log:

<u>Element</u>	<u>Date Time Stamp</u>	<u>Reviewer</u>	<u>Log text</u>
POD	5/24/2005 4:34:18 PM	vmusic	Updated shape
POU	5/24/2005 4:36:20 PM	vmusic	Updated shape for Active POU
Contacts	5/24/2005 4:32:51 PM	vmusic	(No) 1. Do you want to schedule an appointment?
			Comment for 1: DESKTOP REVIEW
POU	5/24/2005 4:35:40 PM	vmusic	(No) 1. Is the basis of this claim a Decree or License? (Yes) 2b. Is the POU required? (No) 3. Is the basis of claim a Application or Permit? (No) 7. Is there evidence that there has been a change in the POU? (Yes) 13. Does the file contain all the necessary information to verify the POU? (Yes) 14. Is a POU remark and/or condition required? Description for Question 13 - AERIALS AND FIELD EXAM

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Recommendation Report 63-5067 V1

Use	5/24/2005 4:37:34 PM	vmusic	(No) 1. Is the basis of this claim a Decree or License? (No) 2. Is the basis of this claim a Application or Permit? (No) 6. Is there evidence that there has been a change in the Purpose of Use? (Yes) 11. Does the file contain all the necessary information to verify the Water Use? (Yes) 13. Is a Purpose of Use remark and/or condition required? Description for Question 10,11,12 - FIELD EXAM
General	5/24/2005 4:33:25 PM	vmusic	(No) 1. Should this water use have been included in a later court decree of the water rights from this source? (No) 4. Is the basis of claim decree or license? (No) 7. Is the basis of claim a Application or Permit? (No) 8. Is the basis of claim a posted notice? (No) 9. Is the Priority Date claimed after the date a permit is required for the source and the water use? (Yes) 12. Does the claim file contain sufficient evidence of Priority Date? (Yes) 15. Is the basis of claim coded correctly? (No) 16. Is a Priority Date remark and/or condition required? Description for Question 12/13 - RECEIPT FOR WELL DATED IN 1930
POD	5/24/2005 4:33:45 PM	vmusic	(No) 1. Is the basis of this claim a Decree or License? (No) 2. Is the basis of this claim a Application or Permit? (No) 6. Is there evidence that there has been a change in the POD? (Yes) 9. Does the file contain all the necessary information to verify the POD? (No) 10. Is a POD remark and/or condition required?
Summary	5/24/2005 4:53:57 PM	vmusic	(No) 1. Is the basis of this claim a Decree, License, Permit, Application or Posted Notice? (No) 3. Is the water being used for all of the purposes claimed and to the extent claimed? (Yes) 4. Is any portion of the claim be recommended? (Yes) 5. Does this right have any combined use limits with other rights? (Yes) 6. Is an additional remark and/or condition required? (Yes) 7. Would you like to view the recommended right? (Yes) 8. Is this a split or combined right? (No) 9. Do you have documents you would like to attach or link to the file? (Yes) 10. Would you like to set the verification date?

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Recommendation Report 63-5067 V1

Source	5/24/2005 4:35:12 PM	vmusic	(No) 1. Is the basis of claim Decree or License? (No) 2. Is the basis of claim an Application or Permit? (No) 6. Is the basis of claim a Posted Notice? (No) 7. Is there evidence that there has been a change in the source? (Yes) 10. Does the file contain all the necessary information to verify the source? (No) 11. Is a Source remark and/or condition required? Description for Question 10 - FIELD EXAM
Season	5/24/2005 4:38:27 PM	vmusic	(No) 1. Is the basis of claim Decree or License? (No) 2. Is the basis of claim a Application or Permit? (No) 6. Is there evidence that there has been a change in the Period of Use? (Yes) 12. Does the file contain all the necessary information to verify the Period of Use? (No) 13. Is the basis of claim a decree, license, or a transferred beneficial use right that has had the Period of Use administratively determined? (Yes) 15. Is irrigation claimed as a Purpose of Use? (No) 18. Is a Period of Use remark and/or condition required?
Quantity	5/24/2005 4:45:10 PM	vmusic	(No) 1. Is the basis of this claim a Decree or License? (No) 2. Is the basis of this claim a Application or Permit? (No) 6. Is the basis of claim a posted notice? (Yes) 7. Is a flow measurement required? (Yes) 9. Is the source Groundwater and does the purpose of use require a diversion volume limit? (Yes) 10. Is a irrigation a purpose of use? (Yes) 12. Is a Quantity remark or condition required? Description for Question 7 - SEE FIELD EXAM FROM MAY 2005 Description for Question 10 - 8.3 ACRES X 4.5 AFA = 37.35

Water Supply Bank:

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

RECEIVED

DEC 14 2007

DEPARTMENT OF WATER RESOURCES

Notice of Security Interest in a Water Right

And Request for Notification of a Change in Ownership or Any Proposed
Or Final Action to Amend, Transfer, or Otherwise Modify a Water Right

RECEIVED

JAN 24 2008

WATER RESOURCES
WESTERN REGION

Please print or type. Attach pages with additional information. Instructions are on the back of this page.
Incomplete forms will be returned.

1. Water Right No(s): AJ AJ AJ 63-14, 63-5065, 63-5067
Adjudication Claim No(s): _____
2. The following **REQUIRED** information must be submitted with this form:
 - A) Evidence of the security interest. This may be a copy of a **DEED of TRUST, MORTGAGE, CONTRACT OF SALE** or other legal document indicating your interest in the property and water rights or claims in question, **WITH ATTACHED LEGAL DESCRIPTION.**
 - B) A **FEE** of \$25.00 per water right or adjudication claim.
3. Name and Mailing Address of Person or Company holding Security Interest

D. L. Evans Bank
P.O. Box 87
Twin Falls, ID 83303
4. Name of Water Right Owner/Claimant(s) EDWARDS FAMILY LLC
5. Expiration Date of Notification Period 11-15-2022
6. Is this a Renewal of Request for Notification? ☐ YES ☐ NO
7. Signature(s) (and title if applicable) MELINDA JOHNSON 
Loan Processor

For Office Use Only

Received by	_____	Date	_____	Fee	<u>75.00</u>
Received by	<u>KAW</u>	Date	<u>12/14/07</u>	Receipt No.	<u>C.085515</u>
Processed by	<u>AJ</u>	Date	<u>1-24-08</u>	WR	_____
				Date	_____

SCANNED

JAN 22 2008

ADA COUNTY RECORDER J. DAVID NAVARRO
BOISE IDAHO 11/30/07 02:27 PM
DEPUTY Bonnie Oberbillig
RECORDED - REQUEST OF
Pioneer

AMOUNT 6.00 2



RECORDATION REQUESTED BY:

D. L. Evans Bank
Meridian Fairview Branch
2560 E. Fairview Ave.
Meridian, ID 83642

WHEN RECORDED MAIL TO:

D. L. Evans Bank
Meridian Fairview Branch
2560 E. Fairview Ave.
Meridian, ID 83642

SEND TAX NOTICES TO:

Edwards Family LLC
4021 Hill Road
Boise, ID 83703

DA 9055

SPACE ABOVE THIS LINE IS FOR RECORDER'S USE ONLY

MODIFICATION OF DEED OF TRUST

THIS MODIFICATION OF DEED OF TRUST dated November 29, 2007, is made and executed between Edwards Family LLC; an Idaho Limited Liability Company ("Grantor") and D. L. Evans Bank, whose address is Meridian Fairview Branch, 2560 E. Fairview Ave., Meridian, ID 83642 ("Lender").

DEED OF TRUST. Lender and Grantor have entered into a Deed of Trust dated November 16, 2007 (the "Deed of Trust") which has been recorded in Ada County, State of Idaho, as follows:

Deed of Trust dated November 16, 2007 and recorded November 20, 2007 as Instrument No. 107156054 and modified this date.

REAL PROPERTY DESCRIPTION. The Deed of Trust covers the following described real property located in Ada County, State of Idaho:

LOT 2, 3 AND 4 OF THOMAS F. EDWARDS SUBDIVISION, ACCORDING TO THE OFFICIAL PLAT THEREOF, FILED IN BOOK 11 OF PLATS AT PAGE 616, OFFICIAL RECORDS OF ADA COUNTY, IDAHO.

The Real Property or its address is commonly known as 4106 Sand Creek Street, Boise, ID 83703.

MODIFICATION. Lender and Grantor hereby modify the Deed of Trust as follows:

Deed of Trust being modified to add the following water right information:

TOGETHER WITH THE WATER RIGHTS REPRESENTED BY IDAHO STATE DEPARTMENT OF WATER RESOURCES WATER RIGHT NO. 63-14 WITH A CLAIMED PRIORITY OF NOVEMBER 22, 1926 TO 0.84 CFS OF GROUNDWATER, AND WATER RIGHT NO. 63-5065 WITH A CLAIMED PRIORITY OF OCTOBER 01, 1956 TO 0.04 CFS OF GROUNDWATER, AND WATER RIGHT NO. 63-5067 WITH A CLAIMED PRIORITY OF OCTOBER 1, 1930 TO 0.33 CFS OF GROUNDWATER, TOGETHER WITH ANY AND ALL OTHER WATER RIGHTS AND DITCH RIGHTS.

CONTINUING VALIDITY. Except as expressly modified above, the terms of the original Deed of Trust shall remain unchanged, and in full force and effect. Consent by Lender to this Modification does not waive Lender's right to require strict performance of the Deed of Trust as changed above nor obligate Lender to make any future modifications. Nothing in this Modification shall constitute a satisfaction of the promissory note or other credit agreement secured by the Deed of Trust (the "Note"). It is the intention of Lender to retain as liable all parties to the Deed of Trust and all parties, makers and endorser to the Note, including accommodation parties, unless a party is expressly released by Lender in writing. Any maker or endorser, including accommodation makers, shall not be released by virtue of this Modification. If any person who signed the original Deed of Trust does not sign this Modification, then all persons signing below acknowledge that this Modification is given conditionally, based on the representation to Lender that the non-signing person consents to the changes and provisions of this Modification or otherwise will not be released by it. This waiver applies not only to any initial extension or modification, but also to all such subsequent actions.

GRANTOR ACKNOWLEDGES HAVING READ ALL THE PROVISIONS OF THIS MODIFICATION OF DEED OF TRUST AND GRANTOR AGREES TO ITS TERMS. THIS MODIFICATION OF DEED OF TRUST IS DATED NOVEMBER 29, 2007.

GRANTOR:

Music, Vicky

From: Music, Vicky
Sent: Tuesday, August 14, 2007 4:11 PM
To: 'Norm Young'
Cc: Shurte, Jan; Dana L. Hofstetter (E-mail)
Subject: RE: Edwards recommendations

Tracking:	Recipient	Delivery	Read
	'Norm Young'		
	Shurte, Jan	Delivered: 8/14/2007 4:11 PM	Read: 8/15/2007 7:45 AM
	Dana L. Hofstetter (E-mail)		

Hi Norm -

Norm, we have discussed these a few times now, and the Department's position has not changed. Here are the contested elements of 63-5067:

Quantity - should be .33 cfs each for irrigation and commercial for total of .33 cfs.

IDWR's position: Thought requested, the claimant has not provided a basis for a flow rate greater than the statutory rate. We have recommended a quantity for other greenhouses in the area at .02 cfs/acre.

Purpose - domestic should be added for the home and commercial use should be consistent with 63-14.

IDWR's position: the domestic use was developed in 1956 and 63-5065 covers this use. we have added the house well as a pod, bit will not add the use. The commercial quantity does not have to be the same as 63-14 which was decreed at a different rate.

