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In The  
**Supreme Court of the United States**

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STATE OF KANSAS,

*Plaintiff,*

v.

STATE OF NEBRASKA

and

STATE OF COLORADO,

*Defendants.*

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**BEFORE THE HONORABLE VINCENT L. MCKUSICK  
SPECIAL MASTER**

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**FINAL SETTLEMENT STIPULATION  
VOLUME 5 OF 5**

December 15, 2002

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**APPENDIX H1**

**Colorado Laws, Rules and Regulations re: Prohibition on Well Construction**

**DEPARTMENT OF  
NATURAL RESOURCES  
DIVISION OF WATER RESOURCES  
RULES OF PROCEDURE FOR ALL  
ADJUDICATORY HEARINGS  
2 CCR 402-3**

**EDITORS NOTES\***

Rulemaking Authority for this Rule is cited in the Attorney General Opinions listed below. Those opinions may be found in the Code of Colorado Regulations, Attorney General Opinions Volume.

**History and Amendments:**

pp. 1-5 adopted 4/1/81, effective 6/1/81, 4 CR 5, pg. 5 adopted 8/7/81, effective 10/1/81, 4 CR 9.

**A. G. Opinions:**

4 AG 92; 4 AG 204

**Annotations:**

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RULES OF PROCEDURE FOR ALL  
ADJUDICATORY HEARINGS BEFORE THE  
GROUND WATER COMMISSION

I. BASIS AND PURPOSE

1. These rules of procedure implement the Colorado Ground Water Management Act, C.R.S. 1973, 37-90-101 *et seq.*, as amended, hereinafter referred to as the "Act." They shall govern the procedure to be followed by parties in adjudicatory hearings held by the Colorado Ground Water Commission, hereinafter referred to as the "commission."

2. These rules of procedure are intended to establish procedures to assure that all adjudicatory hearings held by the commission are conducted in a fair and impartial manner, to assure that all parties to proceedings under the Colorado Ground Water Management Act are accorded due process of law, and to provide the commission with all relevant facts and information pertinent to decision making. These rules shall be construed to carry out these purposes.

3. These rules of procedure are promulgated pursuant to C.R.S. 1973, 37-90-113, as amended, and 24-4-103, as amended.

II. APPLICABILITY OF STATE  
ADMINISTRATIVE PROCEDURE ACT

The procedures described in the State Administrative Procedure Act, C.R.S. 1973, 24-4-101, *et seq*, as amended, shall apply to all adjudicatory hearings held by the commission. Specifically, the provisions of C.R.S. 1973, 24-4-105, as amended, shall apply to all hearings unless such provisions are inconsistent with specific provisions of the Ground Water Management Act, in which case the Ground Water Management Act shall control.

III. PREHEARING CONFERENCES

A prehearing conference may be held if deemed advisable by the commission or the hearing officer assigned to the case. A request for a prehearing conference may be made in writing to the commission or the hearing officer at least 30 days before the scheduled hearing. The prehearing conference shall be for the purpose of facilitating the adjudication of issues to be determined at the hearing. The scope of issues to be raised at the prehearing conference shall be determined by the chairman of the commission or the hearing officer. Prehearing conferences shall be held in the commission offices in Denver unless it is determined by the chairman of the commission or the hearing officer that the conference should be held at some other location. The commission or the hearing officer may hold prehearing conferences by telephone at their discretion for the convenience of the parties.

IV. DISCOVERY

Any party seeking to use discovery pursuant to the Colorado Rules of Civil Procedure shall first attempt to



obtain the information or documents requested informally. All further discovery shall be conducted pursuant to the Colorado Rules of Civil Procedure.

Subpoenae shall be issued by the hearing officer or the commission in accordance with C.R.S. 1973, 24-4-105(5), as amended, on forms provided to the hearing officer or the commission by the party requesting the subpoena.

#### V. CONDUCT OF HEARINGS

1. The hearing officer shall determine the order in which the parties shall present their cases, except that unless good cause is shown, the applicant or petitioner or whichever party shall be determined to bear the burden of proof, shall proceed first.

2. With respect to the submission of evidence, the Colorado Rules of Evidence shall be adhered to to the extent deemed appropriate by the hearing officer, and in accordance with the provisions of C.R.S. 1973, 24-4-105(7), which provides as follows:

(7) Except as otherwise provided by statute, the proponent of an order shall have the burden of proof, and every party to the proceeding shall have the right to present his case or defense by oral and documentary evidence, to submit rebuttal evidence, and to conduct such cross-examination as may be required for a full and true disclosure of the facts. Subject to these rights and requirements, where a hearing will be expedited and the interests of the parties will not be substantially prejudiced thereby, a person conducting a hearing may receive all or part of the evidence in written form. The rules of evidence and requirements of proof shall conform, to the extent practicable, with

those in civil nonjury cases in the district courts. However, when necessary to do so in order to ascertain facts affecting the substantial rights of the parties to the proceeding, the person so conducting the hearing may receive and consider evidence not admissible under such rules if such evidence possesses probative value commonly accepted by reasonable and prudent men in the conduct of their affairs. Objections to evidentiary offers may be made and shall be noted in the record. The person conducting a hearing shall give effect to the rules of privilege recognized by law. He may exclude incompetent and unduly repetitious evidence. Documentary evidence may be received in the form of a copy or excerpt if the original is not readily available; but, upon request, the party shall be given an opportunity to compare the copy with the original. An agency may utilize its experience, technical competence, and specialized knowledge in the evaluation of the evidence presented to it.

3. The hearing officer may examine any witness appearing before him.

#### VI. PARTICIPATION OF THE GROUND WATER COMMISSION STAFF

The staff of the Ground Water Commission may appear to present any testimony or evidence relevant to any matter being heard by the commission or its hearing officer. The staff shall be represented by the attorney general.

VII. TIME FOR FILING APPEALS OF  
ORDERS OF THE GROUND WATER  
COMMISSION OR THE STATE ENGINEER

A. The basis and purpose of this rule are the same as stated in Rule I of the Rules of Procedure for All Adjudicatory Hearings Before the Ground Water Commission (2 CCR 402-3). Rule I is incorporated herein by reference and is hereby re-affirmed.

B. Any person who wishes to request a hearing on or claim injury from an order of the Ground Water Commission or the State Engineer pursuant to C.R.S. 1973, 37-90-114, shall file a written statement with the commission setting forth the grounds for the request for hearing or claim of injury within 30 days of receipt of the order.

After receipt of such a request for hearing or claim of injury, the commission shall conduct a hearing thereon.

C. This rule shall be effective on October 1, 1981.

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**APPENDIX H2**  
**DESIGNATED GROUND WATER COLORADO**  
**REVISED STATUTES**

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**COLORADO REVISED STATUTES GOVERNING  
DESIGNATED GROUND WATER**

**37-90-101 Short Title**

This article shall be known and may be cited as the “Colorado Ground Water Management Act”.

**37-90-102 Legislative declaration – repeal.**

1) It is declared that the traditional policy of the state of Colorado, requiring the water resources of this state to be devoted to beneficial use in reasonable amounts through appropriation, is affirmed with respect to the designated ground waters of this state, as said waters are defined in section 37-90-103(6). While the doctrine of prior appropriation is recognized, such doctrine should be modified to permit the full economic development of designated ground water resources. Prior appropriations of ground water should be protected and reasonable ground water pumping levels maintained, but not to include the maintenance of historical water levels. All designated ground waters in this state are therefore declared to be subject to appropriation in the manner defined in this article.

(2) The general assembly finds and declares that the allocation of nontributary ground water pursuant to statute is based upon the best available evidence at this time. The general assembly recognizes the unique, finite nature of nontributary ground water resources outside of designated ground water basins and declares that such nontributary ground water shall be devoted to beneficial use in amounts based upon conservation of the resource and protection of vested water rights. Economic development of this resource shall allow for the reduction of hydrostatic pressure levels and aquifer water levels consistent with the protection of appropriative rights in the natural stream system. The doctrine of prior appropriation shall not apply to nontributary ground water. To continue the development of nontributary ground water resources consonant with conservation shall be the policy of this state. Such water shall be allocated as provided in this article upon the basis of ownership of the overlying

land. This policy is a reasonable exercise of the general assembly's plenary power over this resource.

(3)(a) The general assembly finds and declares that in water division 3, established pursuant to section 37-92-201(1)(c), there exists a confined aquifer system underlying portions of the San Luis valley. The hydrologic system in water division 3 and, in particular, the hydrology and geology of the shallow aquifer and confined aquifer systems and their relationship to surface streams in water division 3 are unique and are among the most complex in the state. Unless properly augmented, new withdrawals of groundwater affecting the confined aquifer system can materially injure vested water rights and increase the burden of Colorado's scheduled deliveries under the Rio Grande compact. There is currently insufficient comprehensive data and knowledge of the relationship between the surface streams and the confined aquifer system to permit a full understanding of the effect of groundwater withdrawals, affecting the confined aquifer, upon the natural stream and aquifer systems in water division 3.

(b) This subsection (3) is repealed, effective July 1, 2003.

**37-90-103 - Definitions - repeal.**

As used in this article, unless the context otherwise requires:

(1) "Alternate point of diversion well" means any well drilled and used, in addition to an original well or other diversion, for the purpose of obtaining the present appropriation of that original well, from more than one point of diversion.

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(2) "Aquifer" means a formation, group of formations, or part of a formation containing sufficient saturated permeable material that could yield a sufficient quantity of water that may be extracted and applied to a beneficial use.

(3) "Artesian well" means a well tapping an aquifer in which the static water level in the well rises above where it was first encountered in the aquifer, due to hydrostatic pressure.

(4) "Board" or "board of directors" means the board of directors of a ground water management district as organized under section 37-90-124.

(5) "Colorado water conservation board" refers to the board created in section 37-60-102.

(6)(a) "Designated ground water" means that ground water which in its natural course would not be available to and required for the fulfillment of decreed surface rights, or ground water in areas not adjacent to a continuously flowing natural stream wherein ground water withdrawals have constituted the principal water usage for at least fifteen years preceding the date of the first hearing on the proposed designation of the basin, and which in both cases is within the geographic boundaries of a designated ground water basin. "Designated ground water" shall not include any ground water within the Dawson-Arkose, Denver, Arapahoe, or Laramie-Fox Hills formation located outside the boundaries of any designated ground water basin that was in existence on January 1, 1983.

(b)(I) However, "designated ground water" may include any ground water in the Crow Creek drainage area in Weld county, upstream from the confluence of



Crow Creek and Little Crow Creek, within the Laramie-Fox Hills formation located outside such boundaries when the Laramie-Fox Hills formation is not overlaid by the Dawson-Arkose, Denver, or Arapahoe formations.

(II) If, upon receipt by the state engineer of the findings of the Laramie-Fox Hills study, as authorized by Senate Bill 250, 1985 legislative session, that the upper Crow Creek drainage area in Weld county, upstream from the confluence of Crow Creek and Little Crow Creek, within the Laramie-Fox Hills formation when the Laramie-Fox Hills formation is not overlaid by the Dawson-Arkose, Denver, or Arapahoe formations should not be a designated ground water basin, this paragraph (b) is repealed.

(7) "Designated ground water basin" means that area established by the ground water commission in accordance with section 37-90-106.

(8) "Ground water commission" or "commission" refers to the ground water commission created and provided for in section 37-90-104 to facilitate the functioning of this article.

(9) "Ground water management district" or "district" means any district organized under the provisions of this article.

(10) "Historical water level" means the average elevation of the ground water level in any area before being lowered by the activities of man, as nearly as can be determined from scientific investigation and available facts.

(10.5) "Nontributary ground water" means that ground water, located outside the boundaries of any

designated ground water basins in existence on January 1, 1985, the withdrawal of which will not, within one hundred years, deplete the flow of a natural stream, including a natural stream as defined in sections 37-82-101(2) and 37-92-102(1)(b), at an annual rate greater than one-tenth of one percent of the annual rate of withdrawal. The determination of whether ground water is nontributary shall be based on aquifer conditions existing at the time of permit application; except that, in recognition of the de minimis amount of water discharging from the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers into surface streams due to artesian pressure, when compared with the great economic importance of the ground water in those aquifers, and the feasibility and requirement of full augmentation by wells located in the tributary portions of those aquifers, it is specifically found and declared that, in determining whether ground water of the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers is nontributary, it shall be assumed that the hydrostatic pressure level in each such aquifer has been lowered at least to the top of that aquifer throughout that aquifer; except that not nontributary ground water, as defined in subsection (10.7) of this section, in the Denver basin shall not become nontributary ground water as a result of the aquifer's hydrostatic pressure level dropping below the alluvium of an adjacent stream due to Denver basin well pumping activity. Nothing in this subsection (10.5) shall preclude the designation of any aquifer or basin, or any portion thereof, which is otherwise eligible for designation under the standard set forth in subsection (6) of this section relating to ground water in areas not adjacent to a continuously flowing natural stream wherein ground water withdrawals have constituted the principal water usage

for at least fifteen years preceding the date of the first hearing on the proposed designation of a basin.

(10.7) "Not nontributary ground water" means ground water located within those portions of the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers that are outside the boundaries of any designated ground water basin in existence on January 1, 1985, the withdrawal of which will, within one hundred years, deplete the flow of a natural stream, including a natural stream as defined in sections 37-82-101(2) and 37-92-102(1)(b), at an annual rate of greater than one-tenth of one percent of the annual rate of withdrawal.

(11) "Person" means any individual, partnership, association, or corporation authorized to do business in the state of Colorado, or any political subdivision or public agency thereof, or any agency of the United States, making a beneficial use, or taking steps, or doing work preliminary to making a beneficial use of designated underground waters of Colorado.

(12) "Private driller" means any individual, corporation, partnership, association, political subdivision, or public agency which operates as lessee or owner its own well drilling rig and equipment and which digs, drills, redrills, cases, recases, deepens, or excavates a well upon the property of such entity.

(12.5) "Quarter-quarter" means a fourth of a fourth of a section of land and is equal to approximately forty acres.

(12.7) "Replacement plan" means a detailed program to increase the supply of water available for beneficial use in a designated ground water basin or portion thereof for

the purpose of preventing material injury to other water rights by the development of new points of diversion, by pooling of water resources, by water exchange projects, by providing substitute supplies of water, by the development of new sources of water, or by any other appropriate means consistent with the rules adopted by the commission. "Replacement plan" does not include the salvage of designated ground water by the eradication of phreatophytes, nor does it include the use of precipitation water collected from land surfaces that have been made impermeable, thereby increasing the runoff, but not adding to the existing supply of water.

(13) "Replacement well" means a new well which replaces an existing well and which shall be limited to the yield of the original well and shall take the date of priority of the original well, which shall be abandoned upon completion of the new well.

(14) "Resident agriculturist" means a bona fide farmer or rancher residing in the designated ground water basin whose major source of income is derived from the production and sale of agricultural products.

(15) "State engineer" means the state engineer of Colorado or any person deputized by him in writing to perform a duty or exercise a right granted in this article.

(16) "Subdivision" means an area within a ground water basin.

(17) "Supplemental well" means any well drilled and used, in addition to an original well or other diversion, for the purpose of obtaining the quantity of the original appropriation of the original well, which quantity can no longer be obtained from the original well.

(18) "Taxpaying elector" means a person qualified to vote at general elections in Colorado, who owns real or personal property within the district and has paid ad valorem taxes thereon in the twenty months immediately preceding a designated time or event, which property is subject to taxation at the time of any election held under the provisions of this article or at any other time in reference to which the term "taxpaying elector" is used. A person who is obligated to pay taxes under a contract to purchase real property in the district shall be considered an owner. The ownership of any property subject to the payment of a specific ownership tax on a motor vehicle or trailer or of any other excise or property tax other than general ad valorem property taxes shall not constitute the ownership of property subject to taxation as provided in this article.

(19) "Underground water" and "ground water" are used interchangeably in this article and mean any water not visible on the surface of the ground under natural conditions.

(20) "Waste" means causing, suffering, or permitting any well to discharge water unnecessarily above or below the surface of the ground.

(21)(a) "Well" means any structure or device used for the purpose or with the effect of obtaining ground water for beneficial use from an aquifer.

(b) "Well" does not include a naturally flowing spring or springs where the natural spring discharge is captured or concentrated by installation of a near-surface structure or device less than ten feet in depth located at or within fifty feet of the spring or springs' natural discharge point and the water is conveyed directly by gravity flow or into a

separate sump or storage, if the owner obtains a water right for such structure or device as a spring pursuant to article 92 of this title.

(22) "Well driller" means any individual, corporation, partnership, association, political subdivision, or public agency which digs, drills, cases, recases, deepens, or excavates a well either by contract or for hire or for any consideration whatsoever.

**37-90-104 - Commission - organization - expenses.**

(1) There is created a ground water commission to consist of twelve members, nine of whom shall be appointed by the governor and confirmed by the senate.

(2) The appointed members of the commission holding office as of July 1, 1971, shall continue in office for the term of their appointment and until their successors are appointed.

(3)(a) All appointments to the commission shall be for four-year terms, except those made to fill vacancies, which shall be for the remainder of the term vacated.

(b) Appointments made after July 1, 1971, as terms expire or are vacated, shall be made so that the commission includes six members who are resident agriculturists of designated ground water basins, with no more than two resident agriculturists from the same ground water basin to be members of the commission at the same time; one member who shall be a resident agriculturist and who shall be appointed from water division 3; and two residents of the state who shall represent municipal or industrial water users of the state, one of whom shall be appointed from the area west of the continental divide.

(4) In addition to the appointed members, the executive director of the department of natural resources shall be a voting member, and the state engineer, and the director of the Colorado water conservation board shall be nonvoting members of the commission. Six voting members shall constitute a quorum at any regularly or specially called meeting of the commission, and a majority vote of those present shall rule. The commission shall establish and maintain a schedule of at least four general meetings each year. The chairman, at his discretion, or two members may call special meetings of the commission to dispose of accumulated business.

(5) Members of the commission shall be paid no compensation but shall be paid actual necessary expenses incurred by them in the performance of their duties as members thereof and a per diem of fifty dollars per day while performing official duties, not to exceed two thousand four hundred dollars in any year.

(6) The commission shall biennially select a chair and vice-chair from among the appointed members. The state engineer shall be ex officio the executive director of the commission and shall carry out and enforce the decisions, orders, and policies of the commission. The commission may delegate to the executive director the authority to perform any of the functions of the commission as set forth in this article except the determination of a designated ground water basin as set forth in section 37-90-106 and the creation of ground water management districts. If any person is dissatisfied with any action of the executive director under the exercise of the powers delegated by the commission, the person may appeal said action to the commission, which shall hear the person's appeals as specified in sections 37-90-113 and 37-90-114.

(7) The provisions of section 24-6-402(3)(a)(II), C.R.S., concerning imminent court action, as applied to the ground water commission and to any member, employee, contractor, agent, servant, attorney, or consultant thereof, shall not include any actions within the scope of sections 37-90-106 to 37-90-109 and section 37-90-111.

**37-90-105 – Small capacity wells.**

(1) The state engineer has the authority to approve permits for the following types of wells in designated ground water basins without regard to any other provisions of this article:

(a) Wells not exceeding fifty gallons per minute and used for no more than three single-family dwellings, including the normal operations associated with such dwellings but not including the irrigation of more than one acre of land;

(b) Wells not exceeding fifty gallons per minute and used for watering of livestock on range and pasture;

(c)(I) One well not exceeding fifty gallons per minute and used in one commercial business.

(II) To qualify as a “commercial business” under this paragraph (c), the business shall be:

(A) A business that will be operated by the well owner and that will have its own books, bank accounts, checking accounts, and separate tax returns;

(B) A business that will use water solely on the land indicated in the permit for the well and for the purposes stated in such permit;



(C) A business that will maintain its individual assets and will own or lease the property on which the well is to be located or where the business is operated;

(D) A business that will have its own contractual agreements for operation of the business;

(E) A business that agrees not to transfer a permit issued under this paragraph (c) to another entity that also holds a small capacity commercial well permit under this paragraph (c); and

(F) A business that agrees to notify any potential buyer that such buyer shall notify the state engineer of any change in ownership of such business within sixty days after any such change in ownership.

(d) Wells to be used exclusively for monitoring and observation purposes if said wells are capped and locked and used only to monitor water levels or for water quality sampling; or

(e) Wells to be used exclusively for fire-fighting purposes if said wells are capped and locked and available for use only in fighting fires.