POU - should clarify that irrigation does not refer to irrigation inside the greenhouses and domestic pou should be added.

IDWR's position: We can certainly specify that irrigation does not refer to irrigation inside of the greenhouse, but we will decrease the acres irrigated to those few acres outside of the greenhouse and adjust the quantity accordingly.

65-5065: **IDWR's position:** Aerials since 1964 indicate that no more that 1/4 acre has been irrigated under this right. The cold water well under 63-5067 was recommended as a 2nd pod. No change.

Perhaps you, me and Jan could have a phone conference next week to discuss further if you think it necessary. Tuesday or Wednesday morning is good for both of us right now. Let me know. Thanks - Vicky Music

-----Original Message-----

From: Norm Young [mailto:nyoung@erresources.com]
Sent: Tuesday, August 14, 2007 11:25 AM
To: Music, Vicky
Cc: Dana Hofstetter
Subject: Re: Edwards recommendations

Vicky:

Dana Hofstetter asked that I discuss 63-5065 and 63-5067 with you. Will you suggest a time to sit down and review the information together? My schedule is pretty flexible.

Norm

8/16/2007

----- Original Message -----

From: [Music, Vicky](#)
To: [Norm Young](#)
Sent: Tuesday, May 29, 2007 11:15 AM
Subject: RE: Edwards recommendations

9 am?

-----Original Message-----

From: Norm Young [mailto:nyoung@eroresources.com]
Sent: Tuesday, May 29, 2007 9:33 AM
To: Music, Vicky
Cc: Dana Hofstetter
Subject: Re: Edwards recommendations

Vicky:

Tomorrow morning works for me. What time would you like for me to call?

Norm

----- Original Message -----

From: [Music, Vicky](#)
To: [Norm Young](#)
Sent: Tuesday, May 29, 2007 8:37 AM
Subject: RE: Edwards recommendations

Norm, I am in the office Tues, Wed, Thurs of this week and Thurs is my office day. what about tomorrow? Vicky

-----Original Message-----

From: Norm Young [mailto:nyoung@eroresources.com]
Sent: Friday, May 25, 2007 9:05 AM
To: Music, Vicky
Subject: Re: Edwards recommendations

Vicky, I am in the office for only a short time today. Will next week work for you? Norm

----- Original Message -----

From: [Music, Vicky](#)
To: nyoung@eroresources.com
Sent: Thursday, May 24, 2007 8:48 AM
Subject: Edwards recommendations

Hi Norm -

sorry I did not return you call last week as I said I would. Please let me know if and when you are available this week to discuss the Edwards recommendations. Thanks.

Vicky L. Music
Sr. Water Resource Agent
Adjudication Bureau
IDWR/Western Region
2735 Airport Way
Boise, Idaho 83705-5082
(208) 334-2190

MEMORANDUM

TO: VICKY MUSIC
IDAHO DEPARTMENT OF WATER RESOURCES

FROM: NORM YOUNG *NY*

RE: EDWARDS GREENHOUSES SRBA CLAIM 63-5067

DATE: AUGUST 9, 2007

*mem received in on 8/27/10 nts w/
norm, Dana, Ray
nys for
mal
prep*

Information on the following matters is being provided to you as a follow up to our conversations on the above referenced claim:

1. Diversion Rate from the Cold Water Wells. The theoretical diversion rate from the larger diameter well with the larger pumping system is about 0.27 cfs (based upon 5 hp, a 40-psi operating pressure at the pump, a 30-foot pumping lift in the well and a 75% operating efficiency). On September 13, 2006, I used a Peek flow meter to measure the system flow rate with only the larger pump operating. A flow rate of 0.18 cfs was measured with the system operating at 60-psi at the pump. This measurement confirms that the system is capable of pumping 0.27 cfs as determined from the theoretical calculation when the system is operating at a lower pressure representative of operating conditions at times of high water demand.

The smaller diameter well has a theoretical capacity of about 0.08 cfs (based upon 1.5 hp, a 40 psi operating pressure at the pump, a 30 foot pumping lift in the well and a 75% operating efficiency). A measurement made on September 13, 2006 using the Peek flow meter found that the pumping capacity of the smaller system, operating separately, was about 0.10 cfs at 40 psi operating pressure.

The flow rate in the system with both pumps operating could not be measured.

The flow rate that can be recognized for "commercial purposes" is not constrained to the statutory guideline of 0.02 cfs per acre commonly associated with irrigation uses. The entire available flow rate from the cold water system is needed during peak periods of use for watering of plants in the greenhouses, maintenance and cleaning in the greenhouses, and use in the retail shop. The claimant described the typical operating schedule for diverting and using cold water as follows: The larger pump is operated an estimated equivalent of full capacity for 12 hours per day from March 1 to September 30 and at about ½ of that rate the remainder of the year. The smaller pump is used for backup purposes whenever the larger pump is not operating adequately.

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2. The combined diversion rate limitation on Right Nos. 63-14 and 63-5067 should be consistent. IDWR's Recommendation for Right No. 63-14 includes a limitation in the "Quantity" element as follows:

"Use of this right with Right No. 63-5067 is limited to a total combined diversion rate of 0.33 cfs."

Conditions limiting the combined diversion rate from cold water wells and the low-temperature geothermal water use under Right No. 63-14 should be applicable only to irrigation use because during cold weather the full authorized rate for the warm water is used to heat the greenhouses while at the same time, cold ground water is used for plant watering in the greenhouses and other commercial uses.

3. Annual Diversion Volume from Cold Water Wells. The annual volume of diversion IDWR recognizes for irrigation purposes in the Boise area of 4.5 af/a is based upon IDWR's recognized irrigation season for the area of March 1 to November 15 (260 days). It is not appropriate to use these irrigation guidelines to define the annual volume of diversion needed within the Edwards greenhouses. Elevated temperatures are maintained year-round within the greenhouses to encourage plant growth. Water needed for plant growth in greenhouses is unique to each greenhouse operation and can be significantly greater than for outdoor irrigation of crops depending upon factors such as the temperature maintained in the buildings, the stacking of layers of plants, the types and growth stages of the plants, and the rate of air exchange through the building.

IDWR's recommendation should recognize commercial use for year-round watering of plants in the greenhouses. Additionally, other factors that increase the volume required for plant watering in greenhouses compared to outside irrigation should be addressed, such as the elevated temperatures maintained throughout the year in a greenhouse, the difference in plant maturity in a greenhouse environment as compared to field crops, and the layering of trays of plants within the greenhouses. An estimate of annual diversion volume that accounts for these factors is attached. Based upon this estimate 10.9 afa should be recognized for greenhouses in the Boise area. For comparison, a publication from the University of Arkansas (copy attached) indicates that 13 afa is needed for irrigation of nursery stock and over 24 afa for irrigation within greenhouses.

With about 3 acres of greenhouses, the annual volume under Right No. 63-5067 for commercial use for watering of plants within the greenhouses should be at least (3 acres)(10.9 afa) = 32.7 afa.

Additional annual volume is needed for other uses of water within "commercial purposes." The range of volumes of wastewater generated for commercial areas having mixed uses is estimated to be from 800 to 2000 gals/acre-day (*Small and Decentralized Wastewater Management Systems*, Crites and Tchobanoglous,

McGraw-Hill, 1998, p. 170). Using the upper end of this range as an estimate of water diversion requirement, indicates that an additional 6.7 afa is needed. The annual commercial use of cold ground water within the greenhouses is the sum of that needed for plant watering (32.7 afa) and that needed for other commercial uses (6.7 afa) which totals 39.4 afa.

Irrigation of the area outside would require $(8.3 \text{ acres} - 3 \text{ acres})(4.5 \text{ afa}) = 23.9 \text{ afa}$.

Based on these calculations, the combined total use of cold ground water for irrigation of outside crops and landscaping and commercial uses within the greenhouse is 39.4 afa for commercial plus 23.9 afa for outside irrigation = 63.3 afa.

The operating schedule described by the claimant provides a basis for evaluating the accuracy of the annual volume calculated in the preceding paragraphs. Operating the larger pump at the equivalent rate of full capacity 12 hours per day from March 1 to September 30 (214 days) and at one-half of that equivalent rate the remainder of the year would result in the diversion of about 77.5 afa, which also would be a justifiable annual volume.

Conclusions:

1. For Right No. 63-5067, the diversion rate for commercial purposes should be 0.27 cfs.
2. The limitation on the combined rate of diversion for Right Nos. 63-14 and 63-5067 should apply only to irrigation, i.e., not exceed 0.33 cfs combined for irrigation purposes.
3. For Right No. 63-5067, the annual volume of diversion for irrigation purposes should be 37.35 afa (recognizes that irrigation has occurred on the entire parcel); for commercial purposes it should be 39.4 afa (recognizes extent of greenhouse use in 1987), and for combined irrigation and commercial the annual diversion volume should be 63.3 afa to 77.5 afa.

WATER REQUIRED FOR INHOUSE PLANT WATERING

ASSUMPTIONS:

- 1) AVERAGE ANNUAL TEMPERATURE MAINTAINED IN GREENHOUSES IS SIMILAR TO AVERAGE TEMPERATURE DURING SUMMER IN BOISE.
- 2) EVAPOTRANSPIRATION FROM PLANTS IN GREENHOUSE (LUSH FOLIAGE) IS APPROXIMATED BY REFERENCE ET FOR ALFALFA.

DATA + INFORMATION RELIED UPON:

- 1) GARNETTE MONNIE (TELECON 6/6/07):
 - TRY TO MAINTAIN TEMPERATURE OF 68°F TO 74°F IN ALL BUILDINGS ALL YEAR.
 - SUMMER TEMPERATURES OFTEN EXCEED DESIRABLE RANGE (INADEQUATE COOLING)
 - SOME RUNOFF TO IRRIGATION LATERAL/DRYWELLS
 - HUMIDITY IS NOT MAINTAINED @ ELEVATED LEVELS EXCEPT FOR A SMALL ROOM USED FOR PLANT CUTTING / PROPAGATION.
 - PLANTS ARE STACKED IN 3 LAYERS OVER ABOUT 1/2 of building about 1/2 of year.
 - COLD WATER USED @ MAXIMUM RATE APRIL through September + EXTENSIVELY the rest of year.

2) NLWS:

- AVERAGE TEMPERATURES IN BOISE

JUNE	-	67.2°F
JULY	-	74.7°F
AUGUST	-	73.9°F

3) UofI Extension (ALLEN & BRISON 2007) estimate of REFERENCE ET for ALFALFA:

JUNE	-	7.84 mm/day
JULY	-	8.30 mm/day
AUGUST	-	7.16 mm/day
AVE		7.77 mm/day

4) 1986 + 1994 AERIAL PHOTOS FROM IDWR:

AREA COVERED BY GREENHOUSES IS ABOUT 3 ACRES.