(2) The state engineer has the authority to adopt rules in accordance with section 24-4-103, C.R.S., to carry out the provisions of this section. Any party adversely affected or aggrieved by a rule adopted by the state engineer may seek judicial review of such action pursuant to section 24-4-106, C.R.S.

(3)(a)(I) Wells of the type described in this section may be constructed only upon the issuance of a permit in accordance with the provisions of this section. A fee of sixty dollars shall accompany any application for a new

well permit under this section. A fee of twenty dollars shall accompany any application for a replacement well of the type described in subsection (1) of this section.

(II) Notwithstanding the amount specified for any fee in subparagraph (I) of this paragraph (a), the commission by rule or as otherwise provided by law may reduce the amount of one or more of the fees if necessary pursuant to section 24-75-402(3), C.R.S., to reduce the uncommitted reserves of the fund to which all or any portion of one or more of the fees is credited. After the uncommitted reserves of the fund are sufficiently reduced, the commission by rule or as otherwise provided by law may increase the amount of one or more of the fees as provided in section 24-75-402(4), C.R.S.

(b) Beginning on August 5, 1998, the state engineer shall not approve a permit for a small capacity well with an annual volume of use in excess of five acre-feet, unless the well is located in a ground water management district that has adopted rules that allow an annual volume in excess of five acre-feet. This limitation shall not apply to a replacement permit for a well where the original permit allows an annual volume of use in excess of five acre-feet or to a permit for a well covered by the provisions of subsection (4) of this section where the actual annual volume of use was in excess of five acre-feet.

(c) If the application is made pursuant to this section for a well that will be located in a subdivision, as defined in section 30-28-101(10), C.R.S., and approved on or after June 1, 1972, pursuant to article 28 of title 30, C.R.S., for which the water supply plan has not been recommended for approval by the state engineer, the cumulative effect of all such wells in the subdivision shall be considered in

determining material injury, and the state engineer shall deny the application if it is determined that the proposed well will cause material injury to existing water rights.

(d)(I) If any person wishes to replace an existing well of the type described in subsection (1) of this section, such person shall file an application pursuant to this subsection (3) for the construction of a well and shall state in such application such person's intent to abandon the existing well that is to be replaced.

(II) If such a replacement well will not change the amount or type of use of water that can lawfully be made by means of the existing well, a permit to construct and use the replacement well shall be issued, and the existing well shall be abandoned within ninety days after the completion of the replacement well.

(e) Wells for which permits have been granted or may be granted shall be constructed within two years after the permit is issued, which time may be extended for successive years at the discretion of the state engineer for good cause shown.

(4)(a) Any wells of the type described by this section that were put to beneficial use prior to May 8, 1972, and any wells that were used exclusively for monitoring and observation purposes prior to August 1, 1988, not of record in the office of the state engineer, may be recorded in that office upon written application, payment of a processing fee of sixty dollars, and permit approval. The record shall include the date the water is claimed to have been first put to beneficial use.

(b) Any owner of an existing well that was constructed prior to May 8, 1972, or has a well permit issued

prior to January 1, 1996, under the provisions of this section, and that was put to beneficial use for watering livestock in a confined animal-feeding operation prior to January 1, 1996, and has been used for that purpose, may apply by December 31, 1999, to obtain a new permit for that well up to the extent of its beneficial use prior to January 1, 1996, for watering livestock in that commercial business pursuant to paragraph (c) of subsection (1) of this section. Such well shall be in addition to the one commercial business well allowed in paragraph (c) of subsection (1) of this section. Such an application shall include a sixty dollar filing fee and shall provide documentation of the annual volume of water put to beneficial use from the well. The state engineer shall have the authority to determine the adequacy of the submitted information for the purpose of approving completely, approving in part, or denying the application. Permits issued after January 1, 1996, up to August 5, 1998, shall remain valid thereafter according to the terms and conditions of those permits.

(5) The state engineer shall act upon an application filed under this section within forty-five days after such filing and shall support the ruling with a written statement of the basis therefor.

(6)(a) Any person aggrieved by a decision of the state engineer granting or denying an application under this section may request a hearing before the state engineer pursuant to section 24-4-104, C.R.S. The state engineer may, in the state engineer's discretion, have such hearings conducted before such agent as it may designate for a ruling in the matter. Any party who seeks to reverse or modify the ruling of the agent of the state engineer may file an appeal to the state engineer pursuant to section 24-4-105, C.R.S.

(b) Any party aggrieved by a final decision of the state engineer granting or denying an application filed under this section may within thirty days after such decision file a petition for review with the district court in the county in which the well is located. Upon receipt of such petition, the designated ground water judge for the basin in which the well is located shall conduct such hearings, pursuant to section 24-4-106, C.R.S., as necessary to determine whether or not the decision of the state engineer shall be upheld. In any case in which the state engineer's decision is reversed, the judge shall order the state engineer to grant or deny the application, as such reversal may require, and may specify such terms and conditions as are appropriate.

(7) The board of any ground water management district has the authority to adopt rules that further restrict the issuance of small capacity well permits. In addition, the board of any ground water management district has the authority to adopt rules that expand the acre-foot limitations for small capacity wells set forth in this section. However, in no event shall an annual volume of more than eighty acre-feet be allowed for any small capacity well. Rules adopted by the board may be instituted only after a public hearing. Notice of such hearing shall be published. Such notice shall state the time and place of the hearing and describe, in general terms, the rules proposed. Within sixty days after such hearing, the board shall announce the rules adopted and shall cause notice of such action to be published. In addition, the board shall mail, within five days after the adoption of the rules, a copy of the rules to the state engineer. Any party adversely affected or aggrieved by such a rule may, not later than thirty days after the last date of publication,

initiate judicial review in accordance with the provisions of section 24-4-106, C.R.S.; except that venue for such judicial review shall be in the district court for the county in which the office of the ground water management district is located.

**37-90-106 - Determination of designated ground water basins - exception - repeal.**

(1)(a) The commission shall, from time to time as adequate factual data becomes available, determine designated ground water basins and subdivisions thereof by geographic description and, as future conditions require and factual data justify, shall alter the boundaries or description thereof.

(b) In making such determinations the commission shall make the following findings:

(I) The name of the aquifer within the proposed designated basin;

(II) The boundaries of each aquifer being considered;

(III) The estimated quantity of water stored in each aquifer;

(IV) The estimated annual rate of recharge;

(V) The estimated use of the ground water in the area.

(2) If the source is an area of use exceeding fifteen years as defined in section 37-90-103(6), the commission shall list those users who have been withdrawing water during the fifteen-year period, the use made of the water,

the average annual quantity of water withdrawn, and the year in which the user began to withdraw water.

(3) Before determining or altering the boundaries of a designated ground water basin or subdivisions thereof, the state engineer shall prepare and file in his office a map clearly showing all lands included therein, together with a written description thereof sufficient to apprise interested parties of the boundaries of the proposed basin or subdivisions thereof. The commission shall publish the same and hold a hearing thereon. Following such hearing, the commission shall enter an order to either create the proposed designated ground water basin, to include modification of the proposed boundaries, if any, or dismiss the original proposal, according to the factual information presented or available.

(4)(a) The commission shall not, after May 23, 1983, determine as part of any designated ground water basin any ground water within the Dawson-Arkose, Denver, Arapahoe, or Laramie-Fox Hills formations which was located outside the boundaries of any designated ground water basin that was in existence on January 1, 1983.

(b)(I) However, the commission may determine as a part of any designated ground water basin any ground water in the Crow Creek drainage area in Weld county, upstream from the confluence of Crow Creek and Little Crow Creek, within the Laramie-Fox Hills formation when the Laramie-Fox Hills formation is not overlaid by the Dawson-Arkose, Denver, or Arapahoe formations.

(II) If, upon receipt by the state engineer of the findings of the Laramie-Fox Hills study, as authorized by Senate Bill 250, 1985 legislative session, that the upper Crow Creek drainage area in Weld county, upstream from

the confluence of Crow Creek and Little Crow Creek, within the Laramie-Fox Hills formation when the Laramie-Fox Hills formation is not overlaid by the Dawson-Arkose, Denver, or Arapahoe formations should not be a designated ground water basin, this paragraph (b) is repealed.

**37-90-107 - Application for use of ground water - publication of notice - conditional permit - hearing on objections - well permits.**

(1) Any person desiring to appropriate ground water for a beneficial use in a designated ground water basin shall make application to the commission in a form to be prescribed by the commission. The applicant shall specify the particular designated ground water basin or subdivision thereof from which water is proposed to be appropriated, the beneficial use to which it is proposed to apply such water, the location of the proposed well, the name of the owner of the land on which such well will be located, the estimated average annual amount of water applied for in acre-feet, the estimated maximum pumping rate in gallons per minute, and, if the proposed use is irrigation, the description of the land to be irrigated and the name of the owner thereof, together with such other reasonable information as the commission may designate on the form prescribed. The amount of water applied for shall only be utilized on the land designated on the application. The place of use shall not be changed without first obtaining authorization from the ground water commission.

(2) Upon the filing of such application, a preliminary evaluation shall be made to determine if the application may be granted. If the application can be given favorable consideration by the ground water commission under



existing policies, then, within thirty days, the application shall be published.

(3) After the expiration of the time for filing objections, if no such objections have been filed, the commission shall, if it finds that the proposed appropriation will not unreasonably impair existing water rights from the same source and will not create unreasonable waste, grant the said application, and the state engineer shall issue a conditional permit to the applicant within forty-five days after the expiration of the time for filing objections or within forty-five days after the hearing provided for in subsection (4) of this section to appropriate all or a part of the waters applied for, subject to such reasonable conditions and limitations as the commission may specify.

(4) If objections have been filed within the time in said notice specified, the commission shall set a date for a hearing on the application and the objections thereto and shall notify the applicants and the objectors of the time and place. Such hearing shall be held in the designated ground water basin and within the district, if one exists, in which the proposed well will be located or at such other place as may be designated by the commission for the convenience of, and as agreed to by, the parties involved. If after such hearing it appears that there are no unappropriated waters in the designated source or that the proposed appropriation would unreasonably impair existing water rights from such source or would create unreasonable waste, the application shall be denied; otherwise, it shall be granted in accordance with subsection (3) of this section. The commission shall consider all evidence presented at the hearing and all other matters set forth in this section in determining whether the application should be denied or granted.

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(5) In ascertaining whether a proposed use will create unreasonable waste or unreasonably affect the rights of other appropriators, the commission shall take into consideration the area and geologic conditions, the average annual yield and recharge rate of the appropriate water supply, the priority and quantity of existing claims of all persons to use the water, the proposed method of use, and all other matters appropriate to such questions. With regard to whether a proposed use will impair uses under existing water rights, impairment shall include the unreasonable lowering of the water level, or the unreasonable deterioration of water quality, beyond reasonable economic limits of withdrawal or use. If an application for a well permit cannot otherwise be granted pursuant to this section, a well permit may be issued upon approval by the ground water commission of a replacement plan that meets the requirements of this article and the rules adopted by the commission. A replacement plan shall not be used as a vehicle for avoiding limitations on existing wells, including but not limited to restrictions on change of well location. Therefore, before approving any replacement plan that includes existing wells, the commission shall require independent compliance with all rules governing those existing wells in addition to compliance with any guidelines or rules governing replacement plans.

(6)(a)(I) No person shall, in connection with the extraction of sand and gravel by open mining as defined in section 34-32-103(9), C.R.S., expose designated ground water to the atmosphere unless said person has obtained a well permit from the ground water commission. If an application for such a well permit cannot otherwise be granted pursuant to this section, a well permit shall be issued upon approval by the ground water commission of a

replacement plan which meets the requirements of this article, pursuant to the guidelines or rules and regulations adopted by the commission.

(II) Any person who extracted sand and gravel by open mining and exposed ground water to the atmosphere after December 31, 1980, shall apply for a well permit pursuant to this section and, if applicable, shall submit a replacement plan prior to July 15, 1990.

(b) If any designated ground water was exposed to the atmosphere in connection with the extraction of sand and gravel by open mining as defined in section 34-32-103 (9), C.R.S., prior to January 1, 1981, no such well permit or replacement plan shall be required to replace depletions from evaporation; except that the burden of proving that such designated ground water was exposed prior to January 1, 1981, shall be upon the party claiming the benefit of this exception.

(c) Any person who has reactivated or reactivates open mining operations which exposed designated ground water to the atmosphere but which ceased activity prior to January 1, 1981, shall obtain a well permit and shall apply for approval of a replacement plan or a plan of substitute supply pursuant to paragraph (a) of this subsection (6).

(d) In addition to the well permit filing fee required by section 37-90-116, the commission shall collect the following fees:

(I) For persons who exposed ground water to the atmosphere on or after January 1, 1981, but prior to July 15, 1989, one thousand three hundred forty-three dollars; except that, if such plan is filed prior to July 15, 1990, as

required by subparagraph (II) of paragraph (a) of this subsection (6), the filing fee shall be seventy dollars if such plan includes ten acres or less of exposed ground water surface area or three hundred fifty dollars if such plan includes more than ten acres of exposed ground water surface area.

(II) For persons who expose ground water to the atmosphere on or after July 15, 1989, one thousand three hundred forty-three dollars regardless of the number of acres exposed. In the case of new mining operations, such fee shall cover two years of operation of the plan.

(III) For persons who reactivated or who reactivate mining operations which ceased activity prior to January 1, 1981, and who enlarge the surface area of any gravel pit lake beyond the area it covered before the cessation of activity, one thousand three hundred forty-three dollars.

(IV) For persons who request renewal of an approved substitute water supply plan prior to the expiration date of the plan, two hundred seventeen dollars regardless of the number of acres exposed.

(V) For persons whose approved substitute water supply plan has expired and who submit a subsequent plan, one thousand three hundred forty-three dollars regardless of the number of acres exposed. An approved plan shall be considered expired if the applicant has not applied for renewal before the expiration date of the plan. The state engineer shall notify the applicant in writing if the plan is considered expired.

(VI) For persons whose proposed substitute water supply plan was disapproved and who submit a subsequent plan, one thousand three hundred forty-three

dollars regardless of the number of acres exposed. The state engineer shall notify the applicant in writing of disapproval of a plan.

(e) Excluding the well permit filing fee required by section 37-90-116(2), all fees collected with a replacement plan shall be credited to the gravel pit lakes augmentation fund, which fund is created in section 37-90-137(11)(f).

(f) A person who has obtained a reclamation permit pursuant to section 34-32-112, C.R.S., shall be allowed to apply for a single well permit and to submit a single replacement plan for the entire acreage covered by the reclamation plan without regard to the number of gravel pit lakes located within such acreage.

(g) Notwithstanding the amount specified for any fee in paragraph (d) of this subsection (6), the commission by rule or as otherwise provided by law may reduce the amount of one or more of the fees if necessary pursuant to section 24-75-402(3), C.R.S., to reduce the uncommitted reserves of the fund to which all or any portion of one or more of the fees is credited. After the uncommitted reserves of the fund are sufficiently reduced, the commission by rule or as otherwise provided by law may increase the amount of one or more of the fees as provided in section 24-75-402(4), C.R.S.

(7)(a) The commission shall allocate, upon the basis of the ownership of the overlying land, any designated ground water contained in the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers. Permits issued pursuant to this subsection (7) shall allow withdrawals on the basis of an aquifer life of one hundred years. The commission shall adopt the necessary rules to carry out the provisions of this subsection (7).

(b) Any right to the use of ground water entitling its owner or user to construct a well, which right was initiated prior to November 19, 1973, as evidenced by a current decree, well registration statement, or an unexpired well permit issued prior to November 19, 1973, shall not be subject to the provisions of paragraph (a) of this subsection (7).

(c)(I) Rights to designated ground water in the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers to be allocated pursuant to paragraph (a) of this subsection (7) may be determined in accordance with the provisions of this section. Any person desiring to obtain such a determination shall make application to the commission in a form to be prescribed by the commission. A fee of sixty dollars shall be submitted with the application for each aquifer, which sum shall not be refunded. The application may also include a request for approval of a replacement plan if one is required under commission rules to replace any depletions to alluvial aquifers caused due to withdrawal of ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers.

(II) The publication and hearing requirements of this section shall also apply to an application for determination of water rights pursuant to this subsection (7).

(III) Any such commission approved determination shall be considered a final determination of the amount of ground water so determined; except that the commission shall retain jurisdiction for subsequent adjustment of such amount to conform to the actual local aquifer characteristics from adequate information obtained from well drilling or test holes.

(d)(I) Any person desiring a permit for a well to withdraw ground water for a beneficial use from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers shall make application to the commission on a form to be prescribed by the commission. A fee of sixty dollars shall be submitted with the application, which sum shall not be refunded.

(II) A well permit shall not be granted unless a determination of ground water to be withdrawn by the well has been made pursuant to paragraph (c) of this subsection (7).

(III) The application for a well permit shall also include a replacement plan if one is required under commission rules to replace any depletions to alluvial aquifers caused due to withdrawal of ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers and the required plan has not been approved pursuant to paragraph (c) of this subsection (7). The publication and hearing requirements of this section shall apply to an application for such a replacement plan.

(IV) The annual amount of withdrawal allowed in any well permits issued under this subsection (7) shall be less than or equal to the amount determined pursuant to paragraph (c) of this subsection (7) and may, if so provided by any such determination, provide for the subsequent adjustment of such amount to conform to the actual aquifer characteristics encountered upon drilling of the well or test holes.

(8) The commission shall have the exclusive authority to issue or deny well permits under this section. The commission shall consider any recommendation by ground

water management districts concerning well permit applications under this section.

**37-90-107.5 – Replacement plans.**

Any person desiring to obtain an approval of a replacement plan within the boundaries of a designated ground water basin pursuant to the provisions of this article shall make an application to the commission in a form prescribed by the commission. The applicant shall also submit a summary of the application to the commission for publication. If the commission determines the application to be complete, it shall be published pursuant to section 37-90-112 within sixty days after the filing of such an application. If an objection is filed, a hearing shall be held pursuant to section 37-90-113. The commission shall approve the replacement plan if the commission determines that the replacement plan meets the requirements of this article and rules adopted by the commission. A replacement plan shall not be used as a vehicle for avoiding limitations on existing wells, including but not limited to restrictions on change of well location. Therefore, before approving any replacement plan that includes existing wells, the commission shall require independent compliance with all rules governing those existing wells in addition to compliance with any guidelines or rules governing replacement plans.

**37-90-108 – Final permit – evidence of well construction and beneficial use – limitations.**

(1)(a) After having received a conditional permit to appropriate designated ground water, the applicant, within one year from the date of the issuance of said



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permit, shall construct the well or other works necessary to apply the water to a beneficial use.

(b) The applicant, upon completion of the well, shall furnish information to the commission, in the form prescribed by the commission, as to the depth of the well, the water-bearing formations intercepted by the well, and the maximum sustained pumping rate in gallons per minute.

(c) If the well described in the conditional permit is not constructed within one year from the date of the issuance of the conditional permit as provided in this subsection (1), the conditional permit shall expire and be of no force or effect; except that, upon a showing of good cause, the commission may grant one extension of time only for a period not to exceed one year. If the well has been constructed timely but the completion information required by this subsection (1) has not been furnished to the commission, the procedures specified in subsection (6) of this section shall apply.

(2)(a) If the well or wells described in a conditional permit have been constructed in compliance with subsection (1) of this section, the applicant, within three years after the date of the issuance of said permit, shall furnish by sworn affidavit, in the form prescribed by the commission, evidence that water from such well or wells has been put to beneficial use; except that the requirements of this paragraph (a) shall not apply to a well described in a conditional permit issued on or after July 1, 1991, to withdraw designated ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers.

(b) Such affidavit shall be prima facie evidence of the matters contained therein but shall be subject to objection by others, including ground water management districts,

claiming to be injured thereby and to such verification and inquiry as the commission shall consider appropriate in each particular case.

(c) If such required affidavit is not furnished to the commission within the time and as provided in this subsection (2), the conditional permit shall expire and be of no force or effect except as provided in subsection (4) of this section.

(d) If the well described in a conditional permit issued on or after July 1, 1991, to withdraw designated ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers has been constructed in compliance with subsection (1) of this section, the applicant shall file a notice with the commission of commencement of beneficial use on a form prescribed by the commission within thirty days after the first beneficial use of any water withdrawn from such well.