ESTIMATE OF ANNUAL VOLUME OF COLD WATER DIVERTED FOR PLANT WATERING IN GREENHOUSES:

① ESTIMATE BASED UPON SUMMERTIME EVAPOTRANSPIRATION RATE SUSTAINED YEAR-ROUND IN GREENHOUSES:

$$- \frac{(7.77 \text{ mm/day})(365 \text{ days/yr})}{304.8 \text{ mm/ft}} = 9.3 \text{ ft/yr}$$

- @ 85% application efficiency (ref: "DESIGN AND OPERATION OF FARM IRRIGATION SYSTEMS" AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS 1983, P. 695).

$$9.3 \text{ ft/yr} / 0.85 = \boxed{10.9 \text{ ft/yr}}$$

- FOR 3 acres of GREENHOUSES

$$(3)(10.9) = \boxed{32.7 \text{ AF/yr}}$$

② ESTIMATE BASED UPON PUMP OPERATION:

$$- \text{Summer: } (214 \text{ days})(0.27 \text{ cfs})(1.9825) = 57.3 \text{ A-F}$$

$$- \text{Rest of year: } (156 \text{ days})(0.27 \text{ cfs})(1.9825) = 20.2 \text{ A-F}$$

$$- \text{FULL YEAR OPERATION} = \boxed{77.5 \text{ AF/yr}}$$

THIS VOLUME INCLUDES ALL COLD WATER PUMPED FOR ALL PURPOSES, INCLUDING OUTSIDE IRRIGATION + OTHER COMMERCIAL PURPOSES IN GREENHOUSES. INDICATES THAT THE ABOVE ESTIMATE FOR PLANT WATERING IS WITHIN THE AMOUNT PUMPED.

Please note this information is preliminary and subject to revision. Official and certified climatic data can be accessed at the National Climatic Data Center (NCDC) (<http://www.ncdc.noaa.gov/oa/ncdc.html>).

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CXUS55 KBOI 020953

CLMBOI

CLIMATE REPORT...UPDATED
NATIONAL WEATHER SERVICE BOISE
355 AM MDT TUE AUG 1 2006

.....
...THE BOISE CLIMATE SUMMARY FOR THE MONTH OF JULY 2006...

...BLISTERING HEAT DURING JULY 2006 IS ONE FOR THE RECORD BOOKS...

JULY 2006 WILL GO ON RECORD AS THE HOTTEST MONTH SINCE 1940 AND THE SECOND HOTTEST OVERALL. THIS INCLUDES YEARS OF RECORD KEEPING AT THE BOISE AIRPORT AND DOWNTOWN BOISE DATING BACK INTO THE 1800'S. THE AVERAGE MONTHLY TEMPERATURE WAS ~~81.5~~ WHICH WAS ~~6.8~~ DEGREES ABOVE NORMAL. THE AVERAGE HIGH TEMPERATURE WAS A SEARING 97.1.

ODDLY ENOUGH THERE WERE NO INDIVIDUAL DAILY RECORDS SET DURING JULY...HOWEVER BOISE TIED A RECORD OF NINE CONSECUTIVE DAYS OF 100 DEGREES OR MORE. THIS STRING OF INTENSE HEAT BEGAN ON JULY 20TH AND RAN THROUGH JULY 28TH. THE HOTTEST TEMPERATURE DURING THE MONTH WAS 107F ON JULY 22ND. THERE WERE ONLY THREE DAYS WITH HIGHS IN THE 80S BUT THERE WAS A WHOPPING 13 DAYS OF 100 DEGREES OR MORE.

MEASURABLE PRECIPITATION FELL ON ONLY TWO DAYS DURING JULY IN THE BEGINNING OF THE MONTH AND THE TOTAL FOR JULY WAS ONLY A QUARTER OF AN INCH. NEEDLESS TO SAY...AIR CONDITIONING AND IRRIGATION SYSTEMS WERE KEPT WORKING OVERTIME DURING THE ENTIRE MONTH.

.....
CLIMATE NORMAL PERIOD 1971 TO 2000
CLIMATE RECORD PERIOD 1872 TO 2006

WEATHER	OBSERVED		NORMAL	DEPART
	VALUE	DATE(S)	VALUE	FROM
				NORMAL

TEMPERATURE (F)

HIGHEST	107	07/22		
LOWEST	54	07/31		
AVG. MAXIMUM	97.1		89.2	7.9
AVG. MINIMUM	65.9		60.3	5.6
MEAN	81.5		74.7	6.8
DAYS MAX >= 90	28			
DAYS MAX <= 32	0			
DAYS MIN <= 32	0			
DAYS MIN <= 0	0			

PRECIPITATION (INCHES)
RECORD

MAXIMUM	2.01	1913		
TOTALS	0.14		0.39	-0.25
DAYS >= .01	2			
DAYS >= .10	0			
DAYS >= .50	0			
DAYS >= 1.00	0			

GREATEST

24 HR. TOTAL	0.07	07/04 TO 07/04		
--------------	------	----------------	--	--

DEGREE DAYS

COOLING TOTAL	518	297	221
SINCE 1/1	787	453	334

WIND (MPH)

AVERAGE WIND SPEED	7.3		
RESULTANT WIND SPEED/DIRECTION	1/292		
HIGHEST WIND SPEED/DIRECTION	35/120	DATE	07/04
HIGHEST GUST SPEED/DIRECTION	46/090	DATE	07/04

SKY COVER

POSSIBLE SUNSHINE (PERCENT)	96
-----------------------------	----

AVERAGE RH (PERCENT)	32
----------------------	----

- INDICATES NEGATIVE NUMBERS.

R INDICATES RECORD WAS SET OR TIED.

MM INDICATES DATA IS MISSING.

5 INDICATES TRACE AMOUNT.

ET Idaho --- Evapotranspiration and Consumptive Irrigation

Water Requirements for Idaho

Please send suggestions for improving this site to robison at kimberly dot uidaho dot edu Copyright 2007, University Idaho.

Boise WSFO Airport (NWS NOAA--101022)

Statistics based on 30 years between 1974 to 2004

For a different land cover or crop click on the above link.

You can highlight this table and copy via the clipboard to a Microsoft Excel or OpenOffice spreadsheet to plot or otherwise work with this data.

Alfalfa Reference Evapotranspiration ETr														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Growing Season ^a	Annual
Mean	mm/day												mm	
Monthly ^b	0.71	1.61	3.24	5.17	6.52	7.84	8.30	7.16	5.54	3.76	1.44	0.69	0	1586
15-Day Moving Average ^c	0.69	1.57	3.27	5.19	6.52	7.88	8.36	7.10	5.46	3.81	1.42	0.67		
7-Day Moving Average ^d	0.70	1.59	3.25	5.15	6.52	7.87	8.34	7.14	5.50	3.80	1.41	0.68		
3-Day Moving Average ^e	0.70	1.60	3.24	5.15	6.52	7.85	8.31	7.16	5.53	3.77	1.43	0.68		
Standard Deviation	mm/day												mm	
Monthly	0.23	0.37	0.76	0.72	1.04	0.66	0.73	0.66	0.54	0.61	0.29	0.30	0	82
15-Day Moving Average	0.19	0.44	0.66	0.86	1.05	0.90	0.63	0.68	0.77	0.62	0.38	0.24		
7-Day Moving Average	0.27	0.59	0.82	1.18	1.42	1.28	0.82	0.93	0.99	0.89	0.48	0.30		
3-Day Moving Average	0.36	0.73	1.06	1.52	1.81	1.73	1.21	1.20	1.30	1.12	0.60	0.38		
20% Exceedance	mm/day												mm	
Monthly	0.86	1.88	3.54	5.82	7.07	8.46	8.59	7.65	5.99	4.01	1.64	0.80	0	1641
15-Day Moving Average	0.98	2.26	4.36	6.73	8.30	9.14	9.16	8.10	6.50	4.70	2.23	0.97		
7-Day Moving Average	1.22	2.95	4.72	7.50	9.25	10.00	9.89	8.67	7.26	5.27	2.51	1.23		
3-Day Moving Average	1.50	3.25	6.09	8.65	10.59	11.03	10.55	9.40	8.07	6.12	3.01	1.59		

80% Exceedance	mm/day													mm	
Monthly	0.54	1.25	2.72	4.45	5.92	7.32	7.76	6.65	5.12	3.36	1.10	0.48		0	1506
15-Day Moving Average	0.41	0.97	2.36	3.76	4.72	6.50	7.19	5.88	4.32	2.61	0.87	0.33			
7-Day Moving Average	0.14	0.64	1.77	3.29	3.85	5.33	6.58	5.12	3.51	1.97	0.65	0.16			
3-Day Moving Average	0.06	0.23	1.35	2.66	2.92	4.10	5.28	4.00	2.59	1.45	0.40	0.07			
Ave Highest ET	mm/day													--	
15-Day Moving Average ^f	0.86	1.94	3.81	5.87	7.47	8.69	8.82	7.75	6.12	4.41	1.75	0.83			
7-Day Moving Average ^g	1.08	2.36	4.31	6.72	8.45	9.47	9.43	8.37	6.85	5.06	2.07	1.04			
3-Day Moving Average ^h	1.37	2.80	5.19	7.79	9.61	10.47	10.17	8.99	7.68	5.64	2.56	1.34			
Ave Lowest ET	mm/day													--	
15-Day Moving Average ^f	0.54	1.28	2.73	4.47	5.64	7.05	7.80	6.47	4.82	3.15	1.12	0.53			
7-Day Moving Average ^g	0.35	0.96	2.28	3.79	4.72	5.93	7.18	5.92	4.26	2.63	0.89	0.35			
3-Day Moving Average ^h	0.18	0.63	1.78	3.11	3.66	4.69	5.92	4.87	3.43	2.04	0.61	0.13			
Special normal distribution parameters for monthly, seasonal, and annual intervals														--	
Skew	0.04	0.44	0.26	0.48	0.26	-0.02	-0.15	0.00	0.23	0.27	-0.24	0.45		0.00	0.35
Kurtosis	0.64	2.38	0.81	2.95	1.07	2.22	0.81	0.54	2.83	0.85	2.26	1.26		0.00	3.17

^a Growing Season: This is usually the time from green up or planting in the spring to a killing frost or harvest in the fall. It is not applicable for entries without a growing season and will be blank.

^b Mean of the average daily value for month

^c Mean of the fourteen 15-day period averages contained in the month

^d Mean of the twenty three 7-day period averages contained in the month

^e Mean of the twenty seven 3-day period averages contained in the month

^f Mean of the highest/lowest 15-day period average in month

^g Mean of the highest/lowest 7-day period average in month

^h Mean of the highest/lowest 3-day period average in month

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This work and report were prepared by the University of Idaho Research and Extension Center at Kimberly, Idaho under contract with the Idaho Department of Water Resources. Work was supported by funding from IDWR and the Idaho Agricultural Experiment Station and Idaho Engineering Experiment Station. The authors gratefully acknowledged the long-term evapotranspiration data collection and long-standing advice provided by Dr. James L. Wright, USDA-ARS Kimberly (ret.), the more than two decades of high quality agricultural weather data collection by the U.S. Bureau of Reclamation AgriMet system, and the very long-standing, routine data collection by the hundreds of cooperative weather station volunteers across the state who, for more than one-hundred years, have faithfully observed daily air temperature and precipitation.

The citation for the evapotranspiration data used from this site should be: *Allen, Richard G. and Clarence W. Robison 2006 (Revised 2007). Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho, Research Technical Completion Report, Kimberly Research and Extension Center, University of Idaho, Moscow, ID.*

Questions regarding the data should be addressed to Clarence W. Robison or Richard G. Allen, University of Idaho, Kimberly Research and Extension Center, 3793 North 3600 East, Kimberly, ID 83341. Telephone (208)-423-6610

Irrigation Water for Greenhouses and Nurseries

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Both the **quality** and **quantity** of water are critical to the successful production of plants in a greenhouse or nursery. While considered a critical parameter, water issues are frequently overlooked by most growers. Parameters deemed suitable for drinking water purposes are not necessarily acceptable for growing plants. Appropriate tests should be conducted **prior** to selecting a greenhouse or nursery site.

chemical water quality parameters are soluble salts, hardness, sodium and chloride concentration and pH. In a few cases, elements such as iron, boron and fluoride are also considered critical parameters. Chemical properties, like physical and biological, may change significantly during a year, particularly as the demand increases on a ground well and the water table is lowered.