(3)(a)(I) To the extent that the commission finds that water has been put to a beneficial use and that the other terms of the conditional permit have been complied with and after publication of the information required in the final permit, as provided in section 37-90-112, the commission shall order the state engineer to issue a final permit to use designated ground water, containing such limitations and conditions as the commission deems necessary to prevent waste and to protect the rights of other appropriators. In determining the extent of beneficial use for the purpose of issuing final permits, the commission may use the same criteria for determining the amount of water used on each acre that has been irrigated that is used in evaluating the amount of water available for appropriation

under section 37-90-107. The provisions of this subparagraph (I) shall not apply to a well described in a conditional permit issued on or after July 1, 1991, to withdraw designated ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers.

(II) A final permit is not required to be issued for a well described in a conditional permit issued on or after July 1, 1991, to withdraw designated ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers. For such a well, a conditional permit, subject to the conditions of issuance of such a permit, shall be considered a final determination of a well's water right if the well is in compliance with all other applicable requirements of this article.

(b) In determining the extent of beneficial use prior to the issuance of a final permit, the commission may either increase or decrease the quantity of water and the amount of irrigated acreage, if any, according to the evidence presented to the commission, but no increase shall be permitted which will increase the quantity of water beyond that authorized by the original decree, conditional permit, registration statement, or other well permit issued prior to basin designation or which otherwise will unreasonably affect the rights of other appropriators.

(c) Any owner of an existing valid conditional permit issued before July 1, 1978, may file with the commission an amended statement of beneficial use, in the form prescribed by the commission, on or before December 31, 1979, and not thereafter, if any such change occurred and was approved on or before August 5, 1977.

(4) The procedural requirement that a statement of beneficial use shall be filed shall apply to all permits wherein the water was put to beneficial use since May 17, 1965. If information pertaining to completion of the well as required in subsection (1) of this section has been received but evidence that water has been placed to beneficial use has not been received as of three years after the date of issuance of the conditional permit, the commission shall so notify the applicant by certified mail. The notice shall give the applicant the opportunity to submit proof that the water was put to beneficial use prior to three years after the date of issuance of the conditional permit. The proof must be received by the commission within twenty days after receipt of the notice by the applicant, and, if the conditional permit was issued on or after July 14, 1975, the proof must be accompanied by a filing fee of thirty dollars. If the commission finds the proof to be satisfactory, the conditional permit shall remain in force and effect. The commission shall consider any records of the commission and any evidence provided to the commission and all other matters set forth in this section in determining whether the conditional permit should remain in force and effect.

(5) All final permits shall set forth the following information as a minimum:

- (a) The priority date;
- (b) The name of the claimant;
- (c) The quarter-quarter in which the well is located;
- (d) The maximum annual volume of the appropriation in acre-feet per year;
- (e) The maximum pumping rate in gallons per minute; and

(f) The maximum number of acres which have been irrigated, if used for irrigation.

(6) The procedural requirement that the well completion information required by subsection (1) of this section be furnished to the commission shall apply to all permits issued after May 17, 1965. If the well has been constructed within twenty-four months after the date of issuance of the permit where the permit was issued before June 7, 1979, or within twelve months after the date of issuance of the permit where the permit was issued on or after June 7, 1979, or by the expiration date of the permit, including any extension, but the completion information has not been furnished to the commission within six months after said allowable time for the well completion, the commission shall so notify the applicant by certified mail. The notice shall give the applicant the opportunity to submit proof that the well was completed within the time specified above or by the expiration date of the permit and to submit the information required by subsection (1) of this section and a showing that, due to excusable neglect, inadvertence, or mistake, the applicant failed to submit the evidence and information on time. The proof and information must be received by the commission within twenty days after receipt of the notice by the applicant and must be accompanied by a filing fee of thirty dollars. If the commission finds the proof to be satisfactory, the permit shall remain in force and effect. The commission shall consider any records of the commission and any evidence provided to the commission and all other matters set forth in this section in determining whether the permit should remain in force and effect.

(7) Notwithstanding the amount specified for any fee in this section, the commission by rule or as otherwise

provided by law may reduce the amount of one or more of the fees if necessary pursuant to section 24-75-402(3), C.R.S., to reduce the uncommitted reserves of the fund to which all or any portion of one or more of the fees is credited. After the uncommitted reserves of the fund are sufficiently reduced, the commission by rule or as otherwise provided by law may increase the amount of one or more of the fees as provided in section 24-75-402(4), C.R.S.

**37-90-109 - Priority - discontinuance orders - grounds.**

(1) Priority of claims for the appropriation of designated ground water shall be determined by the doctrine of prior appropriation. All claims based on actual taking of designated ground water for beneficial use prior to May 17, 1965, shall be determined by the doctrine of prior appropriation and shall relate back to the date of placing designated ground water to beneficial use. All claims for the beneficial use of designated ground water initiated after May 17, 1965, shall relate back to the date of filing of an application with the commission, unless such application is rejected.

(2) In order to establish priority of a claim to appropriate designated ground water which has existed prior to May 17, 1965, a priority date shall be awarded to each well based upon the time the water was first applied to a beneficial use. The date shown in the records now filed in the state engineer's office shall be prima facie evidence of the date the water was first applied to beneficial use. All wells constructed as replacements for or as supplements to original wells for the same beneficial use shall be

considered as a unit and awarded a priority date of the earliest well.

(3) As soon as practical after the establishment of a designated ground water basin, the commission shall establish tentative priority dates for the respective wells within such designated ground water basin, or subdivisions thereof, in accordance with the information contained in its files. The commission may require such additional information from the well claimant as will permit it to make a proper determination of the priority date and may request such other information as is required to be set forth in a final permit pursuant to section 37-90-108(5). If the claimant fails or refuses to furnish the requested information within a period of thirty days, the commission may proceed to make a determination from the records available.

(4) After establishing the proposed priority date and after receiving the information required by section 37-90-108(5) for the final permit on claims for the beneficial use of designated ground water, the commission shall order the state engineer to issue a final permit to appropriate designated ground water in the manner and pursuant to the standards set forth in section 37-90-108 for final permits; except that a final permit is not required to be issued for a well described in a conditional permit issued on or after July 1, 1991, to withdraw designated ground water from the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers and except that this section shall not apply to any final priority lists established by the commission prior to January 1, 1985, and any final permits issued pursuant to said lists.

(5) and (6) Repealed.

**37-90-110 - Powers of the state engineer.**

(1) In the administration and enforcement of this article and in the effectuation of the policy of this state to conserve its ground water resources and for the protection of vested rights, the state engineer is empowered:

(a) To require all flowing wells to be equipped with valves so that the flow of water can be controlled;

(b) To require both flowing and nonflowing wells to be so constructed and maintained as to prevent the waste of ground waters through leaky wells, casings, pipes, fittings, valves, or pumps, either above or below the land surface;

(c) To go upon all lands, both public and private, for the purpose of inspecting wells, pumps, casings, pipes, fittings, and measuring devices, including wells used or claimed to be used for domestic or stock purposes;

(d) To order the cessation of the use of a well pending the correction of any defect that the state engineer has ordered corrected;

(e) To commence actions to enjoin the illegal opening or excavation of wells or withdrawal or use of water therefrom and to appear and become a party to any action or proceeding pending in any court or administrative agency when it appears that the determination of such action or proceeding might result in depletion of the ground water resources of the state contrary to the public policy expressed in this article or might injure vested rights of other appropriators;



(f) To take such action as may be required to enforce compliance with any regulation, control, or order promulgated pursuant to the provisions of this article.

**37-90-111 – Powers of the ground water commission – limitations.**

(1) In the administration and enforcement of this article and in the effectuation of the policy of this state to conserve its designated ground water resources and for the protection of vested rights and except to the extent that similar authority is vested in ground water management districts pursuant to section 37-90-130(2), the ground water commission is empowered:

(a) To supervise and control the exercise and administration of all rights acquired to the use of designated ground water. In the exercise of this power it may, by summary order, prohibit or limit withdrawal of water from any well during any period that it determines that such withdrawal of water from said well would cause unreasonable injury to prior appropriators; except that nothing in this article shall be construed as entitling any prior designated ground water appropriator to the maintenance of the historic water level or any other level below which water still can be economically extracted when the total economic pattern of the particular designated ground water basin is considered; and further except that no such order shall take effect until six months after its entry.

(b) To establish a reasonable ground water pumping level in an area having a common designated ground water supply. Water in wells shall not be deemed available to fill the water right therefor if withdrawal therefrom of the amount called for by such right would, contrary to the

declared policy of this article, unreasonably affect any prior water right or result in withdrawing the ground water supply at a rate materially in excess of the reasonably anticipated average rate of future recharge.

(c) To issue permits for the construction of replacement wells. Any permits issued shall set forth the conditions under which a well may be modified by a change of the well itself or the pumping equipment therefor, by the drilling of a replacement well, or otherwise, in order to make it possible for the owner of a well to obtain the water to which such owner may be entitled by virtue of his original appropriation.

(d) In the exercise of any of the powers or duties conferred by this section, to confer and consult with the board of directors of the ground water management district board in the affected area, if any such board exists, before promulgating any orders or regulations which would affect the district in general;

(e) To order the total or partial discontinuance of any diversion within a ground water basin to the extent the water being diverted is not necessary for application to a beneficial use;

(f) In any area where a ground water management district has not been formed, to prescribe satisfactory and economical measuring methods for the measurement of water levels in and the amount of water withdrawn from wells and to require reports to be made at the end of each pumping season showing the date and water level at the beginning of the pumping season, the date and water level at the end of the pumping season, and showing any period of more than thirty days' cessation of pumping during such pumping season;

(g) Upon application therefor by any permit holder, to authorize a change in acreage served, volume of appropriation, place, time, or type of use of and by any water right, or of any well location, either conditional or final, granted under the authority of the commission but only upon such terms and conditions as will not cause material injury to the vested rights of other appropriators. No such change that increases the volume of appropriation beyond that authorized by the original decree, conditional permit, registration statement, or other well permit issued prior to basin designation shall be authorized, and no such change shall be approved until after publication of such application as provided in section 37-90-112; except that publication shall not be required to approve a temporary change pursuant to the rules adopted by the commission and except that publication shall not be required for replacement wells that are relocated no further than the maximum distance allowed by district rules and regulations without prior board approval or by commission policy where no district exists or where no district rule has been adopted.

(h) To adopt rules necessary to carry out the provisions of this article.

(2) No supplemental wells or alternate point of diversion wells shall be allowed in any area of any designated ground water basin in which the proposed well or wells combined would deplete the aquifer in excess of the rate of depletion prescribed by the ground water commission or by the ground water management district rules and regulations.

(3) In the exercise of any of the powers or duties conferred by this section, the commission shall confer and consult with the board of directors of the ground water management district board in the affected areas, if any such board exists, before promulgating any orders or regulations which would affect the district in general, and shall request written recommendations from the board of any existing district within which the conditional or final permit has been issued, before taking final action on any request or application made pursuant to this section.

(4) In any area within a designated ground water basin which has not been included within the boundaries of a ground water management district, the commission has the authority to exercise any power given by this article to the board of directors of a ground water management district, but, before instituting control measures pursuant to section 37-90-130, the commission shall follow the procedures set out in section 37-90-131.

(5) Notwithstanding any other provision of this article, the commission shall allocate, upon the basis of ownership of the overlying land, any designated ground water contained in the Dawson, Denver, Arapahoe, or Laramie-Fox Hills aquifers. Permits issued pursuant to this subsection (5) shall allow withdrawals on the basis of an aquifer life of one hundred years.

**37-90-112 - Notice - publication.**

(1) When any notice is required to be published under any section of this article, including notice of elections, it shall be deemed to mean a publication in a newspaper of general circulation in each of the counties concerned. Publication of all notices shall be once each

week for two successive weeks. The notice shall state the hour and date of the commencement of hearings on the subject matter of the notice; the place at which the hearings will be held; the place where written objections may be filed; and the final date by which written objections will be received; or, if for an election, the date, hours, and polling places.

(2) All objections, either to the published notice or any matter contained therein, shall be in writing and shall briefly state the nature of the objection and shall be filed within the time and at the place designated in the notice.

(3) The time for filing any written objections to notices described in this article shall extend to thirty days following the last publication of the notice.

**37-90-113 – Hearings.**

(1) Hearings on all matters to be heard by the commission shall be held within the boundaries of the designated ground water basin and within the ground water management district, if one exists, in which the water rights directly involved are situated or at such other place as may be designated by the commission for the convenience of, and as agreed to by, the parties involved. The hearings shall be conducted before the commission under reasonable rules and regulations of procedure prescribed by it. All parties to the hearing, including the commission, have the right to subpoena witnesses, who shall be sworn by the chairman or acting chairman of the commission to testify under oath at the hearing. All parties to the hearing shall be entitled to be heard either in person or by attorney.

(2) In any hearings required to be conducted by the commission, it may, in its discretion, have such hearings conducted before such agent as it may designate, either alone or in conjunction with the appearance of the commission if the agent is technically qualified to conduct or assist in such hearings. Unless agreed otherwise by all parties to a hearing or unless ordered otherwise by the commission due to extenuating circumstances, a hearing pursuant to this section shall be held within one hundred eighty days after the filing of a request for such a hearing. Appeals of rulings of the agent designated by the commission shall be reviewed at any regular or special commission meeting at the location chosen by the commission for that meeting.

(3) At any hearing or proceedings conducted or authorized by the commission affecting any water rights, either existing or potential, within any ground water management district, the commission shall receive and fully consider the testimony and recommendations of the board of directors or authorized agents of said district, if such testimony and recommendations are offered on behalf of the affected district.

**37-90-114 – Other administrative hearings.**

Any person claiming to be injured within the boundaries of a designated ground water basin by any act of the state engineer or commission under the provisions of this article, or the failure of the state engineer or commission to take any action under the provisions of this article, except as provided for the small capacity wells in section 37-90-105, shall file a written petition with the commission stating the basis of the alleged injury. Thereafter, only

upon request by a petitioner and upon thirty days' written notice to any adverse party, the commission shall conduct a hearing upon the petition in the manner provided in section 37-90-113. If notice of any such act has been published pursuant to section 37-90-112 and no hearing has been requested pursuant to such notice, this section shall not be construed to create a subsequent or additional right to request a hearing concerning such act.

**37-90-115 – Judicial review of actions of the ground water commission or the state engineer.**

(1)(a) Any party, including a ground water management district, adversely affected or aggrieved by any decision or act of the ground water commission, except for the adoption of rules, under the provisions of this article or by a decision or act of the state engineer under section 37-90-110 may take an appeal to the district court in the county wherein the water rights or wells involved are situated.

(b)(I) The notice of such appeal shall be served by the appellant upon the state engineer or the commission and all interested parties within thirty days after the notice of such decision or act and, unless such appeal is taken within said time, the action of the state engineer or the commission shall be final and conclusive. For purposes of service only, "all interested parties" shall be limited to those parties which appeared at, and were granted party status in, any administrative hearing held by the commission or state engineer concerning the decision or act from which the appeal is taken. If no administrative hearing has been held, notice of such appeal shall be given by publication pursuant to section 37-90-112.

(II) Notice of such appeal, proof of service, and docketing of the appeal in the district court shall be accomplished in the same manner as any other civil suit originally commenced in the district courts of this state. Costs shall be charged to the appellant as in any other civil suit.

(III) Proceedings upon appeal shall be de novo; except that evidence taken in any administrative proceeding appealed from may be considered as original evidence, subject to legal objection, as if said evidence were originally offered in such district court.

(IV) It is the duty of the commission or the state engineer, upon being served with a notice of appeal pursuant to this section, to transmit to the district court to which the appeal is taken the papers, maps, plats, field notes, orders, decisions, and other available data affecting the matter in controversy or certified copies thereof, which certified copies shall be admitted in evidence as of equal validity with the originals.

(V) For the purpose of maximizing continuity in the disposition of designated ground water cases, on or before January 10 of each year, the supreme court shall designate or redesignate a designated ground water judge for each designated ground water basin, who shall be selected from a judicial district within which some part of that designated ground water basin lies, and any vacancy that occurs during such year shall be filled by designation of the supreme court. The services of each designated ground water judge shall be in addition to such judge's regular duties as a district judge but shall take priority over such regular duties, and the schedules of the district judges in each such judicial district shall be arranged and adjusted



so that the designated ground water judge shall be free to hear designated ground water cases. All cases relating to designated ground water which are filed in each judicial district shall be assigned to the designated ground water judge, and all proceedings regarding said cases shall be heard by the designated ground water judge. If it becomes necessary during any year for the proper handling of designated ground water cases in any judicial district, the supreme court shall designate one or more additional designated ground water judges from that judicial district or may make temporary assignments of other judges to hear such cases.

(2) Any party adversely affected or aggrieved by a rule adopted by the ground water commission may take an appeal pursuant to section 24-4-106, C.R.S.

**37-90-116 – Fees – ground water publication fund.**

(1) The state engineer or the commission shall collect the following fees:

(a) With an application for the use of ground water, sixty dollars, which sum shall not be refunded;

(b) Repealed.

(c) For issuing a permit to modify or replace an existing well, sixty dollars;

(d) For making a copy of a document filed in his office, fifty cents per page or fraction thereof;

(e) For certifying copies of documents, records, or maps, two dollars for each certification;

(f) The actual expenses of publication, if any is required, which sums shall be promptly billed to the applicant and paid prior to the approval of any permit or other application, unless the commission requires the applicant to pay these expenses directly to the newspaper, and the applicant provides a proof of such payment to the commission; except that, when a publication is made to process final permits pursuant to section 37-90-108, such publication expenses shall be paid by the state engineer from the division of water resources ground water management cash fund created pursuant to section 37-80-111.5 (1) (d). All such publication expenses collected by the state engineer or by the commission shall be transmitted to the state treasurer, who shall credit the same to the ground water publication fund, which fund is hereby created. All moneys in the ground water publication fund are hereby continuously appropriated to the division of water resources for the actual expenses of publications. The moneys in the ground water publication fund shall not be credited or transferred to the general fund or to any other fund of the state.

(g) With an objection to an application for the use of ground water, ten dollars, which sum shall not be refunded;

(h) With an application for any change in a well permit, whether conditional or final, submitted pursuant to section 37-90-111(1)(g), sixty dollars, which sum shall not be refunded;

(i) With a request to extend the expiration date on a well permit, other than a well permit issued pursuant to section 37-90-105, sixty dollars.

(2) Departments and agencies of the state of Colorado shall be exempt from the payment of fees for applications for the use of ground water or for a permit to construct a well.

(3) Notwithstanding the amount specified for any fee in subsection (1) of this section, the commission by rule or as otherwise provided by law may reduce the amount of one or more of the fees if necessary pursuant to section 24-75-402(3), C.R.S., to reduce the uncommitted reserves of the fund to which all or any portion of one or more of the fees is credited. After the uncommitted reserves of the fund are sufficiently reduced, the commission by rule or as otherwise provided by law may increase the amount of one or more of the fees as provided in section 24-75-402(4), C.R.S.

**37-90-117 - Water conservation board - duties.**

The Colorado water conservation board has the power, and it is its duty, to investigate and determine the nature and extent of the ground water resources of the state of Colorado. It is also the duty of said board to study and determine the effect, if any, of the withdrawal of ground water upon aquifer supply and upon the surface flow of streams, and the information obtained thereby shall be made available to the state engineer and the ground water commission and any designated ground water management district. Nothing in this section shall be construed as impairing the authority of the state engineer, the ground water commission, or any ground water management district to make such investigation as it may find necessary or desirable to enable it to perform its duties under this article.

**37-90-118 - Ground water management districts - formation.**

Within areas determined as designated ground water basins by action of the commission in accordance with section 37-90-106, ground water management districts may be formed in the manner, and having the power, provided in sections 37-90-118 to 37-90-135; but no district shall be organized unless all ground water aquifers containing designated ground water within the geographic boundaries of the district have been included as a part of the district by the commission.

**37-90-119 - Creation of districts - proposal - submission - changes - proposed boundaries.**

A proposal for the formation of a designated ground water management district must be first submitted to the ground water commission, which shall make a hydrologic, geographic, and geologic evaluation of the proposed boundaries and recommend any changes in such boundaries as are indicated by such evaluation. No further steps for the formation of such district shall be taken until the commission, in writing, gives its consent to the boundaries thereof. The commission shall give either its consent or disapproval of the proposed boundaries within ninety days after the proposal has been submitted to it.

**37-90-120 - Management districts - petition - signatures required - filing.**

Following receipt of the consent required by section 37-90-119, a petition calling for formation of the proposed district may be filed with the commission. The petition shall be

signed by not less than fifteen percent of the taxpaying electors within the proposed district.