Water Quality

Water quality properties can be divided into three categories: **physical**, **biological** and **chemical**. Critical **physical** properties include suspended solids and temperature. Suspended solids such as soil particles are potential problems since these particulates can clog irrigation nozzles and cause abrasion of irrigation equipment. Water temperature can be an important consideration, particularly when growing foliage plants where high or low temperature water can cause leaf spotting that reduces the value of these plants.

Important **biological** properties include algae, microbes and disease organisms. Algae and microbes are a concern since they may cause clogging of irrigation system components.

Chemical properties are typically given the most focus when dealing with irrigation water. From the grower's standpoint, the most critical

Table 1 includes general guidelines for irrigation water used in plant production. A more detailed discussion on several of these parameters is required.

pH

In general terms, pH is a measure of the hydrogen ion concentration. The pH can vary on a scale from 0-14 with a pH of 7 being neutral, less than 7 considered acid and above 7 called basic or alkaline. Irrigation water with a pH of 4 might be termed **very acid** and water with a pH of 8.5 **very alkaline**. The pH is an important parameter to know since it will influence the relative solubility of certain nutrients and can impact the solubility of certain chemicals or pesticides used in grower operations. The pH of irrigation water is not generally as critical a measurement as the pH of the media. While the term pH is often used interchangeably with **alkalinity**, these are two totally different parameters.

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Table 1. General Guidelines for Irrigation Water Used in Plant Production

Parameter*	Units	Upper Limit	Optimum Range
EC	$\mu\text{mho/cm}^{****}$	750 plugs; 1,250 greenhouse; 1,500 nursery	0-300
TDS** (total dissolved solids)	ppm (1 ppm = 1 mg/l)	480 plugs; 800 greenhouse; 960 nursery	0-192
pH	---	possibly 8.0 upper; 4.5 lower	5.2-6.8
Alkalinity	ppm CaCO_3	200 (90 for foliar spotting) (1 meq/l CaCO_3 = 50 mg/l CaCO_3)	0-60 plugs 0-100 greenhouse 0-140 nursery
Bicarbonate (HCO_3^-) (EW = 61)***	ppm meq/l	150 2.4	30-50 0.5-0.8
Hardness	ppm CaCO_3	200	20-150
Na (EW = 23)	ppm meq/l	50 (keep <10% of total salts) 2.2	0-30 0-1.3
SAR	---	4 greenhouse; 6 nursery	0-3
Ca (EW = 20)	ppm meq/l	120 6	40-100 2-5
Mg (EW = 12)	ppm meq/l	50 4.2	5-25 0.4-2.1
Nitrate-N (EW = 14)	ppm meq/l	50 3.6	0-10 0-0.7
P	ppm	5	0-1
K (EW = 39)	ppm meq/l	10 0.25	1-10 0.02-0.2
Sulfate (EW = 48) SO_4	ppm meq/l	240 5	25-200 0.5-4.2
Fe	ppm	5 (<1 to avoid foliar spotting)	1-3
Mn	ppm	1	0.2-1
B	ppm	2	0.2-0.5
Cl (EW = 35.5)	ppm meq/l	140 3.9	1-50 0.03-1.4
F	ppm	1	0-1
Al	ppm	5	0-5
Mo	ppm	0.07	0-0.05
Zn	ppm	2	0-0.2
Cu	ppm	0.2	0.05-0.15

* Play the charge balance game. Express the concentrations of the four major cations (K, Na, Mg, Ca) and the four major anions (HCO_3 , Cl, SO_4 and NO_3) in meq/l. Add the cations up, then add the anions up. The cation total should be very close to the anion total if the analysis is correct.

** TDS can be estimated from EC. An EC of 1,000 $\mu\text{mho/cm}$ equals approximately 640 ppm total dissolved solids. Also referred to as total suspended solids.

*** EW = equivalent weight of the ion.

**** 1,000 $\mu\text{mho/cm}$ = 1 mmho/cm = 1 dS/m = 1 mS/cm .

Alkalinity

While pH is a measure of the hydrogen ion concentration, alkalinity is a relative measurement of the **capacity** of water to resist a change in pH or the ability of the water to change the pH of the growing media. You may wish to think of alkalinity as the **buffering capacity** of the water – how well it resists or causes a change in pH. It is not uncommon to have irrigation water with a pH of 7.5 (alkaline) but with a low alkalinity value that is quite acceptable for growing plants.

Alkalinity is a measure of the total carbonates (CO_3^{2-}), bicarbonates (HCO_3^-) and hydroxyl ions (OH^-). Alkalinity increases as the amount of dissolved carbonates and bicarbonates rises. Irrigation water with high alkalinity (e.g., 400 ppm CaCO_3) will tend to raise the pH of the growing media over time and will require more acid to lower the pH of the water to an acceptable level should a grower wish to do that. Water with a high alkalinity (e.g., > 100 ppm CaCO_3) will require that a grower consider using acid-type soluble fertilizers rather than calcium-based fertilizers.

Notice that the term **alkaline** (pH > 7) is entirely different from the term **alkalinity** (capacity to change or resist a change in pH).

Hardness

The term hardness refers to the combined concentration of Ca and Mg in the water. Hardness can be used as an indicator of alkalinity. "Hard" water, water with a high concentration of Ca and Mg, should be checked for high alkalinity. Hard water is a potential problem since the calcium and magnesium can combine with bicarbonate to form insoluble calcium and magnesium carbonate salts. These salts can impact media pH and reduce the amount of sodium available to a plant.

Total Soluble Salts

Irrigation water, particularly if the source is from groundwater, usually contains some amount of dissolved salts. Some of these dissolved salts, particularly sodium, chloride, boron, fluoride and iron, are of greater concern to growers than others. Soluble salts are a concern in that they are either directly toxic to the plant, impede the uptake of water by the roots or cause foliar spotting that lowers the overall value of the plants. Water high in soluble salts may be referred to as **saline**. Total soluble salts are easily measured by monitoring the electrical conductivity (EC) of the solution. Note that soluble salts may disassociate in water to form charged ions. If the ion

carries a positive charge (+), it is called a cation; if it carries a negative charge (-), it is called an anion. The most common cations of interest in water are calcium (Ca^{+2}), magnesium (Mg^{+2}) and sodium (Na^+); the most common anions are bicarbonate (HCO_3^-), chloride (Cl^-) and sulfate (SO_4^-). An electrical conductivity meter simply measures the **total** relative amount of either the dissolved anions or the dissolved cations. Pure water, with few or no dissolved salts, would be a poor conductor of electrons so the electrical conductivity value would be very low or approaching zero. Interestingly enough, urea when dissolved in water to make a fertilizer solution does not disassociate so it cannot be monitored adequately using an EC meter.

Electrical conductivity measurements DO NOT indicate the relative amounts of any specific salt or ion. Additional specific tests typically run by outside laboratories must determine concentrations of specific ions.

Specific Ions

Units most frequently used when reporting concentrations of ions are ppm or mg/l; however, they are sometimes reported in units of meq/l. The units meq/l can be calculated from the ppm by dividing the ppm by the equivalent weight (EW) of the respective ion. For example, with sodium, the EW is 23 (molecular weight of 23 divided by the valence which is 1). If the concentration of sodium was 100 ppm, the concentration expressed in meq/l would be 4.3.

Na (sodium): High sodium is a concern to growers since it can contribute to salinity problems, interfere with magnesium and calcium availability in the media and cause foliar burns. Sodium and chloride problems are observed when irrigation water is run through a water softener that is using sodium chloride to "soften" or exchange the calcium and magnesium in the water. "Softened" water is generally not recommended for greenhouse or nursery irrigation purposes.

Cl (chlorine is the element; chloride is the ion, Cl^-): Elevated chloride is often associated with an elevated sodium concentration. Chloride, like sodium, can be directly toxic to the plant. Water is generally not a major source for chloride problems; however, certain fertilizer salts (e.g., potassium chloride) can be.

Fe (iron): Elevated iron levels generally cause aesthetic problems on plants and structures, but high levels can also cause an accumulation on irrigation equipment that leads to plugged emitters. Levels that cause this discoloration are generally below the levels that cause toxicities in plant tissue.

B (boron): Like sodium and chloride, boron can sometimes be found in high concentrations which are toxic to plants. High boron levels are commonly associated with alkaline soil formations in areas of low rainfall and are, therefore, frequently found in many western states. Like other nutrients, crop sensitivity to boron varies so certain species may be susceptible to damage at a concentration of 0.5 ppm while others tolerate levels up to 4 ppm. Plant age also influences susceptibility or degree of problem. Seedlings will generally be more susceptible than mature plants of the same species. Management strategies to minimize boron problems when the water source is high include eliminating boron from the fertilizer sources, increasing the leaching fraction, increasing the media pH and increasing the calcium level.

F (fluorine is the element; fluoride is the ion, F⁻): Several important floriculture crops including Easter lilies, freesias, spider plant (*Chlorophytum*), *Maranta* and *Dracaena* are known to be extremely sensitive to even low levels of fluoride in irrigation water. Fluorine is not considered an essential element for plants, but it can be a concern for greenhouse growers since it is routinely added to drinking water to prevent tooth decay. A fluoride analysis is highly recommended if the greenhouse water is provided by a city water source that is fluoridated.

Zn (zinc) or Cu (copper): Problems associated with Zn or Cu toxicities are generally not associated with water systems; however, in a few cases acid water transported through galvanized or copper pipes may result in toxic levels of these elements in the irrigation water. These elements are a concern if using an acid growing media.

Sodium Adsorption Ratio or SAR

It has already been suggested that sodium concentrations need to be evaluated in terms of the amounts of calcium and magnesium because of the close potential interaction of the three nutrients. To quantify this relationship, the sodium adsorption ratio (SAR) is calculated. Generally, the higher the SAR value, the greater the potential for problems. The type of irrigation method also needs to be considered. High SAR water applied using an overhead irrigation system in a climate with low humidity (i.e., evaporates quickly) can cause leaf injury. The same water applied using surface or drip irrigation may not be a problem.

Some laboratories provide results as an "Adjusted SAR." This value is more difficult to calculate and requires special tables and knowledge of the carbonate and bicarbonate concentrations. An adjusted SAR has the advantage in that it takes into account the tendency of high bicarbonate/carbonate

water to precipitate calcium into calcium carbonate, which reduces the calcium content and increases the potential for a sodium problem.

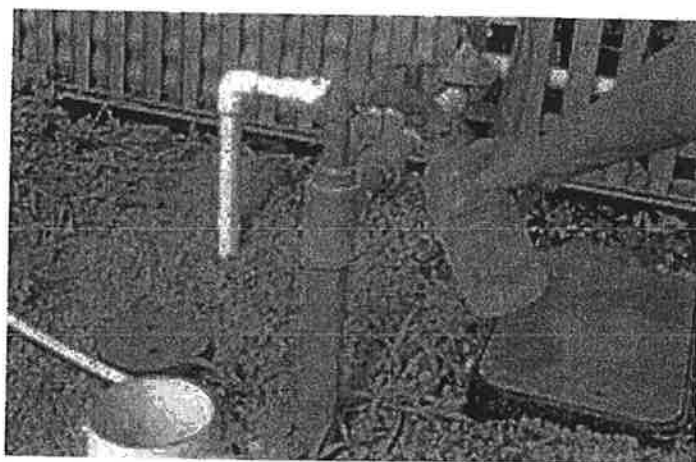
Water Quality Testing

While certain parameters can be tested adequately by a grower, most choose to send water samples out for laboratory analyses. Those parameters that can be tested easily and inexpensively by growers in-house include pH, alkalinity and total soluble salts.

pH can be measured by a grower using an inexpensive pH meter or "pen" or by using indicator test strips. Alkalinity can be measured using test kits available from some grower supply firms or swimming pool supply companies. These test kits usually rely on adding a color indicator to the water sample and then adding acid dropwise to reach a final color that translates into a specific alkalinity value. Soluble salts are easily measured using an inexpensive electrical conductivity meter with automatic temperature compensation.

Several laboratories, including one affiliated with the University of Arkansas Cooperative Extension Service, are capable of analyzing water samples. Most laboratories will offer a flat fee for a standard package of tests (e.g., pH, EC, hardness, alkalinity, sodium, etc.), or they will offer a cafeteria plan for you to pick and choose specific tests. It is critical that you indicate you are submitting an **irrigation water** sample rather than a domestic drinking water sample. It is best to collect the water sample in a clean plastic bottle. Collect the specified volume after running the tap for a few minutes. It is suggested that you fill the bottle to the top to avoid any room for air. If a nitrate analysis is required, the sample should be shipped to the laboratory quickly or significant changes in concentration can occur over time.

An example University of Arkansas Irrigation Water Report can be found on page 6.



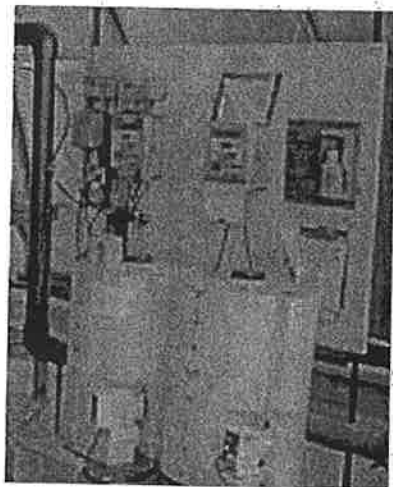
Management Strategies

Working with water quality issues is technical in nature and may require addition of expensive equipment or chemical treatment of the water. Before developing a major water treatment system for your growing operation, you are encouraged to contact your local Cooperative Extension agent for guidance.

Scenario: Water with an alkaline pH and high alkalinity

This scenario is corrected by using the appropriate acid and usually an acid injector.

Phosphoric acid is used more frequently than sulfuric acid or nitric acid since it is considered safer; however, handling any of these concentrated acids is to be considered dangerous. Strict safety guidelines must be followed. Nitric and sulfuric acids should be considered when the alkalinity is high (> 300 ppm) since phosphoric acid might supply excessive amounts of the nutrient phosphorus. Acid injection is usually considered when the alkalinity is over 100 ppm.



Tables are available that calculate the amount of a specific acid required based on the starting pH, the amount of alkalinity, the amount of change in pH required and type of acid used.

The amount of acid required to neutralize the alkalinity of water can also be determined from the following equation.

$$A \times B \times C = \text{the ounces of acid/1,000 gallons of water to lower the pH to 6.4}$$

A is a cofactor determined by the current or starting pH:

Water pH	A	Water pH	A
6.7	0.249	7.7	0.475
6.9	0.342	7.9	0.484
7.1	0.4	8.1	0.49
7.3	0.437	8.3	0.494
7.5	0.46	8.5	0.496

B is the sum of the bicarbonate and carbonate expressed in meq/l.

C is a cofactor determined by the type of acid used.

Acid Source	C
75% phosphoric	10.6
85% phosphoric	8.74
93% sulfuric	3.72
61% nitric	15.6

Example:

Starting pH of the water = 7.5
carbonate + bicarbonate = 3.4 meq/l
using 75% phosphoric acid

$$0.460 \times 3.4 \times 10.6 = \text{add 16.5 ounces of 75\% phosphoric acid/1,000 gallons of water}$$

Scenario: Water with a high EC

There are probably two common approaches to dealing with saline water. The first remedy is to simply blend the higher EC source with water from a purer supplier, usually a surface retention pond. The other approach involves careful management of the irrigation volume being applied. While the ideal scenario is to minimize leaching to avoid wasting fertilizer and water, increasing what is called the leaching fraction (LF) can improve the usability of high EC water. Leaching fraction is simply the volume of water leached divided by the volume of water applied and that result multiplied by 100. Here is a simple example. A general rule of thumb is that if the EC of the irrigation water is >2,000 $\mu\text{mho/cm}$, it would require a leaching fraction of 40 percent or higher (i.e., leach heavily and almost every irrigation). If the EC of your irrigation source is 1,000 $\mu\text{mho/cm}$, you can leach with a smaller volume or percentage (e.g., 15 percent).

A grower faced with high EC water would also not want to let pots dry out. Simply stated, the concentration of salts will increase around roots as the media dries out. Growers would also want to use fertilizer products with a lower salt index if possible. The final resolution is expensive and rarely used. Growers can install expensive reverse osmosis or deionization equipment to reduce the soluble salt concentration in their water source.

Scenario: Water with high concentration of suspended solids

Filtration is the standard method for removing suspended solids. You may wish to work with an irrigation supplier or engineer so the appropriate equipment is selected and positioned within your irrigation system.

Water Quantity

Nurseries

A general rule of thumb used by irrigation designers suggests that a minimum of 1 acre-inch (approximately 27,000 gallons) of water capacity is required per acre of nursery stock **per day** of irrigation. Assuming a grower might irrigate for 180 days during a year in Arkansas, it would require 4.86 million gallons of water per acre of container stock per year. Another common recommendation suggests an estimated

annual use of 13 acre-feet of water per acre of container nursery stock.

Greenhouses

Greenhouse operations also use an impressive amount of water. One rule of thumb is a requirement for 2 quarts per square foot of growing area per day. One acre of growing space would require approximately 22,000 gallons of water per day. This does not include water requirements for evaporative cooling systems or other non-crop uses.

24.6 A-F/YR
@ 365 days

Example of University of Arkansas Irrigation Water Report

Arkansas Cooperative Extension Service in a Cooperative Effort with
Arkansas Water Resources Center - Water Quality Laboratory

DRIP OR TRICKLE IRRIGATION WATER REPORT FORM

Cooperative Extension Service (501) 671-2000

(Owner copy)

Name : Joe Extension

Date : 06/20/04

Address : 9999 University Road

City : Fayetteville

State : AR

Zip : 72701

County : Washington

Date Received : 06/01/04

Lab #: 999901

Sample ID:

WATER ANALYSIS REPORT:

pH	-----	-7.17
E.C.	-----	-250.00 μ mhos/cm
Fe, Total	-----	-0.68 mg/l
Mn	-----	-1.00 mg/l
Na	-----	-0.84 meq/l
Ca	-----	-1.04 meq/l
HCO ₃	-----	-2.20 meq/l
SO ₄	-----	-0.15 meq/l
Cl	-----	-0.10 meq/l
NO ₃ -N (Nitrate-Nitrogen)	-----	-0.00 mg/l
NO ₃ (Nitrate)	-----	-0.00 mg/l
Hardness, Total	-----	-82.20 mg/l as CaCO ₃
Suspended Solids, Total	-----	-1.70 mg/l

Printed by University of Arkansas Cooperative Extension Service Printing Services.

DR. JAMES ROBBINS is Extension horticulture specialist -
ornamentals, University of Arkansas Cooperative Extension Service,
Little Rock. DR. GERALD KLINGAMAN is Extension horticulture
specialist - ornamentals, University of Arkansas Cooperative Extension
Service, Fayetteville.

FSA6061-PD-2-04R

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persons regardless of race, color, national origin, religion, gender, age,
disability, marital or veteran status, or any other legally protected status,
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Memorandum to claim file

To: claim file

CC:

From: Vicky Music, Western Region

Date: 9/13/2007

Re: Edwards Greenhouse claims 63-5065 and 63-5067

I met with Norm Young, Edwards consultant, on Wednesday, 8/22/07. This memo is a summary of that meeting. Norm did not have permission to settle but he did provide me with information that I did not have before.

63-5065 – this is the domestic use for the house that is on site. Norm stated that Dana may be willing to withdraw this claim if we add the domestic use to 63-5067 which simply states the use is for 1 home. I have not been willing to add the use because the 63-5065 statutory claim states a priority date in 1956 for this use. It is clear from the 1939 aerial that the house claimed in 63-5065 is not present.

Norm said that there was a domestic use in 1930 for the bunkhouses for the greenhouse employees. This is the first I have heard of this so I told Norm I would need a statement from Garnette re the domestic use. Then I would add the use to 63-5067.

63-5067 –

1] Quantity – greenhouses

The claim, emails and NOE have stated 2 reasons for the quantity claimed in excess of 1"/acre. The reasons are that the Silkey v Tiegs decree established that the duty of water in the area is 2"/acre, and that greenhouses need more than 1"/acre. However, the Silkey decree only applied to the geothermal wells and I don't know of any other decree that has been interpreted as applying to any rights other than the rights decreed. It would also render I.C. §42-202(6) about the 1"/acre for agricultural purposes, meaningless.

I have asked Norm and Dana for the information that would justify the excess diversion rate for greenhouses but have not received it. Norm said that he has information from the Univ. of Arkansas that states greenhouses need a greater rate though the only figure he provided from the article was a volume of 24.6 afy/acre needed for greenhouses. I did not see the article and he would not provide it because he did not have permission from Dana. I told him I would need to see that article. I went online and found two University of Arkansas articles that reference greenhouse irrigation needs. There are entitled, "Irrigation Water for Greenhouses and Nurseries." A section addressing water quantity for greenhouses is on page 6, and "Starting a Greenhouse Business (Part 1) Some Basic Questions" on page 4. The 2 articles are in the claim file.

I have researched this in the admin and other IDWR memos and cannot find anything about excess diversion rate for greenhouses. I asked Jan and Steve Lester about IDWR allocations or other policies about diversion rates for greenhouses and there aren't any. Steve says they use the 1"/acre.

I think that the 1" / acre used by Idaho in its arid climate, constitutes an excess rate compared with Arkansas.

2] Quantity – diversion rate based on the Edwards system

Norm calculated a well capacity of .27 cfs, however, he used a pump efficiency of 75%. Norm says that for smaller system, this is conceivable because they are more efficient. Based on my past conversations with Jan and Don, when calculating a theoretical diversion rate, we make a generous assumption that the pump efficiency is 70%. I calculated a theoretical system capacity of .25 cfs. So, we are close there.

3] – Volume

Norm would not provide his calculations [I told him I would need to see them] but he came up with 77.5 afy...said something about 63.3 being...acceptable...? Not sure because my notes are not clear here. In 1987, there was at most 1.3 acres of greenhouses and I am pretty sure he did not use this in his calculations. There is about double the greenhouses seen in the 2000 aerial.

One of the University of Arkansas articles suggests that nursery stock needs 13,000 acre-feet of water per acre of nursery stock. $13,000 \times 1.3 \text{ acres} = 16,900 \text{ afy}$. Will wait and see what the claimant provides.

8/22/01

WTP w/ norm volume

1- ~~03-5065~~ will w/p claim if dom use is added
to 03-5067 - used to be domestic. need
affidavit from D. re domestic.