**37-90-121 - Management districts - petition - contents - minor defects - amendment.**

(1) The petition referred to in section 37-90-120 shall set forth:

(a) The name of the proposed district and boundaries thereof;

(b) A proposed division of the district into divisions as nearly equal in size as may be practicable, and considering the population thereof, each of which is to be represented by a director who is a resident taxpaying elector in such division;

(c) The number of directors that the district shall have if formed, not less than five nor more than fifteen in number, together with the name and address of each of the proposed directors, the division to be represented by each of them, and their terms of office, which shall be so designated that approximately one-half of them shall expire on the first Tuesday in March of the second year after the organization of the district is completed, and the remainder of them on the first Tuesday in March of the fourth year after the organization of the district is completed;

(d) Where the offices of such proposed district are to be maintained; and

(e) A prayer that the organization of the district be submitted to a vote of the taxpaying electors as provided in section 37-90-124.

(2) No petition for the organization of a district with the requisite signatures shall be declared null and void on account of minor defects, but the commission may at any time, prior to final determination of the sufficiency thereof, permit the petition to be amended in form to conform to the facts. Several similar petitions or duplicate copies of the same petition for the organization of the same district may be filed and shall together be regarded as one petition. All petitions, filed prior to the determination of the sufficiency of such petition, shall be considered as though filed with the first petition placed on file.

**37-90-122 - Management district - petition - certification of signatures - hearing - notice - publication.**

The commission shall examine the petition, and, if it finds that it bears the requisite number of signatures and otherwise meets the stated requirements, it shall thereupon set a date for hearing upon such petition and shall cause notice of such hearing, together with a copy of such petition, to be published, the final publication being not less than ten days nor more than thirty days prior to the date set for such hearing. The cost of such publication shall be paid by the petitioners and shall be advanced by them prior to publication.

**37-90-123 - Management districts - hearing - objections - change of boundaries.**

At the time set for such hearing, the commission shall examine the petition and hear objections thereto and may order changes in the boundaries thereof by the inclusion or removal of land therefrom upon finding that such change would be hydrologically, geologically, and geographically

sound. The action of the commission may be reviewed by the district court in appeal proceedings filed within twenty days after its decision has been announced, which decision shall be announced within ninety days after the hearing.

**37-90-124 – Election on organization.**

(1) If, after the completion of the hearing on the feasibility of the organization of a district, it is determined that such district shall be organized, the commission shall forthwith make an order allowing the prayer of the petition, and, by order duly entered upon its record, shall call an election of the taxpaying electors in the district for the purpose of determining whether such district shall be organized, and shall set the date for such election.

(2) The commission shall thereupon publish a notice, the final publication to be not less than ten days nor more than thirty days immediately preceding the election, which notice shall state: The fact of filing of the petition; in summary form, the information required by section 37-90-121(1) to be included in the petition; that an election will be held to decide the question of organization of the proposed district; the date of such election; the polling places at which such election is to be held; the qualifications of those eligible to vote at such election; and the specific question to be submitted.

(3) The commission shall appoint three taxpaying electors of the district as judges for each designated polling place. The election shall be held and conducted as nearly as may be in the same manner as general elections in this state. There shall be no special registration for such election, but, for the purpose of determining qualifications of electors, the judges shall be permitted to use the last

official registration lists of electors residing in the district and a certified list of taxpayers in the district prepared by the county treasurer and, in addition, may require the execution of an affidavit concerning the qualification of any such taxpaying elector to vote.

(4) At such election the voters shall vote for or against the organization of the district. The judges of each polling place shall certify the returns of the election to the ground water commission. If a majority of votes cast at said election are against the organization of the district, the commission shall forthwith dismiss the petition, and no election shall be held on the original petition or another petition for organization of the same district within one year of such dismissal.

(5) If a majority of the votes cast at said election are for the organization of said district, the commission, by order duly entered of record, shall declare the district organized, define the boundaries thereof, and give it the corporate name designated in the petition by which in all proceedings it shall thereafter be known and designate the members of the first board of directors, as named in the organization petition and the districts they represent. Thereupon the district shall be a governmental subdivision of the state of Colorado and a body corporate with all the powers of a public or quasi-municipal corporation.

**37-90-125 – Filing decree.**

Within thirty days after the district has been declared a corporation by the commission, it shall transmit to the county clerk and recorder of each of the counties in which the district or a part thereof extends copies of the decree of the commission incorporating the district.



**37-90-126 - Management district - directors - qualifications - oath - bond - vacancies.**

The members of the board of directors shall be resident taxpaying electors within the district. Each member of the board shall take an oath of office, and shall give bond in the sum of five thousand dollars conditioned that he shall faithfully perform the duties of director and of such further office to which he may be elected in such district, and shall account for all funds or property coming into his hands as such director or other officer. Such bonds shall run to the district, shall be signed by a surety approved by the ground water commission, and shall be filed and recorded in the office of the state engineer. When such bond is so filed and approved, such person so elected shall take and hold office until his successor is elected and qualified. When a vacancy occurs on the board, such vacancy shall be filled by the remaining members of the board.

**37-90-127 - Management district - directors - election - term of office.**

As the terms of the members of the board of directors expire, their successors shall be nominated by petitions containing the signatures of not less than fifteen percent of the number of qualified taxpaying electors of the division who voted at the last preceding district election, to be filed with the secretary of the district not less than thirty days before the election; thereafter, the members shall be elected for terms of four years by the plurality vote of the taxpaying electors of the division of the district which they represent. Such elections shall be held on the first Tuesday in February preceding the expiration of such terms and

shall be conducted by the district board in the general manner prescribed in section 37-90-124.

**37-90-128 - Management district - directors - no compensation - expenses.**

The members of the board of directors shall receive no compensation but shall be paid their actual expenses while engaged in the business of such district.

**37-90-129 - Management district - officers - election.**

The board of directors shall annually elect a president, vice-president, secretary, treasurer, and such other officers as may be necessary.

**37-90-130 - Management districts - board of directors.**

(1) The district board has the duty and responsibility of consulting with the commission on all ground water matters affecting the district to determine whether proposed restrictions or regulations are suitable for such area, to determine in conjunction with the commission whether the area of the district should be enlarged or contracted, to cooperate with the commission and the state engineer in the assembling of data on the ground water aquifers in the area and the enforcement of regulations or restrictions which may be imposed thereon, and to assist the commission and the state engineer to the end of conserving the ground water supplies of the area for the maximum beneficial use thereof.

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(2) After the issuance of any well permit for the use of ground water within the district by the ground water commission as provided in sections 37-90-107 and 37-90-108, the district board has the authority to regulate the use, control, and conservation of the ground water of the district covered by such permit by any one or more of the following methods, but the proposed controls, regulations, or conservation measures shall be subject to review and final approval by the ground water commission if objection is made in accordance with section 37-90-131:

(a) To provide for the spacing of wells producing from the ground water aquifer or subdivision thereof and to regulate the production therefrom so as to minimize as far as practicable the lowering of the water table or the reduction of the artesian pressure;

(b) To acquire lands for the erection of dams and for the purpose of draining lakes, draws, and depressions, and to construct dams, drain lakes, depressions, draws, and creeks, and to install pumps and other equipment necessary to recharge the ground water reservoir or subdivision thereof;

(c) To develop comprehensive plans for the most efficient use of the water of the ground water aquifer or subdivision thereof and for the control and prevention of waste of such water, which plans shall specify in such detail as may be practicable the acts, procedure, performance, and avoidance which are or may be necessary to effect such plans, including specifications therefor; to carry out research projects, develop information, and determine limitations, if any, which should be made on the withdrawal of water from the ground water aquifer or subdivisions thereof; to collect and preserve information

regarding the use of such water and the practicability of recharge of the ground water aquifer; and to publish such plans and information and bring them to the notice and attention of the users of such ground water within the district and to encourage their adoption and execution;

(d) To require the owner or operator of any land in the district upon which is located any open or uncovered well to close or cap the same permanently with a covering capable of sustaining weight of not less than four hundred pounds, except when said well is in actual use by the owner or operator thereof;

(e) To promulgate reasonable rules and regulations for the purpose of conserving, preserving, protecting, and recharging the ground water of the ground water aquifer or subdivision thereof, in conformity with the provisions of this article;

(f) To prohibit, after affording an opportunity for a hearing before the board of the local district and presentation of evidence, the use of ground water outside the boundaries of the district where such use materially affects the rights acquired by permit by any owner or operator of land within the district;

(g) In the control and administration of the quantity of ground water extracted from the aquifer, to adopt such devices, procedures, measures, or methods as it deems appropriate to effectuate this purpose;

(h) To promulgate reasonable rules and regulations with respect to the protection and compensation of the owners of any small capacity wells as defined in section 37-90-105 which may be injured by irrigation wells;

(i) To represent the district at any hearings or proceedings conducted or authorized by the commission affecting any water rights, either actual or potential, within the district;

(j) To exercise such other administrative and regulatory authority concerning the ground waters of the district as, without the existence of the district, would otherwise be exercised by the ground water commission.

(3) All special and regular meetings of the board shall be held at locations which are within the boundaries of the district or which are within the boundaries of any county in which the district is located, in whole or in part, or in any county so long as the meeting location does not exceed twenty miles from the district boundaries. The provisions of this subsection (3) may be waived only if the following criteria are met:

(a) The proposed change of location of a meeting of the board appears on the agenda of a regular or special meeting of the board; and

(b) A resolution is adopted by the board stating the reason for which a meeting of the board is to be held in a location other than under the provisions of this subsection (3) and further stating the date, time, and place of such meeting.

(4) After the issuance of any well permit for a small capacity well within the district pursuant to section 37-90-105, the district has the authority to enforce compliance with the terms and conditions governing the use of the ground water allowed by such permit to ensure that such use is within the scope of what is allowed by section 37-90-105 and the well permit.

**37-90-131 – Management district – board of directors  
– control measures – hearing – notice – publication –  
order.**

(1)(a) Whenever the board of directors determines that controls, regulations, or conservation measures are necessary in order to ensure the proper conservation of ground water within the district, it shall confer with the ground water commission and ground water users within the district. No such measures or regulations shall be instituted until after a public hearing. Notice of such hearing shall be published. Such notice shall state the time and place of the hearing and in general terms the corrective measures or regulations proposed. Within sixty days after such hearing, the board shall announce the measures or regulations ordered to be taken and shall cause notice of such action to be published. The board has the authority to compel compliance with such measures or regulations by an action brought in the district court of the county in which any failure to comply is found to exist.

(b) Any person adversely affected or aggrieved by the announcement of control or conservation measures or regulations adopted by the district board may appeal such decision to the ground water commission by filing a notice of appeal and the grounds therefor with the commission not later than thirty days after the date of last publication. The commission shall hear all such appeals pursuant to section 37-90-113. The commission shall have authority to affirm or reject the measures or regulations adopted by the district or to modify such measures or regulations but only upon consent from the district board. Judicial review of commission actions in such appeals may be taken pursuant to section 37-90-115.

(c) Any person adversely affected or aggrieved by an act of the district board, other than the announcement of control or conservation measures or regulations, has the right to be heard by the board. Such person shall file a written request for a hearing that states the basis of the alleged injury. Unless agreed otherwise by all parties to a hearing or unless otherwise approved by the district due to extenuating circumstances, a hearing shall be held within one hundred eighty days after filing the request for such a hearing. Upon thirty days' written notice to all adverse parties, the district shall conduct a hearing upon the matter. Hearing procedures shall be as informal as possible, with due regard for the rights of the parties. All parties shall have the right to subpoena witnesses and to be heard either in person or by attorney. The district board may have such hearings conducted before an agent or hearing officer. After such hearing, the district board shall issue a written decision containing its findings and conclusions and shall serve its decision upon all parties by first-class mail. Judicial review of such district decisions may be taken in the manner and governed by the standards set forth for review of commission and state engineer decisions in section 37-90-115.

(2) Subject to review by the ground water commission pursuant to subsection (1) of this section, the board may institute control measures or regulations to prescribe satisfactory and economical measuring methods for the measurement of water levels in and the amount of water withdrawn from wells and to require reports to be made at the end of each pumping season showing the date and water level at the beginning of the pumping season, the date and water level at the end of the pumping season,

and any period of more than thirty days cessation of pumping during such pumping season.

**37-90-132 - Management district - board of directors - taxes - levy - limitation.**

The board of directors may levy and collect annually taxes necessary to finance the activities of such district to the amount of not more than two mills on the dollar of the valuation for assessment of all taxable property within the district. It shall, in accordance with the schedule prescribed by section 39-5-128, C.R.S., certify its mill levy to the board of county commissioners of the counties wholly or partially within the district, who shall extend the same on the county tax list, and the same shall be collected by the county treasurer in the same manner as state and county taxes are collected. In addition, annually the board of directors of the district may assess and certify a special assessment on all water wells, except those wells described in section 37-90-105, in the district not to exceed fifteen cents per acre-foot of the maximum annual volume of the appropriation of each such well. Said assessment shall be collected by the county treasurer in the same manner as other special assessments. It is the duty of the board to apply for and to receive from the county treasurers all money to the credit of the district.

**37-90-133 - Management district - claims - warrants - payment.**

All claims against ground water management districts may be paid by warrants or orders, duly drawn against the district, as authorized by the board.



**37-90-134 - Management district - issuance of bonds  
- indebtedness - submission to electors.**

(1) To pay for the construction, operation, and maintenance of any works, and expenses preliminary and incidental thereto, which the board is authorized to construct for the benefit of the district, the board is authorized to enter into contracts providing for payment in installments or to issue negotiable bonds of the district. If bonds are authorized, the same shall bear interest at a rate such that the net effective interest rate of the issue does not exceed the maximum net effective interest rate authorized, payable semiannually, and shall be due and payable not more than fifty years from their dates. The form, terms, and provisions of said bonds or contracts, provisions for their payment, and conditions for their retirement and calling, not inconsistent with law, shall be vested and determined by the board, and they shall be issued in payment of the works, equipment, expenses, and interest during and after the period of construction. Said bonds or contracts shall be executed in the name of and on behalf of the district and signed by the president of the board, the seal of the district affixed thereto and attested by the secretary of the board. Said bonds or contracts must be in such denominations or upon such conditions as the board determines and shall be payable to bearer and may be registered in the office of the county treasurer of each of the counties wherein the district or part of it is situated, with the interest coupons payable to bearer, which shall bear the facsimile signature of the president of the board. Bond interest shall be exempt from all state, county, municipal, school, and other taxes imposed by any taxing authority of the state of Colorado and shall not be sold at less than par and accrued interest.

(2) Whenever the board incorporated under this article, by resolution adopted by majority of said board, determines that the interests of said district and the public interest or necessity demand the acquisition, construction, or completion of any source of water supply, waterworks, or other improvements or facilities, or the making of any contract with the United States or other persons or corporations, to carry out the objects and purposes of said district, wherein the indebtedness or obligation is created, to satisfy which shall require a greater expenditure than the ordinary annual income and revenue of the district permits, said board shall order the submission of the proposition of incurring such obligation or bonded or other indebtedness for the purposes set forth in said resolution to the qualified taxpaying electors of the district at an election held for that purpose. Any election held for the purpose of submitting any proposition of incurring such obligation or indebtedness may be held separately or may be consolidated or held concurrently with any other election authorized by law at which such qualified taxpaying electors of the district are entitled to vote. Notice of the resolution and election shall be published in a form sufficient to apprise the taxpaying electors of the objects and purposes for which the indebtedness is proposed to be incurred, the estimated cost of the works or improvement, the amount of principal of the indebtedness to be incurred therefor, and the maximum rate of interest to be paid on such indebtedness. Such resolution and notice shall also fix the date upon which such election shall be held, the manner of holding the same, and the method of voting for or against the incurring of the proposed indebtedness. Such election shall be held in the same general manner as in this article provided for the election of directors. The bond issue or indebtedness

proposed shall not be valid unless a majority of those voting at the election held for that purpose vote in favor of such bond issue or indebtedness in accordance with the terms of the resolution.

**37-90-135 - Management district - dissolution - procedure - funds - disposition.**

If there are no debts outstanding, the board of directors may, on its own motion or on the written petition of twenty percent of the taxpaying electors of the district, request of the ground water commission that the question of dissolution of such district be submitted to the electors of the district. The commission shall fix the date of such election, notice of which shall be given and which shall be conducted in the same manner as elections for the formation of such districts. If a majority of those voting on such question vote in favor of dissolution, the commission shall so certify to the county clerk and recorders of the counties involved and the district shall thereupon be dissolved. The question of dissolution shall not be submitted more often than once every twelve months. In case a district is dissolved the funds on hand or to be collected shall be held by the treasurer, and the directors shall petition the district court of the county in which the main office is located for an order approving the distribution of funds to the taxpayers of the district on the same basis as collected.

**37-90-139 - Existing beneficial uses not recorded - fee.**

Existing uses of ground water put to beneficial use prior to May 17, 1965, not of record in the office of the state engineer on April 21, 1967, may be recorded upon written

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application and payment of a filing fee of twenty-five dollars and shall retain the date of initiation when first put to beneficial use, but no such recording shall be accepted after December 31, 1968.

**37-90-143 - Owners of well permits - update for name and address.**

(1) Effective July 1, 1994, any owner of an unexpired well permit issued pursuant to this article or article 92 of this title who changes a name or mailing address from that on file with the office of the state engineer shall file an update to the name or mailing address with the state engineer by January 1, 1995, on a form prescribed by the state engineer.

(2) Effective January 1, 1995, any owner of an unexpired well permit issued pursuant to this article or article 92 of this title who changes a name or mailing address from that on file with the state engineer shall file, in person, by mail, or by fax, an update with the state engineer within sixty days after the date of the change, on a form prescribed by the state engineer.

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**APPENDIX H3**

**STATE OF COLORADO**

**GROUND WATER COMMISSION**

Division of Water Resources  
Department of Natural Resources

April 8, 1998

**POLICY MEMORANDUM 95-3**

**APPROVED BY THE COMMISSION ON  
FEBRUARY 24, 1995  
AMENDED BY THE COMMISSION ON  
FEBRUARY 13, 1998**

**POLICY OF THE COLORADO GROUND WATER  
COMMISSION PURSUANT TO RULE 8, OF THE  
RULE AND REGULATIONS FOR THE MANAGE-  
MENT AND CONTROL OF DESIGNATED GROUND  
WATER, CONCERNING THE USE OF FLOW ME-  
TERS OR POWER METERS (AS AN ALTERNATE  
METHOD OR DEVICE FOR WATER MEASURE-  
MENT)**

**1. SCOPE**

This policy is applicable to all high capacity wells located in Designated Ground Water Basins that have permits with conditions requiring measurement of withdrawals of water.

**2. DEFINITIONS**

**2.1** The following definitions are applicable to this policy governing the measurement of high capacity wells in Designated Ground Water Basins:

**2.1.1** "Compound system" means a system where the power meter records electrical

usage from any electrical device other than the pumping systems from a single well and its attached sprinklers.

**2.1.2** “Complex system” means any system where the total dynamic head at the pump will vary due to multiple discharge locations in a pipeline, or where the method of delivery will vary between open discharge, gated pipe, or sprinkler system during a single irrigation season, or where multiple wells discharge in to a common pipeline.

**2.1.3** “District” means a Ground Water Management District organized under Article 37-90 of the Colorado Revised Statutes.

**2.1.4** “High capacity well(s)” are those wells issued pursuant to 37-90-107, C.R.S., that produce designated ground water as defined in section 37-90-103(6), C.R.S.

**2.1.5** “Inactive well” means any well that is not in use and is disconnected from a power source.

**2.1.6** “Power coefficient” means the amount of electrical energy expressed as kilo-watt hours (KWH) consumed in pumping one acre-foot of water.

**2.1.7** “Field certified” means to verify that a flow meter is in accurate working condition under field conditions when installed or to verify that testing procedures approved by the Commission are properly adhered to when determining a power coefficient. These procedures are to be conducted under the supervision of an individual or entity

annually approved for field certification by the Colorado Division of Water Resources.

**2.2** Any other term used in this policy that is defined in Article 37-90 or 37-92 is used with the meaning given therein.

**3. GENERAL REQUIREMENTS**

**3.1** All wells within the scope of this policy shall either be equipped with a totalizing flow meter that is installed and maintained according to manufacturer's specifications and recommendations or be tested to determine a power coefficient.

**3.2** The Commission may adopt standards and specifications for the installation, calibration, testing, repair and maintenance of flow meters, or for well testing procedures to determine power coefficients.

**3.3** If the well is part of a compound system, or if the pump is driven by an internal combustion engine, the owner or user of the well must utilize the totalizing flow meter method and the provisions of section (4) of this policy.