2- 03-5067 -
evaporation - greater
commercial

(60) (12 hrs/day) (1.25) (448.8) (214) / 325,850 =
18 @ 60 psi - system capacity = .27 (40 psi)
214 days 6 hr on - 6 hr off 6 hr on

57.3 afy
25
82

Y2 " remainder of year -
5 hp. 40 psi 30' lift 15% efficiency (norm's assumptions)

~~norm notes - norm meeting~~

11.6 afy norm's calculation $\approx$ 63.3 norm's

~~norm notes - norm meeting~~

$$\frac{(8.8)(5)(1.10)}{(30)(2.31)(40)} = 20.8$$

$$24.6 \text{ afy / ac. Univ. Ar. Greenhouse}$$

$$122.4 = .25 \text{ cfs}$$

$$25' \frac{30.8}{117.4} = .26$$

37.35 afy

Nick

- 1- commercial calculation - need norm's calculation.
- 2- domestic - affidavit re dom use but add dom
is antinequest w/p 5065

$$(.25)(1.9835)(214) = 106$$

Univ. of Ar 25 - 1 gallon / ft² during peak (60,000 gpd) (214) +
(30,000 gpd) (151) =
12840000
53.31 afy

VHM notes > norm meeting.

1- calculating theoretical div rate / AF -

(a) norm says 15% efficiency characteristic of small pump systems. Conversations w/ Jan (Carter?), Jan indicate that our theoretical results in an optimistic result, and that 10% efficiency is optimistic.

(b)

Calculations re commercial Q/af, etc.

- ① 1987 aerial - not more than 1.3 ac covered by greenhouses
- 1986 aerial clearer than 87.
- ② 2 articles: ① range is $.25 \text{ bpd/ft}^2 + 1 \text{ bpd/ft}^2$ - peak irrigation
- ② $.5 \text{ bpd/ft}^2$ or 22,000 bpd/acre
- ③ will ~~use~~ calculate using $.5 \text{ bpd/ft}^2$ or 22,000 bpd/acre.
for non-peak
- (1.3 ac) $\cdot 5 \text{ bpd/ft}^2$ (22,000 bpd/acre) = 28600 bpd
- (28600 bpd) (151 days in non-peak) = $\frac{4318600}{325850} = 13.25 \text{ afy}$

peak calculation

$$(44000 \text{ bpd/acre}) (1.3 \text{ ac}) = 57200 \text{ bpd}$$

$$(57200) (214) = \frac{12240800}{325850} = 37.57 \text{ afy}$$

$$\begin{array}{r} 37.57 \\ 13.25 \\ \hline 50.82 \\ \text{afy} = \text{commercial} \end{array}$$

$$(7 \text{ ac}) (4.5) = 31.5 + 50.82 = 82.32 \text{ total afy for irrigation}$$

Irrigation Water for Greenhouses and Nurseries

Dr. James Robbins
Extension Horticulture
Specialist - Ornamentals

Dr. Gerald Klingaman
Extension Horticulture
Specialist - Ornamentals

Both the **quality** and **quantity** of water are critical to the successful production of plants in a greenhouse or nursery. While considered a critical parameter, water issues are frequently overlooked by most growers. Parameters deemed suitable for drinking water purposes are not necessarily acceptable for growing plants. Appropriate tests should be conducted **prior** to selecting a greenhouse or nursery site.

Water Quality

Water quality properties can be divided into three categories: **physical**, **biological** and **chemical**. Critical **physical** properties include suspended solids and temperature. Suspended solids such as soil particles are potential problems since these particulates can clog irrigation nozzles and cause abrasion of irrigation equipment. Water temperature can be an important consideration, particularly when growing foliage plants where high or low temperature water can cause leaf spotting that reduces the value of these plants.

Important **biological** properties include algae, microbes and disease organisms. Algae and microbes are a concern since they may cause clogging of irrigation system components.

Chemical properties are typically given the most focus when dealing with irrigation water. From the grower's standpoint, the most critical

chemical water quality parameters are soluble salts, hardness, sodium and chloride concentration and pH. In a few cases, elements such as iron, boron and fluoride are also considered critical parameters. Chemical properties, like physical and biological, may change significantly during a year, particularly as the demand increases on a ground well and the water table is lowered.

Table 1 includes general guidelines for irrigation water used in plant production. A more detailed discussion on several of these parameters is required.

pH

In general terms, pH is a measure of the hydrogen ion concentration. The pH can vary on a scale from 0-14 with a pH of 7 being neutral, less than 7 considered acid and above 7 called basic or alkaline. Irrigation water with a pH of 4 might be termed **very acid** and water with a pH of 8.5 **very alkaline**. The pH is an important parameter to know since it will influence the relative solubility of certain nutrients and can impact the solubility of certain chemicals or pesticides used in grower operations. The pH of irrigation water is not generally as critical a measurement as the pH of the media. While the term pH is often used interchangeably with **alkalinity**, these are two totally different parameters.

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Table 1. General Guidelines for Irrigation Water Used in Plant Production

Parameter*	Units	Upper Limit	Optimum Range
EC	$\mu\text{mho/cm}^{****}$	750 plugs; 1,250 greenhouse; 1,500 nursery	0-300
TDS** (total dissolved solids)	ppm (1 ppm = 1 mg/l)	480 plugs; 800 greenhouse; 960 nursery	0-192
pH	---	possibly 8.0 upper; 4.5 lower	5.2-6.8
Alkalinity	ppm CaCO_3	200 (90 for foliar spotting) (1 meq/l CaCO_3 = 50 mg/l CaCO_3)	0-60 plugs 0-100 greenhouse 0-140 nursery
Bicarbonate (HCO_3^-) (EW = 61)***	ppm meq/l	150 2.4	30-50 0.5-0.8
Hardness	ppm CaCO_3	200	20-150
Na (EW = 23)	ppm meq/l	50 (keep <10% of total salts) 2.2	0-30 0-1.3
SAR	---	4 greenhouse; 6 nursery	0-3
Ca (EW = 20)	ppm meq/l	120 6	40-100 2-5
Mg (EW = 12)	ppm meq/l	50 4.2	5-25 0.4-2.1
Nitrate-N (EW = 14)	ppm meq/l	50 3.6	0-10 0-0.7
P	ppm	5	0-1
K (EW = 39)	ppm meq/l	10 0.25	1-10 0.02-0.2
Sulfate (EW = 48) SO_4	ppm meq/l	240 5	25-200 0.5-4.2
Fe	ppm	5 (<1 to avoid foliar spotting)	1-3
Mn	ppm	1	0.2-1
B	ppm	2	0.2-0.5
Cl (EW = 35.5)	ppm meq/l	140 3.9	1-50 0.03-1.4
F	ppm	1	0-1
Al	ppm	5	0-5
Mo	ppm	0.07	0-0.05
Zn	ppm	2	0-0.2
Cu	ppm	0.2	0.05-0.15

* Play the charge balance game. Express the concentrations of the four major cations (K, Na, Mg, Ca) and the four major anions (HCO_3 , Cl, SO_4 and NO_3) in meq/l. Add the cations up, then add the anions up. The cation total should be very close to the anion total if the analysis is correct.

** TDS can be estimated from EC. An EC of 1,000 $\mu\text{mho/cm}$ equals approximately 640 ppm total dissolved solids. Also referred to as total suspended solids.

*** EW = equivalent weight of the ion.

**** 1,000 $\mu\text{mho/cm}$ = 1 mmho/cm = 1 dS/m = 1 mS/cm .

Alkalinity

While pH is a measure of the hydrogen ion concentration, alkalinity is a relative measurement of the **capacity** of water to resist a change in pH or the ability of the water to change the pH of the growing media. You may wish to think of alkalinity as the **buffering capacity** of the water – how well it resists or causes a change in pH. It is not uncommon to have irrigation water with a pH of 7.5 (alkaline) but with a low alkalinity value that is quite acceptable for growing plants.

Alkalinity is a measure of the total carbonates (CO_3^{2-}), bicarbonates (HCO_3^-) and hydroxyl ions (OH^-). Alkalinity increases as the amount of dissolved carbonates and bicarbonates rises. Irrigation water with high alkalinity (e.g., 400 ppm CaCO_3) will tend to raise the pH of the growing media over time and will require more acid to lower the pH of the water to an acceptable level should a grower wish to do that. Water with a high alkalinity (e.g., > 100 ppm CaCO_3) will require that a grower consider using acid-type soluble fertilizers rather than calcium-based fertilizers.

Notice that the term **alkaline** (pH > 7) is entirely different from the term **alkalinity (capacity)** to change or resist a change in pH).

Hardness

The term hardness refers to the combined concentration of Ca and Mg in the water. Hardness can be used as an indicator of alkalinity. “Hard” water, water with a high concentration of Ca and Mg, should be checked for high alkalinity. Hard water is a potential problem since the calcium and magnesium can combine with bicarbonate to form insoluble calcium and magnesium carbonate salts. These salts can impact media pH and reduce the amount of sodium available to a plant.

Total Soluble Salts

Irrigation water, particularly if the source is from groundwater, usually contains some amount of dissolved salts. Some of these dissolved salts, particularly sodium, chloride, boron, fluoride and iron, are of greater concern to growers than others. Soluble salts are a concern in that they are either directly toxic to the plant, impede the uptake of water by the roots or cause foliar spotting that lowers the overall value of the plants. Water high in soluble salts may be referred to as **saline**. Total soluble salts are easily measured by monitoring the electrical conductivity (EC) of the solution. Note that soluble salts may disassociate in water to form charged ions. If the ion

carries a positive charge (+), it is called a cation; if it carries a negative charge (-), it is called an anion. The most common cations of interest in water are calcium (Ca^{+2}), magnesium (Mg^{+2}) and sodium (Na^{+}); the most common anions are bicarbonate (HCO_3^-), chloride (Cl^-) and sulfate (SO_4^{+}). An electrical conductivity meter simply measures the **total** relative amount of either the dissolved anions or the dissolved cations. Pure water, with few or no dissolved salts, would be a poor conductor of electrons so the electrical conductivity value would be very low or approaching zero. Interestingly enough, urea when dissolved in water to make a fertilizer solution does not disassociate so it cannot be monitored adequately using an EC meter.

Electrical conductivity measurements DO NOT indicate the relative amounts of any specific salt or ion. Additional specific tests typically run by outside laboratories must determine concentrations of specific ions.

Specific Ions

Units most frequently used when reporting concentrations of ions are ppm or mg/l; however, they are sometimes reported in units of meq/l. The units meq/l can be calculated from the ppm by dividing the ppm by the equivalent weight (EW) of the respective ion. For example, with sodium, the EW is 23 (molecular weight of 23 divided by the valence which is 1). If the concentration of sodium was 100 ppm, the concentration expressed in meq/l would be 4.3.

Na (sodium): High sodium is a concern to growers since it can contribute to salinity problems, interfere with magnesium and calcium availability in the media and cause foliar burns. Sodium and chloride problems are observed when irrigation water is run through a water softener that is using sodium chloride to “soften” or exchange the calcium and magnesium in the water. “Softened” water is generally not recommended for greenhouse or nursery irrigation purposes.

Cl (chlorine is the element; chloride is the ion, Cl^-): Elevated chloride is often associated with an elevated sodium concentration. Chloride, like sodium, can be directly toxic to the plant. Water is generally not a major source for chloride problems; however, certain fertilizer salts (e.g., potassium chloride) can be.