**3.4** If the well is part of a complex system the owner or user of the well must utilize the totalizing flow meter method and the provisions of section (4) of this policy shall apply; except that the power coefficient method may be utilized after obtaining Commission approval and subject to the following:

(a) That power coefficients are field certified for the well under every method of delivery and for every irrigation system configuration for which the well will be operated, or as required by the Commission.

(b) The Commission shall use the lowest power coefficient to calculate annual withdrawal from the well.

(c) Calculated water withdrawals obtained by using the lowest power coefficient method are not acceptable for any type of future historic use determination.

**3.5** All flow measuring equipment or devices utilized in field certification must have an accuracy within plus or minus 2 percent.

**3.6** No water shall be withdrawn from any well not in compliance with this policy except to determine a power coefficient or to field certify a totalizing flow meter.

**4. USING A TOTALIZING FLOW METER**

**4.1** Any owner of a well within the scope of this policy who installs a totalizing flow meter after the effective date of this policy shall provide written documentation, to the Commission and the district on a form prescribed by the Commission, verifying the proper meter installation and field certification. This documentation shall be received by the Commission and the district prior to any use of the well.

**4.2** The owner of any well with a flow meter that is required pursuant to Rule 8 of the Designated Basin Rules may be required to submit the form specified in section (4.1) of this policy at the request of the Commission.

**4.3** A totalizing flow meter shall be considered acceptable for the purpose of this policy if it meets the following specifications:



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**4.3.1** The totalizing flow meter is capable of having an operating accuracy of plus or minus 5 percent under the manufacturer's recommendations.

**4.3.2** The totalizing flow meter shall be constructed from a material acceptable to the Commission of suitable strength and rigidity to maintain its shape and integrity under all normal field conditions. Where metals subject to rust or corrosion (cast iron, steel, or aluminum) are used, the entire surface of the body of the meter shall be protected with an impervious coating applied by the manufacturer.

**4.3.3** Totalizing flow meters shall be equipped with a direct reading odometer type totalizing register and rate of flow indicator sealed in a water tight (weather proof) case equipped with a viewing glass. The totalizing register shall provide direct readings in acre-feet or gallons, and have sufficient recording digits to assure that "roll over" to zero does not occur within three years. The rate of flow indicator shall be either a direct display of rate of flow in gallons per minute, or a center sweep hand indicating gallons or acre-feet per revolution.

**4.3.4** The totalizing register and rate flow indicator may be required by the Commission, to be sealed with a device or procedure acceptable to Commission (e.g. a wire and lead seal) to prevent tampering or unauthorized removal.

**4.4** When a totalizing flow meter is used, it shall be the owner's responsibility to keep the meter in

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acceptable operating condition as to provide a cumulative, accurate record of withdrawals.

**4.5** The Commission and the District shall be notified in writing of the date and person performing the field certification of a flow meter 3 days in advance of this procedure.

**4.5.1** Totalizing flow meters installed within the scope of this policy on or after the effective date of this policy shall be field certified when installed.

**4.5.2** Totalizing flow meters installed on said wells as of the effective date of this policy shall be field certified prior to any use of the well in the calendar year following the effective date of this policy, and be field certified every four years thereafter; except that any meter installed and field certified on or after February 24, 1995 and prior to the effective date of this policy shall be field certified every four years thereafter from the date of the last field certification.

**4.5.3** Totalizing flow meters installed on wells that are required to be administered pursuant to Rule 7 of the Designated Basin Rules are required to be field certified every four years after the date of original installation.

**4.5.4** Other flow meters that are required to be installed pursuant to Rule 8 of the Designated Basin Rules may be required to be field certified at the request of the Commission.

**4.6** If the flow meter is not operational, the well shall not be pumped unless an operating flow

meter is installed or unless a specific backup water measurement program approved by the Commission is put into effect.

**SETTING A POWER COEFFICIENT**

**5.1** Any owner of a well within the scope of this policy who utilizes a power coefficient method shall provide written documentation, to the Commission and the district on a form prescribed by the Commission, evidence that the power coefficient was properly determined prior to any use of water from the well.

**5.2** Power coefficients in existence on said wells as of the effective date of this policy shall be field certified on or after the effective date of this policy and field certified every four years thereafter; except that any field certification of a power coefficient determined on or after February 24, 1995 and prior to the effective date of this policy shall be field certified every four years thereafter from the date of the last field certification.

**5.3** The Commission and the District shall be notified in writing of the date and person performing the field certification 3 days in advance of the field certification.

**5.4** When doing a field certification, it shall be conducted when the pumping system has stabilized, i.e., both operating pressure and pumping drawdown has not changed more than 10% in the last hour.

**5.5** If there is any change or adjustment of the well pump, pump motor, irrigation system (e.g. piping, nozzling, etc.), system pressure, pumping lift or any other equipment or factor that would affect the efficiency of the pumping system and

thus change the power coefficient the well must be field certified.

**5.5.1** The Commission and District shall be notified within 7 days of the change or adjustment.

**5.5.2** The well must be field certified within 30 days of reinitiating the use of the well to determine a new power coefficient.

**6. DATA SUBMITTAL**

**6.1** Data as to the annual amounts of water pumped from wells within the scope of this policy shall be for the calendar year and shall be filed with the Commission and District no later than February 15, of each year for the prior years withdrawals.

**6.2** Data for wells which are required to measure withdrawals but are not presently required to report these withdrawals to the Commission or District, shall record the meter readings as required by the Commission or District, and to retain these records and submit such data at the request of the Commission or District.

**6.3** Data shall be complete and shall be submitted on forms prescribed by the Commission. Incomplete forms will not be considered adequate to fulfill the data submittal requirements of this policy.

**6.4** Consent to release power company data to the Commission and the District shall be included with the data submittal.

**7. INACTIVE WELLS**

**7.1** Inactive wells are excluded from this policy provided a sworn affidavit, on a form prescribed by the Commission, is filed with the Commission and District by February 15 of each year, stating the status of the well as inactive.

**7.2** If the well owner desires to have the power to the well remain connected for any reason, written approval of such must be first obtained from the Commission.

**7.3** Should the well become active at any time, all aspects of this policy are immediately in effect.

**8. COMPLIANCE**

**8.1** Failure to comply with any of this policy may subject the well owner and/or user to court proceedings and the Commission's and the District's costs, including reasonable attorneys fees, associated with enforcement of this policy pursuant to section 37-90-110, C.R.S.

**8.2** Prior to filing any court action, the Commission and District shall notify the well owner of the violation in writing and shall advise the well owner of the date by which the violation must be corrected to avoid court proceedings, which date shall be at least ten days following the mailings of the notice to the well owner or personal service on the well owner.

**9. SEVERABILITY**

If any portion of this policy is found to be invalid, the remaining portion of the policy shall remain in force and unaffected.

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**10. VARIANCE**

When the strict application of any provisions of this policy would cause unusual hardship, the Commission may grant a variance for a specific instance provided a written request for the variance is made to the Commission and the Commission finds the request justifiable.

Hal D. Simpson  
Executive Director  
Colorado Ground Water Commission

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**APPENDIX H4**

**RULES FOR SMALL CAPACITY WELL PERMITS  
IN DESIGNATED GROUND WATER BASINS**

Rule 1. Authority: These rules are promulgated pursuant to Sections 37-80-102 (1)(g) and 37-90-105(2), C. R. S.

Rule 2. Scope and Purpose:

These rules shall be applicable to all well permits issued by the State Engineer pursuant to Section 37-90-105, C.R.S. for small capacity wells in the Designated Ground Water Basins.

These rules are intended to establish a fair and impartial method for validation and expiration of well permits issued by the State Engineer pursuant to Section 37-90-105, C.R.S. These rules shall be construed to carry out this purpose.

Rule 3. New Permits – Permit Validation – Evidence of Beneficial Use: A small capacity well permit issued on or after the effective date of these rules shall be considered valid provided the well is constructed timely and a well construction and test report is filed with the State Engineer in accordance with the Water Well Construction Rules (2 CCR 402-2). Evidence of beneficial use shall not be required for such a permit. If evidence of beneficial use is filed with the State Engineer it shall not, in any way, alter the terms of the permit.

Rule 4. Previously Issued Permits – Permit Validation – Evidence of Beneficial Use: A small capacity well permit issued prior to the effective date of these rules shall be considered valid provided the well is constructed timely and a well construction and test report is filed with the State Engineer in accordance with the Water Well Construction Rules (2 CCR 402-2). The requirement of

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evidence of beneficial use, if it was required under a previous rule, shall be considered waived. If a permit condition refers to a potential limitation on allowed annual acre-feet due to a requirement of evidence of beneficial use under a previous rule, that limitation shall also be considered waived. If evidence of beneficial use is filed with the State Engineer it shall not, in any way, alter the terms of the permit.

Rule 5. Restrictions by District Rules: As provided by Section 37-90-105, C.R.S., the ground water management districts within the designated ground water basins have been authorized, by rules and regulations, to further restrict or expand the limitations for issuance of small capacity well permits within their respective districts. The State Engineer shall implement such limitations established by valid management district rules.

Rule 6. Replacement of Previous Rule: The previous rule titled "Rules for Small-Capacity Well Permits in Designated Ground Water Basins", 2 CCR 402-4, adopted by the State Engineer effective November 1, 1991, shall be replaced by these rules on the effective date of these rules.

Rule 7. Severability: If any portion of these rules is found to be invalid, the remaining portion of the rules shall remain in force and unaffected.

Rule 8. Variance: When the strict application of any provision of these rules or previous versions of these rules present practical difficulty or unusual hardship, the State Engineer may grant a variance for a specific instance provided a written request for the variance is made to the State Engineer and the State Engineer finds the request justifiable.



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Rule 9. Statement of basis and purpose incorporated by reference: the statement of basis and purpose for these rules for small capacity well permits is incorporated by reference as part of these rules.

Rule 10. Effective Date: These rules shall become effective on July 1, 1999.

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**APPENDIX H5**

**STATE OF COLORADO**

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**OFFICE OF THE STATE ENGINEER**

Division of Water Resources

Department of Natural Resources

October 13, 1994

**POLICY MEMORANDUM 94-4**

**SUBJECT:** Small Capacity Commercial Wells for  
Confined Animal Feeding Operations Designated  
Ground Water Basins

Effective immediately, the following policy will be used to permit the use of ground water through small capacity commercial well permits for confined animal feeding operations within designated ground water basins. This policy shall be modified or revoked only in writing.

- 1) The total amount of water permitted to be withdrawn from a small capacity commercial well shall be limited to the amount of water estimated to be necessary for the operation of the facility and safe disposal of the effluent, considering the requirements of this policy. The State Engineer's rules for small capacity well permits in designated basins, the provisions of Section 37-90-105, C.R.S. and the rules and regulations of local ground water management districts shall also apply.
- 2) The applicant may either accept the State Engineer's guidelines (to be developed) for withdrawal limitations or supply a report detailing the amount of water estimated to be necessary to operate that particular facility. This report shall include an estimate of total water use, the estimated water use in individual categories including (as appropriate), but not limited to, drinking, flushing, washing, and office use, and any information necessary to verify the water use

estimates. This report is subject to review and acceptance by the State Engineer. All applications must include a description of the land on which the effluent will be disposed and the Permit Nos. of any irrigation wells which are permitted to irrigate the subject land.

- 3) Diversion of water from a small capacity commercial well for dilution of effluent, except for water used in the normal operation of the confined animal feeding operation for drinking, flushing, washing and office use, is not permitted unless specifically applied for in the well permit application and approved after consideration for the following criteria:
  - a. Supporting documentation for the use of water requested for the required dilution must be provided with the well permit application. Only the minimum amount of water necessary may be permitted for dilution use.
  - b. The use of water from a small capacity commercial well to dilute effluent will not be permitted if it is determined by staff that the intent and/or effect is to obtain a benefit of crop irrigation through a small capacity well.
  - c. The use of water from other wells for the dilution of effluent must be approved in writing by the State Engineer's Office and/or the Ground Water Commission, as appropriate, prior to commencement of such action.
- 4) The disposal of effluent through application onto dry land or onto land permitted for irrigation may not be commenced until authorized, if required, by the Colorado Water Quality Control Commission pursuant to the "Confined Animal Feeding Operations Control Regulation: 4.8.0 (5 CCR 1002-19) and/or other requirements of that agency. It shall be the responsibility of the operator to determine if such authorization

is mandated. A memorandum of understanding between this office and the office of the Water Quality Control Commission will be drafted to facilitate safe disposal of effluent.

- 5) A totalizing flow meter must be installed on the wellhead to measure the total production of the small capacity commercial well. Flow meters should be easily accessible so that authorized representatives of this office and the local Ground Water Management District may inspect and read these meters at any reasonable time. Furthermore, flow meters must either be accessible without entering restricted areas of the facility or must be equipped with a remote display that is accessible without entering restricted areas of the facility.
- 6) Unless otherwise specified by the approval, annual reports must be submitted to the District and/or this office by February 15 of each year for the preceding calendar year. These reports must provide the total withdrawal of water from the small capacity commercial well and the total and average number of animals present that calendar year.

Explanation of the Rationale for Policy Related  
to Permitting the Use of Ground Water through  
Small Capacity Wells for Confined Animal  
Feeding Operations.

The development of this policy was due specifically to concerns expressed to the State Engineer's Office about the use of small capacity commercial wells for the disposal of effluent through land application. On one side of the issue is the fact that new appropriations for irrigation wells can no longer be obtained in most designated basins, and that through land application for effluent and water used to dilute the effluent, the effective irrigation of

additional lands may be possible. This would circumvent the authority of the Ground Water Commission and the appropriation process under Section 37-90-107, C.R.S., and possibly cause unreasonable impairment of existing water rights. On the other side of the issue is the fact that land application of effluent, if properly administered, may be a practical, efficient, economic and safe method of effluent disposal.

Considering both arguments, the use of ground water of the disposal of effluent through land application can be permitted through a small capacity commercial well since this may generally not result in the additional use of water over that required for the operation of a confined animal feeding operation which uses lagoons for effluent disposal. This is justified through the assumption that the present practice of using lagoons for effluent disposal usually results in the evaporation of all water that reaches the lagoon. Additional use that occurs due to necessary dilution of the effluent may be a valid use, providing that the intent and/or effect is not illegal crop irrigation through a small capacity well.

Specific problems that the above policy is designed to alleviate are as follows:

- 1) Irrigation of additional acres through the disposal of effluent onto lands not permitted to be irrigated.
- 2) Use of small capacity commercial well to supplement a poorly producing irrigation well or as an alternate point of diversion for an irrigation well.

Both of these problems are addressed by assuring that the intent and/or effect is to dispose of effluent, and not to

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obtain the benefit of crop irrigation through a small capacity well.

/s/ Hal D. Simpson  
Hal D. Simpson  
State Engineer

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**APPENDIX H6**

**STATE OF COLORADO  
GROUND WATER COMMISSION**

Hal D. Simpson  
Executive Director  
1313 Sherman Street  
Denver, Colorado 80203

**RULES AND REGULATIONS FOR  
THE MANAGEMENT AND CONTROL  
OF DESIGNATED GROUND WATER**

**2 CCR 410-1**

Effective Date: May 1, 1992  
Amended: March 30, 1995  
Re-amended: April 1, 1997  
Re-amended: February 1, 2001

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RULES AND REGULATIONS FOR THE  
MANAGEMENT AND CONTROL OF  
DESIGNATED GROUND WATER

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RULES AND REGULATIONS FOR THE  
MANAGEMENT AND CONTROL OF  
DESIGNATED GROUND WATER

**RULE 1 TITLE**

1.1 The title of these rules and regulations is "Rules and Regulations for the Management and Control of Designated Ground Water." The short title is "Designated Basin



Rules,” and may be referred to herein collectively as the “Rules” or individually as a “Rule.”

**RULE 2 AUTHORITY**

2.1 These Rules are promulgated pursuant to the authority of the Colorado Ground Water Commission in the “Colorado Ground Water Management Act,” Title 37, Article 90, Colorado Revised Statutes, primarily Sections 37-90-107, 108, 109 and 111, C.R.S.

**RULE 3 SCOPE AND PURPOSE**

3.1 The rules establish the management criteria or allowable rate of depletion for ground water in each designated ground water basin. Such management criteria will be used as the basis for the review of applications to use ground water pursuant to Section 37-90-107, C.R.S. The management criteria establish the basis to determine whether a proposed permit would result in unreasonable impairment to existing water rights.

3.2 The rules for replacement wells will expedite the processing of replacement applications and establish limits to differentiate between a replacement well pursuant to Section 37-90-111(1)(c), C.R.S. and a change of water right pursuant to Section 37-90-111(1)(g), C.R.S.

3.3 The rules establish equitable standards for the review of applications to change a right to use designated ground water pursuant to Section 37-90-111(1)(g), C.R.S. These standards also set limitations necessary to prevent material injury.

3.4 The rules establish reasonable guidelines for water measuring devices to be required as a condition of a permit or change application approval.

3.5 The rules seek to improve communication and coordination between the Ground Water Commission and the Designated Ground Water Management Districts.

3.6 The rules are intended to standardize policies and procedures of the Ground Water Commission, to make information as widely available as possible, and to ensure uniform and consistent action by the Commission.

3.7 The rules are not intended to change any terms or conditions of any permits already issued or of any approvals already granted. However, the State Engineer or the Commission, in the exercise of their statutory authority, may impose certain additional terms or conditions on such previously issued permits or approvals.

#### **RULE 4 DEFINITIONS**

4.1 The following terms are defined in Section 37-90-103, C.R.S., and these terms shall have identical meaning where used in these Rules:

Alternate Point of Diversion Well, Aquifer, Artesian Well, Board or Board of Directors, Designated Ground Water, Designated Ground Water Basin, Ground Water Commission or Commission, Ground Water Management District or District, Historical Water Level, Person, Replacement Well, Subdivision, Supplemental Well, Underground Water and Ground Water, Waste, and Well.

4.2 Specific Definitions – Unless expressly stated otherwise the following terms when used in these Rules shall have the meaning indicated in this Rule.

4.2.1 “Additional Well” Means a well permitted under Rule 5.3.9 wherein an additional well, together with the previously permitted well(s) withdrawing ground

water under provisions of Rule 5.3 or 5.4 may withdraw the allowed average annual amount of withdrawal of the previously permitted well(s).

4.2.2 "Allowed Maximum Annual Amount of Withdrawal" means the maximum amount of water in acre-feet that a permittee may withdraw from a well in a calendar year.

4.2.2.5 "Allowed Average Annual Amount of Withdrawal" means the average amount of water in acre-feet that a permittee may withdraw from a well in a calendar year.

4.2.3 "Applicant" means that person or entity who applies to the Ground Water Commission for a well permit or for a change in water right or for any other permitting action from the Commission pursuant to these Rules.

4.2.4 "Appropriation" means the application of a specified portion of the designated waters of the state to a beneficial use pursuant to the procedures prescribed by law.

4.2.5 "Artificial Recharge" means the intentional introduction of water into any underground formation.

4.2.6 "Bedrock Aquifers" means Denver Basin bedrock aquifers as identified in Rule 5.3.1 and those other aquifers within the Designated Basins considered for appropriation under Rule 5.4.

4.2.7 "Beneficial Use" is the use of that amount of water that is reasonable and appropriate under reasonably efficient practices to accomplish without waste the purpose for which the appropriation is lawfully made and, without limiting the generality of the foregoing, includes

the impoundment of water for recreational purposes, including fishery or wildlife.

4.2.8 "Change of Water Right" means a change in acreage served, volume of appropriation, pumping rate, well location, place, time or type of use by any water right, either conditional or final, or any combination of these changes including commingling of waters under such water rights.

4.2.9 "Commission Staff or Staff" means an employee or agent of the Colorado Division of Water Resources authorized by the State Engineer to act or assist in discharging the duties of the Commission.

4.2.10 "Conditional Water Right" means a right to perfect a water right under the provisions of the law with a certain priority upon the completion of the appropriation upon which such water right is to be based.

4.2.11 "Confining Layer" means all or part of a formation which impedes the flow of ground water from an adjacent aquifer.

4.2.12 "Confined Well" means a well completed in or producing from an aquifer or portion of an aquifer in which the static water level in the well rises due to hydrostatic pressure above where it was first encountered in the aquifer.

4.2.13 "Contiguous Parcel" means that portion of the overlying land that is in contact with itself so that no part is totally separated.

4.2.14 "Crop Consumptive Use" means the total amount of water taken up by vegetation for transpiration or building of plant tissue, plus the evaporation from the

adjacent soil or from intercepted precipitation on the plant foliage.

4.2.15 “Cylinder of Appropriation” means a hypothetical cylinder centered around the location of an existing or proposed well which, for a specific aquifer, contains a volume of water equal to one hundred times the annual appropriation of an existing well or the allowed average annual amount of withdrawal of a proposed well. The radius of the cylinder of appropriation is computed from the following formula:

Radius of Cylinder (ft.) = the square root of:

$$\frac{43,560 \text{ (ft. sq./acres)} \times \text{withdrawal (acre ft./yr.)} \times 100 \text{ (yr.)}}{\text{Specific yield} \times \text{saturated aquifer materials (ft.)} \times 3.1416}$$

where withdrawal means the annual appropriation or allowed average annual amount of withdrawal.

4.2.16 “Denver Basin Bedrock Aquifers” or “Denver Basin Aquifers” means the Upper Dawson, Lower Dawson, Denver, Upper Arapahoe, Lower Arapahoe and Laramie-Fox Hills aquifers as defined in the Denver Basin Rules, 2 CCR 402-6.

4.2.17 “Historic Withdrawal” means the average annual volumetric amount of ground water withdrawn by a well including any replacement well(s) during the life of the well permit. This amount shall be computed under the provisions of Rule 7.10 unless it is a bedrock aquifer well, where the provisions of Rule 7.1.3 shall apply. These terms differ from the term “the historic depletion of the aquifer” in the sense that the amount of historic depletion of the aquifer is equal to the amount of historic withdrawal from the aquifer minus the portion of the withdrawal which percolates back to the aquifer.

4.2.18 “Large Capacity Well” means any well which is permitted to put designated ground water to beneficial use provided the said permit is not for a small capacity well pursuant to Section 37-90-105, C.R.S.

4.2.19 “Nontributary Ground Water” means that ground water, the withdrawal of which will not, within one hundred years, deplete the flow of a natural stream, or its alluvial aquifer, at an annual rate greater than one-tenth of one percent of the annual rate of withdrawal. The determination of whether ground water is nontributary shall be based on aquifer conditions existing at the time of permit application; except that, in recognition of the de minimis amount of water discharging from the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers into surface streams due to artesian pressure, in determining whether ground water of the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers is nontributary, it shall be assumed that the hydrostatic pressure level in each such aquifer has been lowered at least to the top of that aquifer throughout that aquifer.

4.2.20 “Overappropriated Aquifer” means an aquifer for which the net average annual depletion rate of ground water is considered to be in excess of the allowable net average annual depletion rate for that aquifer as set by the Commission.

4.2.21 “Overlying Land” means that land owned by the applicant, or by another who has consented to the applicant’s withdrawal of ground water, which overlies the bedrock aquifers as described in Rule 5.3 and 5.4 of these Rules, and which the applicant requests be considered in determining the allowed average annual amount of withdrawal sought in the application.

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4.2.22 “Priority” means the date that a water right or a conditional water right will be entitled to use water in relation to other water rights and conditional water rights deriving their supply from a common source.

4.2.23 “Replacement Plan” means a detailed program to increase the supply of water available for beneficial use in a designated basin or portion thereof by the development of new or alternate means or points of diversion, by a pooling of water resources, by water exchange projects, by providing substitute supplies of water, by the development of new sources of water, or by any other appropriate means. “Replacement Plan” does not include the salvage of designated waters by the eradication of phreatophytes, nor does it include the use of precipitation water collected from land surfaces which have been made impermeable, thereby increasing the runoff but not adding to the existing supply of water.

4.2.24 “Saturated Aquifer Material(s)” means those aquifer materials containing sufficient water that can be drained by gravity and placed to beneficial use.

4.2.25 “Specific Yield” means the volume of water which can be drained by gravity from a saturated volume of aquifer material divided by the volume of material. This ratio can be expressed as a percentage.

4.2.26 “Three-Mile Circle” or “Circle” means a circle with a radius of three miles centered at the location of the well or proposed well used to appropriate water from the Ogallala Aquifer of the Northern High Plains Designated Ground Water Basin.

4.2.27 “Waiver of Claim of Injury” means a written affidavit given by a well owner to an applicant waiving all

claims of any injury to an existing water right as a result of the approval of applicant's request by the Commission.

4.2.28 "Water Right" means a right to use in accordance with its priority a certain portion of the designated ground water by reasons of the appropriation of the same.

4.2.29 "Well Field" means two or more wells, which are permitted to withdraw ground water from the same aquifer in any combination thereof up to the full permitted amount of the aggregate appropriations.

4.2.30 "Well Owner" means any person or his agent who holds the title or other rights of property in a well.

4.2.31 "Wire to Water Efficiency" or "Overall Pumping Plant Efficiency" means the ratio of the water energy output from the pump divided by the input energy to the power plant expressed as a percentage.

4.3 Other Definitions – All other words used herein shall be given their usual customary and accepted meaning. Terms that were not defined in this Rule which are defined in the statutes or other rules of the State Engineer shall use the meaning given therein. All words of a technical nature specific to the water well industry shall be given the meaning which is generally accepted in said industry.

## **RULE 5 APPROPRIATION OF DESIGNATED GROUND WATER**

### 5.1 Applicability

5.1.1 Section 37-90-107, C.R.S. provides for the Commission's review and approval of applications to use designated ground water. The availability of water for appropriation, prevention of unreasonable impairment to



the rights of other appropriators, and prevention of unreasonable waste are criteria the Commission is to consider in determining whether to grant or deny an application.

5.1.2 The use of ground water requiring a permit pursuant to Section 37-90-107, C.R.S. may include use for irrigation, municipal, commercial, industrial, mining, fishery, recreational and all other beneficial uses as occur through the use of a well. The use of ground water may also include the incidental use through evaporation from mining excavations or recreational ponds.

5.1.3 The spacing limits, calculations of appropriation and other limits set forth herein apply to large capacity wells. Certain applications to be considered pursuant to prior court decree may not be subject to this rule but when a conditional decree previously granted by a court becomes absolute by reason of a well being drilled and water put to beneficial use, the well becomes fully subject to the Colorado Ground Water Management Act, Title 37, Article 90 and the Commission's rules and policies. For all applications to construct wells or use ground water within the boundaries of a designated basin, the Commission shall first determine if it has jurisdiction.

5.1.4 If an application to appropriate designated ground water can be given favorable consideration, such fact shall be published in accordance with Sections 37-90-107(2), and 112 C.R.S.

5.1.5 Applications for well permits pursuant to Section 37-90-105, C.R.S. may be granted by the State Engineer without regard to any provisions of these rules.

5.2 Appropriation from all Aquifers except Bedrock Aquifers – This rule applies to all aquifers except bedrock

aquifers. Aquifer boundaries defined here are deemed presumptive upon the Commission and applicants, except that site specific data may be used to better define an aquifer boundary.

5.2.1 No application for a permit to appropriate ground water from an aquifer under Rule 5.2 shall be granted within 1/2 mile of an existing large capacity well unless a Waiver of Claim of Injury is obtained from the owner of such a well or unless the Commission, after a hearing, finds that circumstances in a particular instance allow a permit to be issued without regard to the above limitation.

5.2.2 Northern High Plains Designated Ground Water Basin – Ogallala and White River Aquifers.

5.2.2.1 The areal extent of the Ogallala and White River Aquifers are considered to coincide with the areal extent of the Northern High Plains Designated Basin.

5.2.2.2 All new appropriations shall be controlled by management criteria that limit the maximum allowable rate of depletion to 40% of the water in storage within the saturated materials over a 100 year period. The amount of water in storage shall be determined as of the date of acceptance of a complete application.

5.2.2.3 In the evaluation of new permit applications, the following three-mile radius circle formula shall be used in the determination of whether an application shall be granted or denied:

$$A = \frac{640(D)(S.Y.)}{(1.0 - Ir)t} 3.1416 R^2 H + \frac{640(f)(Pr)}{12(1.0 - Ir)} 3.1416 R^2$$

where,

- A = Annual appropriation allowable within the circle being evaluated in acre-feet per year
- D = Allowable depletion (expressed as a decimal)
- S.Y. = Specific yield (dimensionless)
- R = Radius of circle (miles)
- H = Average saturated thickness within the circle (feet)
- t = Time period during which depletion, D, occurs (years)
- Pr = Precipitation recharge (inches/yr.)
- f = Fraction of Pr that is available for appropriation in the circle (dimensionless)
- Ir = Fraction of A that returns to the aquifer as deep percolation, i.e., irrigation return (dimensionless)

The constants in the above equation are:

$$D = 0.4, S.Y. = 0.15, R = 3 \text{ miles}, t = 100 \text{ years}, \\ f = 0.2 \text{ and } Ir = 0.15$$

Use of these constants in the formula above gives:

$$A = 12.77H + 354.82Pr$$

Saturated thickness, H, shall be determined by an evaluation of contour maps developed from well completion reports of existing wells as well as other pertinent available water level data. Precipitation recharge, Pr, will be determined from Figure 18 of the report "Distribution of Ground Water Recharge," AER66-67 DLR9, Colorado State University, June 1967 by Donald L. Reddell.

5.2.2.4 When the three-mile circle includes the White River Formation, located in the area as shown on figure 1, the value for Specific Yield (S.Y.) in the above formula will be 0.25. The thickness of saturated materials,

H, will be the average net sands thickness in the three-mile circle. The annual available appropriation from within the three-mile circle can then be computed as:

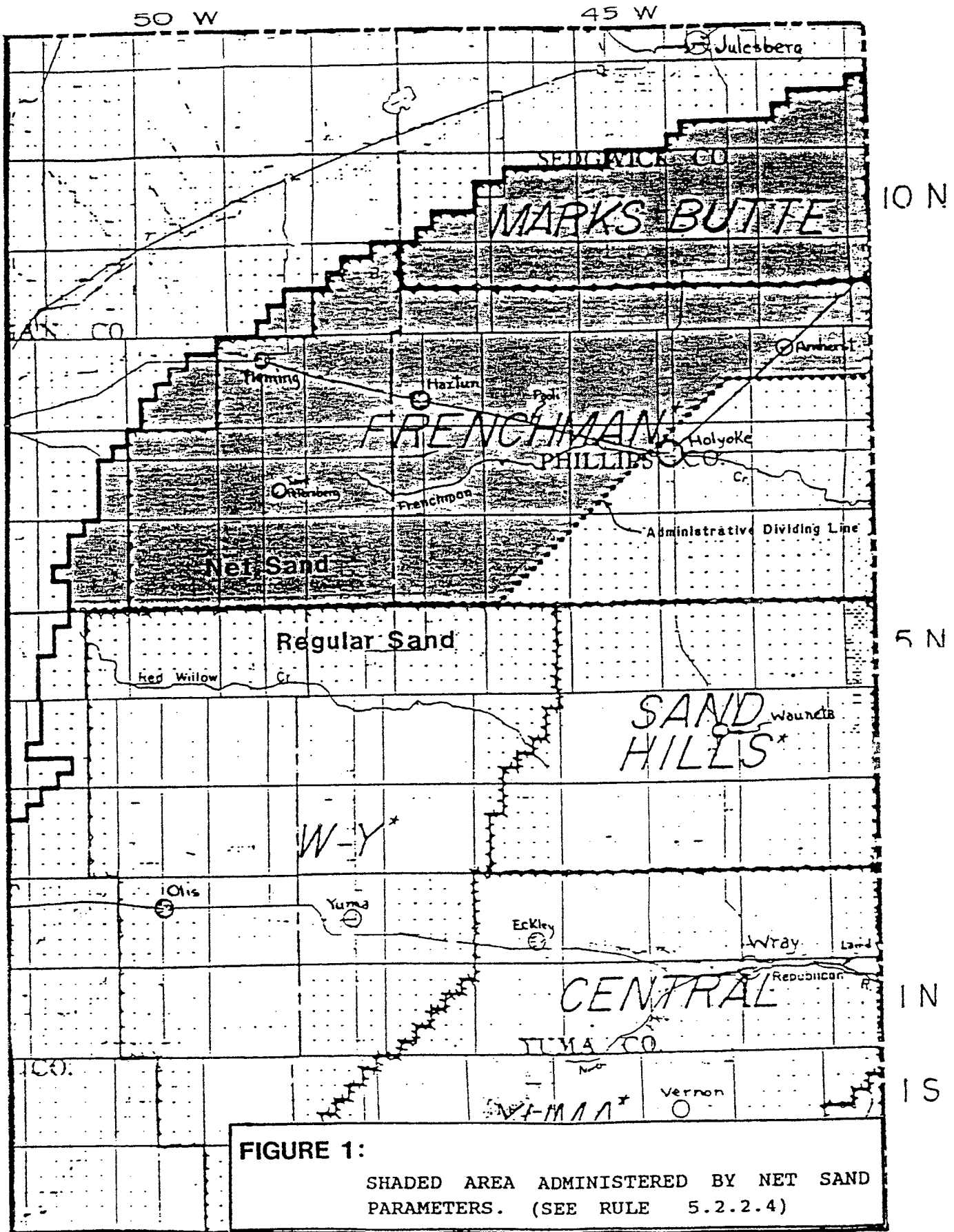
$$A = 21.29H + 354.82Pr$$

5.2.2.5 Appropriations within the three-mile circle shall be included as a chargeable appropriation against the application for the stated annual appropriation on a final permit or for the amount evidenced to have been put to beneficial use under a valid conditional permit. The appropriation amounts on all new conditional permits and prior applications not yet permitted shall also be included as chargeable amounts against the application.

5.2.2.6 When an application is received within 3 miles of the state line or the boundary of the Northern High Plains Designated Basin, the volume of water in storage, the amount of precipitation recharge and the existing appropriations shall be calculated in such a way as to only include those amounts within the basin and within Colorado.

5.2.2.7 When an application is received within 3 miles of the administrative line shown in Figure 1, the amount of water in storage shall be determined by adding the amounts of water in storage under the parts of the three-mile circle in the net sand area (Rule 5.2.2.4) and the regular sand area (Rule 5.2.2.3).

5.2.2.8 No new application for a well in the Ogallala Aquifer, absent a replacement plan in accordance with Rule 5.6, shall be granted in an area within three miles of a point of live flow on the North Fork of the Republican River, Chief Creek, or their tributaries. This area is shown in Figure 2.



5.2.2.9 The following sections in Kiowa and Prowers Counties are deemed overappropriated for the Ogallala Aquifer and no new appropriations will be approved absent a replacement plan in accordance with Rule 5.6:

Township 21 South, Range 41 West:  
Sections 5 through 8, 18;

Township 21 South, Range 42 West:  
Sections 1 through 20

Township 21 South, Range 43 West:  
Sections 1, 2, 11 through 13;

Township 20 South, Range 42 West:  
Sections 7, 8, 17 through 21,  
and Sections 28 through 36

Township 20 South, Range 43 West:  
Sections 1, 2, 10 through 36;

Township 20 South, Range 44 West:  
Sections 13, 24, 25, 36.

5.2.3 Southern High Plains Designated Ground Water Basin – Alluvium, Cheyenne, Dakota, Dokum and Ogallala Aquifers

5.2.3.1 The areal extent of the Cheyenne, Dakota, and Ogallala aquifers are shown in Figures 3, 4, and 5 respectively of the report entitled “Ground Water Resources Study – Relating to Portions of Prowers, Baca and Las Animas Counties, Colorado” prepared for the Colorado Ground Water Commission by R. W. Beck and Associates, Denver, Colorado, 1967. The areal extent of Alluvium and Dokum aquifers shall be determined by site specific information and any applicable literature.

5.2.3.2 A new large capacity well permit can be granted by the Commission to appropriate water from any of the aquifers identified above in Rule 5.2.3.1 if this appropriation does not unreasonably impair any existing water rights.

5.2.4 Kiowa-Bijou Designated Ground Water Basin – Alluvial Aquifer

5.2.4.1 The Alluvial Aquifer shall be defined as identified in Plate 2 of the report “Evaluation of Water Resources in Kiowa and Bijou Creek Basins, Colorado” prepared for the Colorado Water Conservation Board by Colorado State University, Fort Collins, Colorado, 1966.

5.2.4.2 The Alluvial Aquifer within the Kiowa-Bijou Designated Ground Water Basin is determined to be overappropriated and, therefore, no new large capacity well permits shall be granted in the Alluvial Aquifer unless a replacement plan is approved by the Commission in accordance with Rule 5.6.

5.2.5 Lost Creek Designated Ground Water Basin – Alluvial Aquifer

5.2.5.1 The Alluvial Aquifer shall be defined as the area identified in Plate 3 of the report entitled “Ground Water Resources of the Lost Creek Drainage Basin – Weld, Adams and Arapahoe counties, Colorado,” prepared for the Colorado Ground Water Commission by Nelson, Haley, Patterson and Quirk, Inc., Greeley, Colorado, 1967.

5.2.5.2 The Alluvial Aquifer within the Lost Creek Designated Ground Water Basin area south of the line between Township 2 North and Township 3 North is determined to be overappropriated and, therefore, no new

large capacity well permits shall be granted in this area unless a replacement plan is approved by the Commission in accordance with Rule 5.6. A new large capacity well permit can be granted to appropriate water from the Alluvial Aquifer within the Lost Creek Designated Ground Water Basin area north of the line between Township 2 North and Township 3 North if this appropriation does not unreasonably impair any existing water rights.

5.2.6 Upper Black Squirrel Creek Designated Ground Water Basin – Alluvial Aquifer

5.2.6.1 The Alluvial Aquifer shall be defined as the area identified in Plate 3 of a report entitled “Ground Water Resources of the Upper Black Squirrel Creek Basin, El Paso County, Colorado,” prepared by the Colorado Division of Water Resources, Denver, Colorado, 1967.

5.2.6.2 The Alluvial Aquifer within the Upper Black Squirrel Creek Designated Basin is determined to be overappropriated and, therefore, no new large capacity well permits shall be granted in the Alluvial Aquifer unless a replacement plan is approved by the Commission in accordance with Rule 5.6.

5.2.7 Upper Big Sandy Designated Ground Water Basin – Alluvial Aquifer

5.2.7.1 The Alluvial Aquifer shall be defined as the area identified in Plate 1 of the report entitled, “Geology and Ground Water Resources of Parts of Lincoln, Elbert, and El Paso Counties, Colorado,” by the Colorado Water Conservation Board and the U.S. Geological Survey, Denver, Colorado, 1946.

5.2.7.2 A new large capacity well permit can be granted by the Commission to appropriate water from the



Alluvial Aquifer identified above in Rule 5.2.7.1 if this appropriation does not unreasonably impair any existing water rights.

5.2.8 Camp Creek Designated Ground Water Basin – All Aquifers

5.2.8.1 Camp Creek Designated Ground Water Basin consists of Alluvial, Dune Sand, Chadron and Ogallala aquifers. The aquifer boundaries within the basin are identified in Plates 2, 3 and 5 of the report entitled, “Ground Water Resources of Northwest Washington County, Colorado” prepared for Town of Akron by Nelson, Haley, Patterson, and Quirk, Inc., Greeley, Colorado, 1967.

5.2.8.2 A new large capacity well permit can be granted by the Commission to appropriate water from any of the aquifers identified above in Rule 5.2.8.1 if this appropriation does not unreasonably impair any existing water rights.

5.2.9 Upper Crow Creek Designated Ground Water Basin – Alluvial, Fan and White River Aquifers

5.2.9.1 The extent of each aquifer shall be defined as the area identified in Plate 1 of the report entitled, “Water Resources of Upper Crow Creek, Colorado” prepared for the Colorado Geological Survey by Robert Kirkham and John Rold, Denver, Colorado 1986. All but the southern tip of the study area is underlain by the White River Aquifer. The southern tip area is underlain by the Laramie formation.

5.2.9.2 The Fan Aquifer east of Crow Creek and the White River Aquifer underlying this part of the Fan Aquifer is determined to be overappropriated and, therefore, no new large capacity well permits shall be granted

in these aquifers unless a replacement plan is approved by the Commission in accordance with Rule 5.6. A well permit can be approved in the Alluvial Aquifer and in the Fan and White River Aquifer not mentioned above if this appropriation does not unreasonably impair any existing water rights.

### 5.3 Appropriation from Denver Basin Bedrock Aquifers

#### 5.3.1 Denver Basin Aquifer Definitions

5.3.1.1 The Denver Basin Aquifers are Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers within the Kiowa-Bijou, Lost Creek, Upper Big Sandy, and Upper Black Squirrel Creek Designated Ground Water Basins. The extent of each aquifer is defined in Rule 4(A) of the Denver Basin Rules, 2 CCR 402-6.