Fe (iron): Elevated iron levels generally cause aesthetic problems on plants and structures, but high levels can also cause an accumulation on irrigation equipment that leads to plugged emitters. Levels that cause this discoloration are generally below the levels that cause toxicities in plant tissue.

B (boron): Like sodium and chloride, boron can sometimes be found in high concentrations which are toxic to plants. High boron levels are commonly associated with alkaline soil formations in areas of low rainfall and are, therefore, frequently found in many western states. Like other nutrients, crop sensitivity to boron varies so certain species may be susceptible to damage at a concentration of 0.5 ppm while others tolerate levels up to 4 ppm. Plant age also influences susceptibility or degree of problem. Seedlings will generally be more susceptible than mature plants of the same species. Management strategies to minimize boron problems when the water source is high include eliminating boron from the fertilizer sources, increasing the leaching fraction, increasing the media pH and increasing the calcium level.

F (fluorine is the element; fluoride is the ion, F⁻): Several important floriculture crops including Easter lilies, freesias, spider plant (*Chlorophytum*), *Maranta* and *Dracaena* are known to be extremely sensitive to even low levels of fluoride in irrigation water. Fluorine is not considered an essential element for plants, but it can be a concern for greenhouse growers since it is routinely added to drinking water to prevent tooth decay. A fluoride analysis is highly recommended if the greenhouse water is provided by a city water source that is fluoridated.

Zn (zinc) or Cu (copper): Problems associated with Zn or Cu toxicities are generally not associated with water systems; however, in a few cases acid water transported through galvanized or copper pipes may result in toxic levels of these elements in the irrigation water. These elements are a concern if using an acid growing media.

Sodium Adsorption Ratio or SAR

It has already been suggested that sodium concentrations need to be evaluated in terms of the amounts of calcium and magnesium because of the close potential interaction of the three nutrients. To quantify this relationship, the sodium adsorption ratio (SAR) is calculated. Generally, the higher the SAR value, the greater the potential for problems. The type of irrigation method also needs to be considered. High SAR water applied using an overhead irrigation system in a climate with low humidity (i.e., evaporates quickly) can cause leaf injury. The same water applied using surface or drip irrigation may not be a problem.

Some laboratories provide results as an "Adjusted SAR." This value is more difficult to calculate and requires special tables and knowledge of the carbonate and bicarbonate concentrations. An adjusted SAR has the advantage in that it takes into account the tendency of high bicarbonate/carbonate

water to precipitate calcium into calcium carbonate, which reduces the calcium content and increases the potential for a sodium problem.

Water Quality Testing

While certain parameters can be tested adequately by a grower, most choose to send water samples out for laboratory analyses. Those parameters that can be tested easily and inexpensively by growers in-house include pH, alkalinity and total soluble salts.

pH can be measured by a grower using an inexpensive pH meter or "pen" or by using indicator test strips. Alkalinity can be measured using test kits available from some grower supply firms or swimming pool supply companies. These test kits usually rely on adding a color indicator to the water sample and then adding acid dropwise to reach a final color that translates into a specific alkalinity value. Soluble salts are easily measured using an inexpensive electrical conductivity meter with automatic temperature compensation.

Several laboratories, including one affiliated with the University of Arkansas Cooperative Extension Service, are capable of analyzing water samples. Most laboratories will offer a flat fee for a standard package of tests (e.g., pH, EC, hardness, alkalinity, sodium, etc.), or they will offer a cafeteria plan for you to pick and choose specific tests. It is critical that you indicate you are submitting an **irrigation water** sample rather than a domestic drinking water sample. It is best to collect the water sample in a clean plastic bottle. Collect the specified volume after running the tap for a few minutes. It is suggested that you fill the bottle to the top to avoid any room for air. If a nitrate analysis is required, the sample should be shipped to the laboratory quickly or significant changes in concentration can occur over time.

An example University of Arkansas Irrigation Water Report can be found on page 6.



Management Strategies

Working with water quality issues is technical in nature and may require addition of expensive equipment or chemical treatment of the water. Before developing a major water treatment system for your growing operation, you are encouraged to contact your local Cooperative Extension agent for guidance.

Scenario: Water with an alkaline pH and high alkalinity

This scenario is corrected by using the appropriate acid and usually an acid injector. Phosphoric acid is used more frequently than sulfuric acid or nitric acid since it is considered safer; however, handling any of these concentrated acids is to be considered dangerous. Strict safety guidelines must be followed. Nitric and sulfuric acids should be considered when the alkalinity is high (> 300 ppm) since phosphoric acid might supply excessive amounts of the nutrient phosphorus. Acid injection is usually considered when the alkalinity is over 100 ppm.



Tables are available that calculate the amount of a specific acid required based on the starting pH, the amount of alkalinity, the amount of change in pH required and type of acid used.

The amount of acid required to neutralize the alkalinity of water can also be determined from the following equation.

$$A \times B \times C = \text{the ounces of acid/1,000 gallons of water to lower the pH to 6.4}$$

A is a cofactor determined by the current or starting pH:

Water pH	A	Water pH	A
6.7	0.249	7.7	0.475
6.9	0.342	7.9	0.484
7.1	0.4	8.1	0.49
7.3	0.437	8.3	0.494
7.5	0.46	8.5	0.496

B is the sum of the bicarbonate and carbonate expressed in meq/l.

C is a cofactor determined by the type of acid used.

Acid Source	C
75% phosphoric	10.6
85% phosphoric	8.74
93% sulfuric	3.72
61% nitric	15.6

Example:

Starting pH of the water = 7.5
carbonate + bicarbonate = 3.4 meq/l
using 75% phosphoric acid

$0.460 \times 3.4 \times 10.6 = \text{add 16.5 ounces of 75\% phosphoric acid/1,000 gallons of water}$

Scenario: Water with a high EC

There are probably two common approaches to dealing with saline water. The first remedy is to simply blend the higher EC source with water from a purer supplier, usually a surface retention pond. The other approach involves careful management of the irrigation volume being applied. While the ideal scenario is to minimize leaching to avoid wasting fertilizer and water, increasing what is called the leaching fraction (LF) can improve the usability of high EC water. Leaching fraction is simply the volume of water leached divided by the volume of water applied and that result multiplied by 100. Here is a simple example. A general rule of thumb is that if the EC of the irrigation water is >2,000 $\mu\text{mho/cm}$, it would require a leaching fraction of 40 percent or higher (i.e., leach heavily and almost every irrigation). If the EC of your irrigation source is 1,000 $\mu\text{mho/cm}$, you can leach with a smaller volume or percentage (e.g., 15 percent).

A grower faced with high EC water would also not want to let pots dry out. Simply stated, the concentration of salts will increase around roots as the media dries out. Growers would also want to use fertilizer products with a lower salt index if possible. The final resolution is expensive and rarely used. Growers can install expensive reverse osmosis or deionization equipment to reduce the soluble salt concentration in their water source.

Scenario: Water with high concentration of suspended solids

Filtration is the standard method for removing suspended solids. You may wish to work with an irrigation supplier or engineer so the appropriate equipment is selected and positioned within your irrigation system.

Water Quantity

Nurseries

A general rule of thumb used by irrigation designers suggests that a minimum of 1 acre-inch (approximately 27,000 gallons) of water capacity is required per acre of nursery stock **per day** of irrigation. Assuming a grower might irrigate for 180 days during a year in Arkansas, it would require 4.86 million gallons of water per acre of container stock per year. Another common recommendation suggests an estimated

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Greenhouse operations also use an impressive amount of water. One rule of thumb is a requirement for 2 quarts per square foot of growing area per day. One acre of growing space would require approximately 22,000 gallons of water per day. This does not include water requirements for evaporative cooling systems or other non-crop uses.

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Arkansas Water Resources Center - Water Quality Laboratory

DRIP OR TRICKLE IRRIGATION WATER REPORT FORM

Cooperative Extension Service (501) 671-2000

(Owner copy)

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County	: Washington	Date Received	: 06/01/04

Lab #: 999901

Sample ID:

WATER ANALYSIS REPORT:

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E.C.	-----	-250.00 μ mhos/cm
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Mn	-----	-1.00 mg/l
Na	-----	-0.84 meq/l
Ca	-----	-1.04 meq/l
HCO ₃	-----	-2.20 meq/l
SO ₄	-----	-0.15 meq/l
Cl	-----	-0.10 meq/l
NO ₃ -N (Nitrate-Nitrogen)	-----	-0.00 mg/l
NO ₃ (Nitrate)	-----	-0.00 mg/l
Hardness, Total	-----	-82.20 mg/l as CaCO ₃
Suspended Solids, Total	-----	-1.70 mg/l

Printed by University of Arkansas Cooperative Extension Service Printing Services.

DR. JAMES ROBBINS is Extension horticulture specialist - ornamentals, University of Arkansas Cooperative Extension Service, Little Rock. **DR. GERALD KLINGAMAN** is Extension horticulture specialist - ornamentals, University of Arkansas Cooperative Extension Service, Fayetteville.

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Starting a Greenhouse Business (Part 1)

Some Basic Questions

Gerald Klingaman
Extension Horticulture
Specialist - Ornamentals

Jim Robbins
Extension Horticulture
Specialist - Ornamentals

Greenhouse growing has a long history in the U.S. and has expanded dramatically since the mid-1980s. Greenhouses are expensive to build and operate. As a result, potential profits are high, but so is the risk involved. Greenhouse growing is an intensive form of plant production and has the potential for high returns, but crops grown in greenhouses have exacting requirements and the markets have very high quality demand.

The failure rate for greenhouses is high and mirrors the 80 percent failure rate (firms that fail to stay in business five years) of most start-up businesses. Prospective new greenhouse growers must do their homework by critically evaluating their own experience, their abilities as managers, their stick-to-it-iveness and their financial backing. Most new businesses fail because of a failure to manage the business end of the operation, not the production end. So, if business management experience is an individual weakness, outside assistance should be sought.

The technical details necessary for greenhouse growing can be acquired by trial and error, but there is nothing like firsthand experience in greenhouse production to make the venture more successful. Prospective growers with no firsthand experience are encouraged to start small and learn the technical details first, and then expand as experience increases.

Wholesale or Retail?

Opportunities exist in both retail and wholesale growing. Generally, retail growing works best if you

enjoy working with people and helping them satisfy their needs and wants. Wholesale growing is more feasible if a suitable retail location is unavailable or if you have figured out some way of providing a needed wholesale product and delivering it to your customers.

Retail growing and selling directly to the customer is the easiest area to break into at present because growers can obtain higher prices for their products at the retail level. Retail growing requires an area on a paved road which is easy to find and within a reasonably large population center. On average, a population base of about 6,500 people will marginally support one retail greenhouse outlet. When evaluating your potential customer base, consider the size of your community's trade area, not just the size of the town or city. When assessing competition, count both traditional full-service greenhouse and nursery operations, but don't forget to include other plant outlets such as chain stores, feed stores and even some food stores. It is always easiest to come into a market as the population base is expanding, so check local records concerning past and expected future trends. Traditional retailing, where you attempt to buy in all product and resell it to the customer, is increasingly difficult because of competition from mass market firms.

Wholesale production can take several forms. Wholesale growers almost always deliver their product to their retail customers, so transportation logistics becomes an important part of the challenge required to succeed as a wholesale grower.

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The customers may be retail greenhouses or nurseries, florists, grocery stores, chain stores, landscape contractors or farm store outlets. Many wholesale growers set up truck routes and stop by their customers' businesses weekly during the busy spring season.