5.3.1.2 These aquifer definitions are deemed presumptive upon the Commission and applicants except that the Commission, after reviewing any site specific data, may revise an aquifer boundary.

#### 5.3.2 Allowable Rate of Withdrawal

5.3.2.1 The allowable rate of withdrawal for these aquifers shall be limited so as to allow at least a 100 year aquifer life. Waters which have not been separated from land owned by the applicant or waters to which applicant has separate title under a described land area shall be available for appropriation. The availability of such waters is limited by the provisions of these rules to prevent unreasonable impairment to existing water rights.

5.3.2.2 Applicant shall demonstrate prima facie land ownership or consent of an overlying landowner as evidenced by a completed consent statement provided by

the Office of the State Engineer. Any waters identified as a water supply to be developed through individual wells in an approved subdivision water supply plan shall be deemed as being under the control of the individual lot owners absent a legal conveyance to the contrary or absent a resolution adopted pursuant to Rule 5.3.10.

5.3.2.3 The allowed average annual amount of withdrawal of water from any of these aquifers is determined by the formula:

$$\text{Average Annual Withdrawal (acre-feet)} = \frac{\text{land area (acres)} \times \text{saturated aquifer materials (ft.)} \times \text{S.Y.}}{100 \text{ years}}$$

where S.Y. is the specific yield of the aquifer (dimensionless). See Rule 5.3.4 for the thickness of saturated aquifer materials and Rule 5.7 for Specific Yield values.

5.3.2.4 In computing the land area to be used under Rule 5.3.2.3, the area of the cylinder of appropriation for a well(s) which has or can be issued a small-capacity well permit pursuant to Section 37-90-105, C.R.S., shall be considered to be zero. The average annual withdrawal computed under Rule 5.3.2.3 may be reduced by any applicable appropriation amount for such a small-capacity well(s) located on this land area and withdrawing water from the aquifer under consideration.

5.3.2.5 The allowed maximum annual amount of withdrawal may exceed the allowed average annual amount of withdrawal as long as the total volume of water withdrawn from the well or wells does not exceed the product of the number of years since the date or dates of issuance of the well permit or permits times the allowed average annual amount of withdrawal. This provision is

applicable only for Denver Basin aquifer wells but is not applicable to a well whose water right was created prior to November 19, 1973 in accordance with the provisions of Rule 5.3.3. Existing permitted well owners may avail themselves to this provision upon written approval of the Commission.

5.3.3 Determination of the extent of appropriations created prior to November 19, 1973

5.3.3.1 If the cylinder of appropriation of a well for which a right was created prior to November 19, 1973 as evidenced by a well registration or by a well permit and its beneficial use statement, overlap(s) the overlying land claimed in the application, the number of acres of overlying land to be used in determining the available water in storage shall be reduced by the number of acres of the cylinder of appropriation which overlaps the land. An applicant whose water rights are reduced by such cylinder(s) may, upon notice to all affected parties, challenge the Commission's determination of the size of such overlap by requesting an evidentiary hearing before the Commission.

5.3.3.2 In the event that a well completed prior to November 19, 1973 does not fully penetrate the aquifer, the radius of the cylinder of appropriation for that well shall be calculated assuming that it does fully penetrate that aquifer.

5.3.3.3 In the event that a well initiated prior to November 19, 1973 is constructed so as to produce water from more than one aquifer, cylinders of appropriation shall be calculated for each aquifer. The production of the well from each aquifer shall be allocated in proportion to the historical production of the well from each aquifer. The

interval of each aquifer through which the well is completed shall be considered in the determination of the historical production from each aquifer. Where this perforation interval cannot be determined, the well shall be assumed to be producing from the entire interval of the aquifers involved.

#### 5.3.4 Determination of thickness of Saturated Aquifer Materials in the Denver Basin Aquifers

5.3.4.1 The thicknesses of sandstones and siltstones in the Denver Basin Aquifers are shown on the following figures prepared by the Colorado Division of Water Resources:

- |                      |  |
|----------------------|--|
| a. Upper Dawson      | Denver Basin Atlas No. 1,<br>Plate 3, Figure 1E                              |
| b. Lower Dawson      | Denver Basin Atlas No. 1,<br>Plate 2, Figure 1C                              |
| c. Denver            | Denver Basin Atlas No. 2,<br>Plate 2, Figure 2C                              |
| d. Upper Arapahoe    | Denver Basin Atlas No. 3,<br>Plate 4, Figure 3E minus<br>Plate 5, Figure 3F* |
| e. Lower Arapahoe    | Denver Basin Atlas No. 3,<br>Plate 5, Figure 3F                              |
| f. Laramie-Fox Hills | Denver Basin Atlas No. 4,<br>Plate 3, Figure 4C                              |

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\* To find the thickness of the Upper Arapahoe Aquifer subtract the thickness value shown in Plate 5, Figure 3F from the thickness value shown in Plate 4, Figure 3E. Where there is no overlap between figures, Figure 3F value is zero.

5.3.4.2 The thicknesses on the above figures, subject to any revisions thereof by the Commission based upon any site specific data, shall be considered to be the thickness of saturated aquifer material as long as the aquifer is confined, i.e., under artesian pressure. The applicant may be required by the Commission to demonstrate that the aquifer is still confined or, if the aquifer is unconfined, to provide data on the site specific location of the water table. Upon evaluating the location of the water table, the Commission shall determine the thickness of saturated aquifer materials.

5.3.5 Standards for requirements of geophysical logs and test holes in the Denver Basin aquifers shall be the same as set forth in Rules 9 and 10 of the Statewide Nontributary Ground Water Rules, 2 CCR 402-7.

5.3.6 Replacement Water Requirements for the Denver Basin aquifers: The Commission recognizes that the pumping of waters from the Dawson, Denver, Arapahoe and Laramie-Fox Hills aquifers may cause depletions in the overlying alluvial aquifers which may affect vested water rights. Necessary terms and conditions shall be imposed on any new well permit to insure no unreasonable impairment to the rights of other appropriators.

5.3.6.1 The locations of Nontributary Ground Water for the Denver Basin aquifers are shown in the figures referenced below. The Commission may accept site specific information if it finds that information is more precise.

- A. The location of nontributary ground water in the Upper Dawson Aquifer is shown in Denver Basin Atlas No. 1, Plate 4, Figure 1G as revised March 21, 1991.

- B. The location of nontributary ground water in the Lower Dawson Aquifer is shown in Denver Basin Atlas No. 1, Plate 4, Figure 1F as revised March 21, 1991.
- C. The location of nontributary ground water in the Denver Aquifer is shown in Denver Basin Atlas No. 2, Plate 2, Figure 2D as revised March 21, 1991.
- D. The location of nontributary ground water in the Upper Arapahoe Aquifer is shown in Denver Basin Atlas No. 3, Plate 6, Figure 3H as revised March 21, 1991.
- E. The location of nontributary ground water in the Lower Arapahoe Aquifer is shown in Denver Basin Atlas No. 3, Plate 5, Figure 3G as revised March 21, 1991.
- F. The location of nontributary ground water in the Laramie-Fox Hills Aquifer is shown in Denver Basin Atlas No. 4, Plate 4, Figure 4D as revised March 21, 1991.

5.3.6.2 Replacement Water Required:

- A. For wells proposing to withdraw water from the Dawson, Denver, Arapahoe and Laramie-Fox Hills aquifers within the nontributary zone, the terms and conditions shall provide that no more than 98% of the water withdrawn annually is consumed.
- B. For wells proposing to withdraw not-nontributary ground water from the Denver, Arapahoe, or Laramie-Fox Hills aquifers at a point farther than 1 mile from the contact with the alluvium, the terms and conditions shall provide for the replacement of 4 percent of the water diverted from such well. The return of replacement water to the

uppermost aquifer in the vicinity of the point of withdrawal shall be presumed to be in compliance with Rule 5.6.1.(C) but replacement at other locations may be approved by the Commission.

- C. For wells proposing to withdraw not-nontributary ground water from a Dawson Aquifer or not-nontributary ground water from the Denver, Arapahoe, or Laramie-Fox Hills aquifers at a point closer than one mile from the contact with the alluvium, the amount of such replacement water shall provide for the depletion of alluvial water for the first 100 years due to all previous pumping and if pumping continues beyond 100 years, shall replace actual impact until pumping ceases, assuming water table conditions in the bedrock aquifer. The applicant shall be required to develop terms and conditions necessary to prevent injury to prior designated ground water rights. Such terms and conditions shall meet the standards for a Replacement Plan as defined in Rule 5.6.

5.3.6.3 For wells which will appropriate water from more than one zone of an aquifer as identified in Items A, B, and C of Rule 5.3.6.2, the replacement requirements to meet the intent of replacement needs of Rule 5.3.6.2 shall be determined based upon the overlying land acreage located in each zone and the location of the well.

5.3.6.4 The measurement of annual withdrawals and the keeping of records is the responsibility of the well owner. The annual diversion from the period January 1 to December 31 of each year shall be the basis for computation of the replacement requirement.



5.3.6.5 The replacement water may occur as a return flow from the owner's use of the well pursuant to a plan which provides an accounting for the use of the well and the source of each point of return flow. The well owner shall be responsible for any required measurements of the return flow. Credit for diffuse return flow shall be given only to the extent that the well owner has maintained control over such waters and can quantify such returns by reasonable engineering methods acceptable to the Commission. A plan proposing return flow as a source of replacement water must be incorporated as a term and condition of the permit.

5.3.6.6 The well owner shall be required to provide such self-administration as necessary to assure compliance with permit terms and conditions. Self-administration may include metering, reporting or the retention of a neutral third party as reporting agent.

5.3.7 Well Location: All wells, including additional wells, withdrawing water from the Denver Basin aquifers, must be located on the overlying land.

5.3.7.1 A permit shall not be issued for a large-capacity well under Rule 5.3 if this well is to be located within 600 feet of an existing large-capacity well in the same aquifer unless a Waiver of Claim of Injury is obtained from the owner of the existing well or unless the Commission, after a hearing, finds that circumstances in a particular instance warrant that a permit can be issued without regard to the above limitation.

5.3.7.2 If the applicant has identified noncontiguous parcels of overlying land, the applicant may withdraw the total allowed average annual amount of withdrawal from one or more wells, provided that the well

or wells are located so that the cylinder or cylinders of appropriation for at least one of the wells overlap, at least in part, the noncontiguous parcels. In determining the cylinder of appropriation, the acreage from the noncontiguous parcels shall be included in the calculation.

5.3.8 Operation of a well field may be permitted where the entire appropriation for the several wells withdrawing water from the same aquifer may be withdrawn from any combination of wells within the well field. Such a plan may be approved at the time of original permitting or by subsequent request for a change pursuant to Section 37-90-111(1)(g).

5.3.9 Additional wells may be permitted so long as the effect is that the allowed annual amount of withdrawal from all wells involved will not exceed the permitted average annual amount as originally established pursuant to Rule 5.3.2.

5.3.10 It is recognized that economic considerations generally make it impractical for individual landowners to drill wells into the aquifers named in Rule 5.3 for individual water supplies where municipal or quasi-municipal water service is available and that public interest justifies the use of such ground water by municipal or quasi-municipal water suppliers under certain conditions. Therefore, wherever any existing municipal or quasi-municipal water supplier is obligated either by law or by contract in effect prior to January 1, 1985, to be the principal provider of public water service to landowners within a certain municipal or quasi-municipal boundary in existence on January 1, 1985, said water supplier may adopt an ordinance or resolution, after ten days notice pursuant to the provisions of Part 1 of Article 70 of Title

24, C.R.S, which incorporates ground water from the Dawson, Denver, Arapahoe, Laramie-Fox Hills, or Dakota aquifers underlying all or any specified portion of such municipality's or quasi-municipality's boundary into its actual municipal service plan. Upon adoption of such ordinance or resolution, a detailed map of the land area as to which consent is deemed to have been given shall be filed with the Commission. Upon the effective date of such ordinance or resolution, the owners of land which overlies such ground water shall be deemed to have consented to the withdrawal by that water supplier of all such ground water, except that no such consent shall be deemed to be given with respect to any portion of the land if:

- A. Water service to such portion of the land is not reasonably available from said water supplier and no plan has been established by that supplier allowing the landowner to obtain an alternative water supply;
- B. Such ordinance or resolution was adopted prior to the effective date of these Rules, and, prior to January 1, 1985, such ground water was conveyed or reserved or consent to use such ground water was given or reserved in writing to anyone other than such water supplier and such conveyance, reservation, or consent has been properly recorded prior to the effective date of these rules;
- C. Such ordinance or resolution is adopted on or after the effective date of these Rules, and said ground water has been conveyed or reserved or consent to use such ground water has been given or reserved in writing to anyone other than such water supplier and such conveyance, reservation, or consent is properly recorded before the effective date of that ordinance or resolution;

- D. Consent to use such ground water has been given to anyone other than such water supplier by the lawful effect of an ordinance or resolution adopted prior to January 1, 1985;
- E. Such ground water has been decreed or permitted to anyone other than such water supplier prior to the effective date of such ordinance or resolution; or
- F. Such portion of the land is not being served by said water supplier as of the effective date of such ordinance or resolution and such ground water is the subject of an application for determination of a right to use ground water filed with the Commission prior to the effective date of these Rules.

5.4 Appropriation from all Bedrock Aquifers Except the Denver Basin Bedrock Aquifers

5.4.1 This Rule shall apply to all aquifers in all the designated basins except those aquifers listed below:

- A. Lost Creek, Kiowa-Bijou, Upper Big Sandy and Upper Black Squirrel Creek Basins: Alluvium and Denver Basin Bedrock aquifers.
- B. Northern High Plains and Camp Creek Basins: Alluvium, Ogallala, and White River.
- C. Southern High Plains Basin: Alluvium, Ogallala, Dakota, Cheyenne and Dokum.
- D. Upper Crow Creek: Alluvium, Fan, and White River.

5.4.2 An application to appropriate ground water from these aquifers shall be analyzed on the basis of the ownership of the overlying land and on the basis of an aquifer life of one hundred years.

5.4.3 The amount of water available in storage in a specified bedrock aquifer under a specified parcel of land shall be computed based upon the site specific hydro-geologic information available to the Commission.

5.4.4 The provisions of Rule 5.3.7 dealing with the well location for the Denver Basin bedrock aquifer wells shall also apply to all other bedrock aquifer wells.

5.5 Water Quantity Requirements for Issuance of New Permits for Irrigation Use – For new permits, the amount of water to be appropriated for irrigation of agricultural lands shall be 2-1/2 acre-feet per irrigated acre for all aquifers in all designated basins except the Southern High Plains Basin where this amount shall be 3-1/2 acre-feet per acre. In reviewing permit applications, the amount of water available for appropriation must be sufficient to irrigate the requested acreage at the prescribed rate unless an exception is granted by the Commission.

#### 5.6 Replacement Plans

5.6.1 New appropriations of designated ground water from aquifers which are otherwise overappropriated or where such approval may result in unreasonable impairment to existing water rights may be allowed pursuant to a detailed replacement plan. This plan must be adequate to prevent any material injury to water rights of other appropriators. A replacement plan must contain, as a minimum, the following elements:

- A. A detailed description of the source of the replacement water. The source must be such that the water it provides is not required for the fulfillment of vested water rights which are not a part of the plan.

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- B. A detailed description of the proposed diversion, use, and depletion of designated ground water which would result under the plan.
- C. Proof that the plan will not cause material injury to water rights of other appropriators.
- D. Proof that the plan will not cause unreasonable impairment of water quality.
- E. Proof that the plan can and will be operated and administered on an ongoing and reliable basis, which must include at least the following general conditions of approval:
  - 1. Flow measurement devices shall be required on all wells involved in the plan unless the Commission finds that such devices would be unnecessary or impractical.
  - 2. Monitoring to insure that the estimates of consumptive use, return flows, and replacement water are accurate and that depletions are actually replaced.
  - 3. Monitoring of ground water quality to insure that the water quality of the receiving aquifer is not unreasonably impaired.
  - 4. Providing a plan compliance report acceptable to the Commission.
  - 5. Reporting the information required by subparagraphs (1) through (4) above and any other data required by the conditions of approval for the plan to the Commission and District on a schedule determined by the Commission, but on no less than a yearly basis.

6. Recording the terms and conditions of the plan with the county clerk and recorder. Such terms and conditions shall be regarded as covenants running with the land.

F. The Commission retains jurisdiction to modify or revoke approval of the plan, if monitoring or operating experience reveals that the plan results in any material injury to water rights of other appropriators or in unreasonable impairment to water quality.

5.6.2 Upon receipt of any such replacement plan, the staff shall review it to determine whether it is adequate to meet these criteria and the provisions of C.R.S. 37-90-107. The applicant shall have the burden of proving the adequacy of the plan in all respects. If the plan is located within a ground water management district, a copy of the application shall be sent by the staff to the management district and the staff shall consider any comments or recommendations from the management district. The staff shall propose any additional terms and conditions or limitations which are necessary to prevent material injury and to ensure that the plan is administrable and enforceable.

5.7 Specific Yield Values – Unless site specific information acceptable to the Commission is available, the specific yield for the various aquifers to be used in the evaluation of applications pursuant to these Rules is determined to be as follows. For all other aquifers, the specific yield will be determined from the best available information to the Commission.

<u>Aquifer</u>	<u>Specific Yield</u>
Dawson (Upper and Lower)	20%
Denver	17%
Arapahoe (Upper and Lower)	17%
Laramie-Fox Hills	15%
Lost Creek Alluvium	17%
Kiowa Bijou Alluvium	17%
Upper Black Squirrel Alluvium	20%
Upper Big Sandy Alluvium	20%
Upper Crow Creek – Fan Aquifer east of Crow Creek	20%
Upper Crow Creek Alluvium	20%
Northern High Plains – Ogallala Aquifer	15%
Northern High Plains – Ogallala and White River formations north of the Administrative Line (on Figure 1).	25%
Southern High Plains – Ogallala Aquifer	15%

5.8 Artificial Recharge – Subject to permitting requirements, artificial recharge may be captured by the person causing such recharge to the extent that other water rights are not impaired and provided that the waters used for recharge are either imported to the basin, or originate from a different aquifer, or are waters which would not otherwise recharge the same basin at some downstream point. The capture of these waters is subject to permitting requirements pursuant to Section 37-90-107, C.R.S. As such waters move away from applicant's ability to capture, they become designated ground water available to other appropriators within the Basin.

5.9 Well Completion – All wells must be completed in accordance with the Rules and Regulations of the Board of Examiners of Water Well Construction and Pump Installation Contractors for the State of Colorado (2 CCR 402-2).



5.10 Geophysical Logs – Geophysical logging is required for all large-capacity wells from any bedrock aquifers as permitted under Rules 5.3 and 5.4. Such logs shall be made in accordance with Rule 9 of the Statewide Non-tributary Ground Water Rules 2 CCR 402-7.

5.11 Deviation from Permitted Location for New Wells – The following distances are the allowable variation from the permitted site in each aquifer or basin. Wells completed farther than the specified distance from the permitted location shall be deemed to be in violation of permit conditions. If a Management District’s Rules and Regulations specify a lesser distance for a new or replacement well, the lesser distance shall apply. For bedrock aquifer wells, well to well minimum spacing requirements of Rule 5.3.7.1 shall also apply.

<u>Aquifer</u>	<u>Allowable Variation</u> from the <u>Permitted Well Site</u>
Bedrock Aquifers	200 feet
All other aquifers	300 feet

**RULE 6 REPLACEMENT WELL PERMITS**

6.1 Applicability – For consideration as a replacement well under Section 37-90-111(1)(c), C.R.S., the limitations in this Rule 6 shall apply. All replacement applications not within the limits of this rule shall be reviewed under Rule 7 as a change of water right.

6.2 A replacement well shall be constructed within the following distance of the originally permitted well site

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except where a Management District's Rules and Regulations specify a lesser distance, in which case, the lesser distance shall apply:

<u>Aquifer</u>	<u>Allowable Distance from Originally Permitted Well Site</u>
Bedrock Aquifers	200 feet
All other aquifers	300 feet

6.3 A replacement well in a bedrock aquifer subjected to the 200 feet distance limitation of Rule 6.2 shall also satisfy the well to well minimum spacing requirement of Rule 5.3.7.1 but a replacement well in any other aquifer subjected to the 300 feet distance limitation of Rule 6.2 shall not be required to satisfy the well to well minimum spacing requirement of Rule 5.2.1.