The most common wholesale producer in Arkansas is the **bedding plant-mum-poinsettia grower**. These three crops are produced at different times of the year and can occupy the same greenhouse space. Presently this wholesale market area appears to be overproducing, and product prices have been falling during recent years. Very large regional growers are emerging with 10 to 50 acres of production. These firms are highly automated and



A gutter-connected poly greenhouse with an open-roof design for summer cooling.

are setting up to serve the chain store market. There may be opportunity to play in this market by becoming a **wholesale contract grower**. One of the needs for the bedding plant-mum-poinsettia growers to succeed is to diversify their product offering by growing unique or specialty crops. As such, you might contract your production to one of the larger firms in the area and produce one or more specific product types at a predetermined price.

The **wholesale florist grower** is the traditional wholesale grower in the industry, but this segment has shrunk dramatically over the past 30 years as chain stores became more important in the sale of plants. Florist growers usually produce a very high-quality product and a wide assortment of items. They have scheduled production with items ready for market every week during the year. Crops such as Easter lilies, forced bulbs, pot chrysanthemums, gloxinias, hydrangeas and other less common offerings are just part of the product mix these growers provide their customers. Bedding plants, unless they are grown for local retail sales, are usually not grown because they require too much space and would interrupt the orderly year-round production schedule. This

segment of the industry is technically challenging from a growing standpoint and also very competitive.

Another type is the **wholesale specialist grower**. This area of specialization might include anything from a bread and butter item such as perennials or fern hanging baskets to specialty items such as bromeliads or fancy leafed begonias. The more specialized the product, the larger the market area will be required to support the business. Sometimes a specialist grower simply takes a common plant and produces or packages it in some unique way. Another area of specialization that is often overlooked is the possibility of becoming a propagator and producing either vegetatively- or seed-grown liners which would be sold to retail growers for finishing. Wholesale specialist growers sometimes market their product by working with national companies that sell on commission a full line of plants directly to retail growers.

How Big a Greenhouse Is Needed?

Deciding on how much greenhouse space is needed requires that one must first determine who the customers will be. If you find there is room in the market for your product, then do some quick math to test the feasibility of the idea. Let's assume you want to make \$24,000 a year growing bedding plants (two-thirds of the money) and poinsettias (one-third of the money). Just guessing, you figure you can make \$2.00 per flat profit on bedding plants and \$1.00 per pot on poinsettias. That means you would need to grow 8,000 flats of bedding plants and 8,000 pots of poinsettias to earn your \$24,000. Now that you have some very rough numbers, you can begin to assess the ability to actually sell that much product. In any given market, selling the bedding plants at the retail level might be relatively easy, whereas moving that many poinsettias could be a challenge. You might choose to reassess your plan and consider selling 8,000 flats of bedding plants, 4,000 garden mums and 4,000 poinsettias. This production plan would probably be easier to accomplish.

Now, given that you have estimated a need to produce 8,000 flats of bedding plants in the spring, you can work backwards and estimate the greenhouse space needed. Most bedding plant growers have an early and a late crop, thus producing two "turns" of their space each spring. That means that 4,000 flats would be grown in the first turn and 4,000 in the second turn. If a bedding plant flat occupies 1.5 square feet per flat, then 6,000 square feet of growing space would be needed for each crop. Assuming that 70 percent of the greenhouse space is in "production space" and the remainder is in walks and isles, then a greenhouse with 8,570 sq. ft. would be needed ($6,000 \div 0.7 = 8,570$). Our proposed poinsettia crop is grown on 14 inch centers, therefore each plant will require 1.36 sq. ft. ($14^2 \div 144 = 1.36$ sq. ft.). Our 4,000 plants would require

5,440 square feet, so we have sufficient room to grow the crop in the space provided for the spring bedding crop. This example approximates what is needed for a full-time greenhouse business. Most experts say that at least 6,000 sq. ft., but preferably 10,000 sq. ft., of greenhouse space is needed for a full-time operation.

Wholesale growing usually requires more space because the profit margin per unit of production is usually less. In the example cited above, the potential profits might be only half of what would be expected for retail sales. Therefore, twice as much space would be required to produce the same profit margin. In recent years, a new kind of wholesale market has emerged, the "landscaper market." These individuals install landscape plants and flowers for their customers and often maintain their planting beds. Most wholesale growers sell their largest volume to the traditional retail outlets, with the best prices afforded to their best customers. The landscaper market usually purchases sufficient plants to buy wholesale but not enough to command the best wholesale price. Many wholesale growers provide the landscaper a price midway between their best wholesale price and what would be a retail price for their product.

What Will a Greenhouse Cost?

Greenhouse costs vary considerably depending on the permanence of the structure. Simple overwintering houses with minimal heating capability can cost as little as \$2.00 per square foot while quonset-style poly greenhouses with heating and cooling capacity typically cost in the \$4.00 per square foot range. Table 1 compares the cost of some modern types of greenhouse construction while Table 2 gives the actual bid estimate on a quonset-style house.

Table 1. Approximate square foot cost of several greenhouse styles.

Quonset-style poly house with no heating or cooling	\$ 1.25
Quonset-style poly house with heating	.200
Quonset-style poly house with heating and cooling	4.00
Quonset-style gutter-connected house with heating and cooling	4.50
High sidewall, gutter-connected poly house with heating	6.00
Open-roof type (z-top style)	8.00
Retractable roof style with drop sidewall	10.00
Aluminum frame, glass or polycarbonate panels	20.00
Benching costs \$1.00 to \$2.50 per square foot	
Concrete flooring costs from \$0.80 to \$1.00 per square foot, excluding labor	

Table 2. Estimated cost for a 30 ft. by 96 ft. double-poly quonset-style greenhouse with 2,880 sq. ft. of growing space.¹

Structure and Covering	Cost/sq. ft.	Actual Cost
Dirt work – pad leveling and drainage	0.34	\$1,000
Frame bows (galvanized steel tubing) for 6 foot spacing with ground pipes and fitting hardware (\$2,300 for 5 foot spacing)	0.64	1,843
Framing materials for endwall construction, brackets for hanging fans and a 36" door and a 42" door	0.24	677
Two layers 3-4 year polyethylene sheeting (inner 4 mil, outer 6 mil)	0.17	481
Base perimeter treated 2x6 lumber	0.05	145
Flooring		
Ground cloth for weed control	0.06	185
Concrete 5 foot wide center walkway	0.11	320
Heating and Cooling Equipment		
Two gas heaters (215,000 btu each)	0.42	1,215
Heating accessories (valve, venting and hanging kit)	0.12	343
Two 3/4 hp 42" angle flow fans	0.50	1,454
Four horizontal air flow fans	0.14	400
Cooling pad system (4 inch Cool-Cell with in-ground tank and pump)	0.63	1,827
Electrical service work	0.17	500
Plumbing service work (gas and water)	0.17	500
Add ons		
Assembly and installation (frame assembly only)	0.53	1,480
Benching (1" grid, 14 gauge coated wire with 2x4 frame)	0.97	2,800
Total	5.26	\$15,171

¹Costs vary depending on location, terrain, distance from utility services.

What Is the Best Location for a Greenhouse?

Once the decision has been made between becoming a retail grower or a wholesale producer, several considerations must be taken into account before locating a greenhouse. Few sites will have every desirable feature, but the more closely the site can match the ideal, the more efficient the operation will be.

Location for retail growing. Retail growers must have highly visible sites that have adequate room for parking and easy on and off road access. The ideal site would be visible from a highly traveled road yet not dangerous for customers to enter or exit. Your local state highway engineer can provide information on traffic volume counts for various locations. Some room for expansion of a retail site is always desirable. Most good retail locations will be provided with adequate utility services such as natural gas, city water and electricity. Sites that are too brightly lighted by street lights may cause problems in growing stray-light sensitive crops such as poinsettias. Good retail sites will be expensive to acquire, but keep in mind that as long as the city is expanding in your direction, the land value will only increase over time. City zoning ordinances should be checked prior to signing any agreements to make sure that the type of business you are proposing is permitted in the area you are considering.

Wholesale growing requirements: A readily available, high-quality, year-round supply of water is one of the most important requirements for wholesale

growing. Water quality, especially if taken from a well, must be checked for irrigation purposes before deciding to build a greenhouse range. Your local Cooperative Extension Service office can arrange for the test. The water requirements of a greenhouse range vary according to the kind of crop being grown but range from one-fourth gallon to one gallon per square foot per day during periods of peak demand.

Ideally, access to natural gas would be desirable because it is usually about one-half the cost of propane. The site should have good truck access and there should be room for future expansion. Greenhouses should be oriented north and south for best light coverage.

Level locations, so long as they are out of flood-prone areas, are less expensive to build on. Make sure that there is some up-front provision for storm water runoff from the site and that waste water from production facilities is retained on the site. At present Arkansas has no requirements for containing crop production waste water on the site, but surrounding states are requiring it, so it would be prudent to design a wholesale greenhouse range with that goal in mind in anticipation of future requirements. Individual greenhouse pads should be built up 6 to 12 inches above surrounding grade, or drainage swales should be cut to prevent a loblolly from forming around individual houses. The greenhouse pad should also be crowned to provide drainage before the structure is built. Drainage issues are easy to deal with on the front end but difficult later on. Standing water and/or wet spots encourage disease development and reduce efficiency of workers as they work around wet locations.

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05/24/2005

IDAHO DEPARTMENT OF WATER RESOURCES
PRELIMINARY RECOMMENDATION OF WATER RIGHTS ACQUIRED UNDER STATE LAW

RIGHT NUMBER: 63-5067

NAME AND ADDRESS: EDWARDS FAMILY LLC
4106 SAND CREEK
BOISE ID 83703

SOURCE: GROUND WATER

TRIBUTARY:

QUANTITY: 17 0.330 CFS
37.350 AFY

Use of this right with Right No. 64-14 is limited to a total combined diversion rate of .33 cfs for irrigation.

PRIORITY DATE: 10/01/1930

POINT OF DIVERSION:

T04N R02E S29 SWNE Within ADA County

PURPOSE AND
PERIOD OF USE:

PURPOSE OF USE	PERIOD OF USE	QUANTITY
COMMERCIAL	01/01 12/31	0.170 CFS
		37.35 AFY
IRRIGATION	3/1 01/01 12/31 11/15	0.170 CFS

Commercial use is for a greenhouse business and includes all associated uses including use for retail offices and shop, heating, and irrigation inside and outside of the greenhouses.

PLACE OF USE: COMMERCIAL Within ADA County

T04N R02E S29 SWNE

IRRIGATION Within ADA County

T04N R02E S29 SWNE 8.3

8.3 ACRES TOTAL

Use of this right with Right No. 63-14 is limited to the irrigation of a combined total of 8.3 acres.

OTHER PROVISIONS NECESSARY FOR DEFINITION OR ADMINISTRATION OF THIS WATER RIGHT:

This partial decree is subject to such general provisions necessary for the definition of the rights or for the efficient administration of the water rights as may be ultimately determined by the Court at a point in time no later than the entry of a final unified decree. Section 42-1412(6), Idaho Code.

EXPLANATORY MATERIAL: Beneficial Use

Right includes accomplished change in purpose of use pursuant to Section 42-1425, Idaho Code.

003 Acc Change in POD

[103-5067 - Partially covered
PP covered & skno. signed
103-5065 - Observed thru the
marched.]

Kana will have her apartment
lost at the mo- 5065 -

5067 already.

Spot trail -
Aug. 17th & Aug. ~~spot~~ spot
8:00 AM

5067- 1930 well

5065- 1956 well

5067- PP covered. 2 wells
earlier dots all used 8.3
over