6.4 The originally permitted well site shall be the site as specified on the original well permit or a relocated site as approved by the Commission pursuant to Section 37-90-111(1)(g), C.R.S. Where sectional coordinate distances are not available from any document in the permit file, the original site may be established by field location of the original well.

6.5 A replacement well permit will be limited so as to produce water from the same aquifer or aquifers as the original well.

6.6 A permit for the replacement of a well which was previously completed in one aquifer, but did not fully penetrate the water-bearing materials in that aquifer, shall allow full penetration of that aquifer, except that for a Denver Basin aquifer well, it shall not result in increasing its cylinder(s) of appropriation.

6.7 A replacement well permit shall be limited to the same terms and conditions as the original well permit.

**RULE 7 CHANGE OF RIGHTS TO DESIGNATED GROUND WATER**

7.1 Applicability and Exceptions

7.1.1 This rule applies to all changes of rights to designated ground water to be processed pursuant to Section 37-90-111(1)(g), C.R.S. A change can be approved only upon such terms and conditions as will not cause material injury to the vested rights of other appropriators. It shall be the applicant's burden to demonstrate that the above criteria are met. Also, the Commission may require the applicant to provide for any administration necessary to ensure compliance with the terms and conditions of any approval under Rule 7.

7.1.2 A change request may consist of but is not limited to the following:

- A. Change of well location greater than the distance that was authorized for a replacement well as set forth in Rule 6.2;
- B. Change of description of irrigated acreage without an increase in the number of acres irrigated;
- C. An increase in the number of acres to be irrigated above the number of acres permitted;
- D. A change to commingle two or more wells;
- E. A change of type of use (with or without export from a designated basin);

- F. A change of the volume of annual appropriation;
- G. An increase in the pumping rate in gpm.

7.1.3 For bedrock aquifer wells which are permitted to use designated ground water on the basis of the ownership of the overlying land pursuant to Section 37-90-111(5), C.R.S. or pursuant to an equivalent Commission policy to include those wells covered under Rule 5.4, the historic use amount for such a well shall be the maximum annual amount of water put to beneficial use pursuant to Section 37-90-108, C.R.S. but within the limits of the permitted annual amount except that for those Denver Basin aquifer wells issued on or after July 1, 1991, the historic use amount shall be the permitted annual amount provided a well completion report for the well is filed with the Commission pursuant to Section 37-90-108, C.R.S. This provision shall override any other requirement under Rule 7 to estimate historic use but shall not apply to those wells whose appropriation is not based upon the ownership of the overlying land including those wells having claims to cylinder(s) of appropriation under Rule 5.3.3. If the historic use amount as defined above is less than the permitted annual amount, additional well permits for any such unappropriated ground water may be obtained from the Commission in accordance with the applicable statutes and rules in effect at the time such a new application(s) is filed with the Commission.

7.2 Publication – Except as noted in this section, applications for changes of rights to designated ground water shall be published in accordance with Section 37-90-112, C.R.S. The staff shall act upon an application, or a resubmitted application, within sixty days of the receipt thereof. An incomplete application shall be returned to the

applicant with an explanation; this shall be deemed action by the staff. An application that is found to be complete and requires a publication, shall be submitted to the appropriate newspaper for publication; which shall also be deemed action by the staff. Publication does not require a favorable staff finding and no such indication shall be made. The publication shall indicate (a) the name of the applicant, (b) the well permit number, presently permitted annual volume, presently permitted pumping rate, presently permitted well location, and presently permitted irrigated land or other appropriate description of type of use for each well included within the application, and (c) a general statement describing the changes requested by the applicant. The publication shall also indicate the deadline and location for filing any objections to the application.

7.2.1 The following types of applications may be authorized without publication:

- A. A decrease in either the pumping rate, annual appropriation or acreage to be irrigated by a well;
- B. A correction in the description of the acreage historically irrigated which is at least 70% within the description of acreage authorized by the conditional permit or the final permit, if a final permit has been granted for the well; or
- C. A temporary change of use to overcome an emergency situation for a time period not to exceed ninety days if the staff determines the change will not cause material injury to the vested rights of other appropriators. An emergency situation is defined as a situation affecting public health or safety where a water supply is needed more quickly than the time required to process a permanent change in use.

7.2.2 If an emergency situation as defined in Rule 7.2.1(C) will last for more than ninety days, a temporary change of use may be approved for a time period not to exceed one year, if the staff determines that the change will not cause material injury to the vested rights of other appropriators and the following requirements have been met: (a) an application for a permanent change of use has been filed; (b) the publication of the permanent change application has been initiated; and (c) the publication describes both the temporary change of use and the permanent change of use requested by the applicant. All objections to both the temporary and permanent changes of use will be heard and resolved using the normal hearing process for change of use applications. If the hearing officer (or the Commission) enters a decision which is different than the decision of the staff regarding an emergency situation, the decision of the hearing officer (or the Commission) shall immediately supersede the decision of the staff. Any extension of a temporary approval beyond one year, if the emergency situation continues and the permanent change of use hearing process has not been completed, will be considered and acted upon by the hearing officer (or the Commission) and not by the staff.

7.3 Change of Well Location – In determining whether a proposed new well location will cause material injury to the vested rights of other appropriators, the following factors shall be considered for wells other than those wells covered by Rule 6 and Rule 7.3.6.

7.3.1 The applicant shall be required to provide evidence of historic withdrawals and depletions of water from the well, in accordance with Rule 7.10. In addition, to crop data, applicant may be required to submit a wire to water pump efficiency test and power use data. Terms and

conditions shall be imposed to prevent an increase over historic depletion to the aquifer.

7.3.2 Where the proposed well site would have a greater saturated thickness than the original site, terms and conditions shall be imposed to limit future withdrawals to the permitted historic withdrawal of the well. Future withdrawals shall also be limited so as to not exceed the amount of water physically divertable at the well site if the well was replaced under Rule 6. Limitations on future diversions may include consideration of the effect of any future water level declines at the original site.

7.3.3 No relocation site shall place a well closer to an existing well than the minimum distance required for new wells under rule 5 unless specifically approved by the Commission, or unless the owner of the existing well gives a waiver of claim of injury in writing.

7.3.4 For the Northern High Plains Designated Ground Water Basin, a request to change the location of any well in excess of 300 feet from the original permitted site shall be denied, unless there is water available for appropriation at the proposed well location using the methodology described in Rule 5.2.2.

7.3.5 For all designated ground water basins other than the Northern High Plains Designated Ground Water Basin, a request to change the location of any well in excess of 1/2 mile from the original permitted site shall be denied.

7.3.6 A change in the permitted site of the well to allow its original historic site in the field may be approved by the Commission without any other requirements of Rule 7.3 provided that, based upon the records available in

the State Engineer's office, the same permit could have been issued by the Commission at that location at the time the well was constructed, and that such a change will not otherwise cause material injury to the vested rights of other appropriators.

#### 7.4 Change of Description of Irrigated Acres (No Increase in Acreage).

7.4.1 An application to change the description of acres may be approved if a right to irrigate the claimed number of acres is established pursuant to Sections 37-90-107 and 108, C.R.S., and the requested change will not result in any material injury to the vested rights of other appropriators.

7.4.2 In the case of applications to rotate the irrigation of permitted number of acres within a described area from one year to another, such an application may be approved subject to necessary terms and conditions to ensure no material injury to other vested rights. Such conditions may include, but are not limited to, a totalizing flow meter on the well head, annual reporting requirement of the irrigation plan prior to the irrigation season, and the applicant agreeing to provide for any administration necessary to check compliance with the terms and conditions of such an approval.

#### 7.5 Increase in Permitted Irrigated Acreage

7.5.1 Application shall be on a form prescribed by the Commission. No application shall be considered complete without a statement from the applicant agreeing to comply with metering and administrative requirements set forth in the application.



7.5.2 An increase in acreage allowed to be irrigated shall not result in an increase over the amount of water historically depleted by the well from the aquifer. The future average annual appropriation allowed from a well under this Rule shall not exceed the average legal historic withdrawal of water from the well and may be less than the historic withdrawal to ensure no increased depletion of the aquifer, i.e., to compensate for any reduction in return flows back to the aquifer. The burden of proof for the application shall rest with the applicant. The provisions of Rule 7.10 shall apply to establish the historic withdrawal and depletion by a well.

7.5.3 The allowed maximum annual amount of withdrawal from a well shall be administered by the three-year modified banking provisions of Rule 7.11.

7.5.4 Administrative Conditions – The following conditions are necessary in order to control and monitor ground water withdrawals when operating under an approval of expanded acres:

7.5.4.1 All wells approved for expanded acres shall have a flow meter installed and approved by the Commission or its authorized agent. Any alternate method or device for measurement instead of a flow meter must be Commission approved. A backup meter shall be kept on hand unless a specific backup water measurement program is approved by the staff.

7.5.4.2 No person shall begin the irrigation of expanded acres until the well owner has signed a contract with the Management District or the Commission to pay the actual cost of administration, or until the well owner has contracted with a person or entity acceptable to the Commission to perform the same services as would

otherwise be performed by the Commission, and the Commission determines, after consultation with the District, that the terms of the said contract provide for the required administration of the expanded acres.

## 7.6 Commingling

7.6.1 Commingling of water from two or more wells may be allowed by the Commission to achieve greater efficiency of water use, to encourage new irrigation methods, to facilitate water availability during temporary shutdown of a well or for any other purpose that enhances the beneficial use of water without causing material injury to vested rights.

7.6.2 A commingling request may be approved only upon such terms and conditions as will prevent material injury to the vested rights of other appropriators. For irrigation wells the applicant shall also be required to demonstrate that the acre-feet per acre appropriation of each well to be commingled is the same when used on their originally permitted acreages. The data required may include crop data, irrigation methods, pump tests and power records.

7.6.3 The withdrawal from each individual well shall not exceed its permitted annual acre-feet appropriation and may be further restricted to ensure no increase in the historic depletion of the aquifer.

7.6.4 Since commingling may be considered as a mechanism of achieving an alternate point of diversion, commingling shall not be allowed where the effect is to enable a greater withdrawal of water than would otherwise be available. For example, commingling shall not be approved if it results in supplementing the water needs of

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a use served by a poorly producing well by commingling this well with a better producing well.

7.6.5 Commingling shall not be allowed where the intent or effect is to perfect the water right of a well by means of diversions through another well.

7.6.6 All wells approved for commingling shall have a flow meter installed at their individual wellhead and all such wells must be connected together with pipe(s) or other water-carrying devices of reasonable size sufficient to carry water for the requested use. No commingling of water shall actually commence without first obtaining a commingling permit from the Commission and the approval of the improvements required by this Rule, from the Commission or its authorized agent.

7.6.7 No person shall begin the actual commingling of water of such wells until the owner of the wells has signed a contract with the Management District or the Commission to pay the actual cost of administration or until the owner has contracted with a person or entity acceptable to the Commission to perform the same services as would otherwise be performed by the Commission, and the Commission determines, after consultation with the District, that the terms of the said contract provide for the required administration of the commingling of the wells.

7.7 Change of Type of Use (With or Without Export from a Designated Basin)

7.7.1 A change of type of use or an export out of a designated basin shall not result in an increase over the historic depletion of the aquifer by the well. The future average annual withdrawal from a well under this Rule

shall not exceed the average annual legal historic withdrawal by the well and may be less than this amount to ensure no increased depletion of the aquifer, i.e. to compensate for any reduction in return flows back to the aquifer. Where a change in the season of use will result in an increased ability to withdraw water, conditions or limitations shall be imposed to prevent the changed season of use from resulting in an increase in the withdrawal of water over what would occur during the original season of use under present and future aquifer conditions at the original point of withdrawal.

7.7.2 It shall be the burden of the applicant to demonstrate the historic withdrawal of water and the resulting depletion to the aquifer. The provisions of Rule 7.10 shall apply to determine the historic withdrawal and depletion by a well.

7.7.3 The permitted average annual withdrawal from a well shall be controlled by the three-year modified banking provisions of Rule 7.11.

7.7.4 In consideration of the authority granted to management districts pursuant to Section 37-90-130(2)(f), C.R.S., if the requested change involves export of water out of the boundary of a Designated Ground Water Management District, the Commission shall request written recommendation from the District and shall limit the approval of any export out of the District to an annual acre-feet amount not to exceed the amount approved for export by the District. Such an approval shall also be limited by the provisions of Rules 7.7.1, 7.7.2, and 7.7.3.

7.8 Change of Annual Volume of Appropriation – A change of annual volume of appropriation that does not exceed the permitted amount for a well may be allowed as

determined by the historic use of the well within the limits of other permit parameters and provided that no material injury occurs to the vested rights of other appropriators. For irrigation use the appropriation shall not exceed the current allowable duty of water (acre-feet/acre), as determined under Rule 5.5.

#### 7.9 Increase in Pumping Rate in GPM

7.9.1 An increase in pumping rate for a well may be allowed if such a change does not materially injure the permitted pumping capabilities of other wells and does not result in increased depletion of the aquifer on an annual basis. Where necessary, conditions or limitations shall be imposed to prevent any increase over the historic depletion of the aquifer.

#### 7.10 Determining Historic Withdrawal and Depletion

7.10.1 It shall be the burden of the applicant to determine the average annual historic withdrawal and depletion by a well. The evidence required to determine historic withdrawal and depletion may include irrigation system and pump efficiency tests, information on pump and irrigation method(s), flow meter readings and water consumption records where available, power and crop data and such other data as is determined by the staff to be necessary. Ten or more most recent consecutive years of records shall be submitted unless the applicant can show good cause why the data cannot be supplied.

7.10.2 No credit toward historic use shall be given for water used on acreage which exceeds the number of permitted acres, or for any other water use not authorized by the permit.

7.10.3 The annual historic withdrawal of water computed for any given year shall not exceed the permitted annual appropriation.

7.10.4(a) If in any given year or years the land permitted to be irrigated by a well was placed into a federal set aside or conservation reserve program resulting in limited or no irrigation, average historic use may be computed by excluding such year(s) from the average. Annual reporting to the Commission is not required to take advantage of the provisions of this subrule (a).

7.10.4(b) Water diversion during the calendar year 1997 and during any successive calendar year may be excluded in computing average annual historic use provided at least ten years of water use information is available to compute historic use and provided a written request to exclude water use for any given calendar year is received by the Commission by May 1 of that calendar year. This written request must be on a form prescribed by the Commission. To avoid having applicants pick and choose water use years during this period to maximize the estimate of average annual historic use, a request to exclude water use for any year once submitted can not be withdrawn.

7.10.5 Where historic withdrawal cannot be established using power records or flow meter records, the average annual historic withdrawal shall be determined as follows:

- (a) for an irrigation well, the allowable average annual historic withdrawal shall be limited to the historic average of net crop irrigation requirement in acre-feet (potential crop consumptive use minus effective precipitation) on the authorized number of acres

as determined by the Modified Blaney-Criddle method. This determination shall be made as an average of such use for consecutive years for the period of record defined under Rule 7.10.1. When crops which may be grown as irrigated or dry land, i.e., pasture or winter wheat, are included in the cropping pattern, it shall be the burden of the applicant to demonstrate the land was irrigated.

(b) For a well used for other than an irrigation use, the allowable average annual historic withdrawal shall be limited to the actual average historic use as determined from actual records or other data establishing the amount of actual historic use. This determination shall be made as an average of such use for consecutive years for the period of record defined under Rule 7.10.1.

7.10.6 Limitations necessary to prevent an increase over historic depletions to the aquifer shall include a reduction in allowable withdrawal where necessary to compensate for any decrease in return flows to the aquifer, resulting from a change in method of operation.

7.10.7 The Commission staff will make available the values for potential crop consumptive use, effective precipitation, and net irrigation requirement for major crops at key weather station locations in the vicinity of the designated ground water basins as computed by the Modified Blaney-Criddle method. The staff will update this information as necessary.

#### 7.11 Three-Year Modified Banking

7.11.1 Only those wells for which a change in water right has determined historic withdrawal in accordance with Rule 7.10 can use the three-year modified banking provision. To initiate a banking reserve, an applicant must

have a written authorization from the Commission. In the first year, the applicant will be allowed to withdraw an amount up to the specified amount determined to be the allowed average annual historic withdrawal. In successive years, the amount which can be withdrawn during the current year will be the allowed average annual historic withdrawal plus the amount of water in banking reserve for the well, not to exceed the maximum annual permitted appropriation of that well.

7.11.2 The maximum number of acre-feet that can be placed in banking reserve shall not exceed an amount equal to three times the difference between the maximum annual permitted appropriation of that well and the allowed average annual historic withdrawal for that well. The annual amount of water to be added to the banking reserve is the difference in the allowed average annual historic withdrawal minus the amount of water actually withdrawn by the well for that year. Likewise, the banking reserve shall be reduced by an amount equal to the quantity of banking reserve water pumped by the specific well for that year.

7.11.3 The applicant may choose to operate an irrigation well under the terms of the original permit rather than those required for expanded acres, limiting the pumping for that year to the maximum annual permitted appropriation of that well so long as said water is applied only to the land as appropriated under its original permit and none is used elsewhere and the well is not in violation of its permit and/or other approval conditions and any past withdrawals in excess of the approved limitations have been remedied to the Commission's satisfaction. However, this will be cause for reinitiating



the three-year modified banking program to the first year situation with no credit for real or claimed carryover.

7.11.4 For any situation where actual pumping cannot be determined using flow meter records and/or power meter records, it shall be the applicant's burden to demonstrate estimated pumping from the well; (a) for irrigation use from the net crop irrigation requirement (potential crop consumptive use minus effective precipitation) as determined by the Modified Blaney-Criddle method, (b) for any other use, from actual records or other data establishing the amount of actual use. The Commission shall make the final decision on the reasonableness of such pumping estimates. Failure of the applicant to meet this requirement will be a cause for reinitiating the three-year modified banking program to the first year situation with no credit for real or claimed carryover. However, any deficit or overpumping will be carried over the reinitiation of the banking program to prevent injury to other water rights.

7.11.5 The three-year modified banking program shall be adjusted to account for a change in the method of irrigation or any other factor which would affect the allowed historic depletion of the aquifer from the well.

7.11.6 The owners of wells for which a previous change in water right has determined average annual historic withdrawal may apply to the Commission to avail themselves of the provisions of three-year modified banking. For these applications the banking reserve for the current calendar year shall be computed using the pumping that occurred in the prior three consecutive calendar years, so long as the well was operating under average

annual historic withdrawal limits. If the well was operating under average annual historic withdrawal limits for less than the prior three consecutive calendar years, then the actual number of prior consecutive calendar years for which the well operated under the said limits shall be used to compute the banking reserve for the current calendar year.

#### **RULE 8 FLOW METER REQUIREMENTS**

8.1 The Commission has the authority to require a totalizing flow meter or other measuring device for any well in a designated ground water basin. In the exercise of this authority the Commission shall consider these rules and Management District rules and regulations. In cases where Management District rules and regulations require a meter, the Commission shall require a meter and notify the applicant of the District's meter requirements as a condition of a new permit, replacement permit, or a change of water right approval unless the District notifies the Commission that it waives the requirement. The Commission shall require meters in the following cases regardless of the Districts' metering requirements:

- A. For wells which are relocated pursuant to Rule 7.3.
- B. For any rotation of acres approved pursuant to Rule 7.4.2.
- C. For all increases of acreage pursuant to Rule 7.5.
- D. For any commingling of wells pursuant to Rule 7.6.
- E. For any change of type of use approved pursuant to Rule 7.7.

- F. For all large-capacity wells for municipal, commercial or industrial use.
- G. For all large-capacity wells completed in bedrock aquifers.

8.2 When a meter is required, it shall be the owner's responsibility to keep the meter in acceptable operating condition. The Commission may adopt standards and specifications for measuring devices and the installation, repair, and maintenance of measuring devices. As a minimum, meters shall be installed according to the manufacturer's recommendations and shall contain sufficient recording digits to assure that "roll over" to zero does not occur within three years. Meters shall be maintained by the well owner so as to provide a continuous, accurate record of withdrawals. If the meter is not operational, the well shall not be pumped unless a working meter is installed or unless a specific backup water measurement program approved by the Commission is put into effect.

8.3 The Commission may allow any alternate methods or devices for measurement instead of totalizing flow meters.

8.4 Well owners are responsible to record the meter reading as required but no less than once each year and to retain these records and submit them to the Colorado Ground Water Commission and the applicable management district upon request.

8.5 Exceptions to these metering guidelines may be approved by the Commission on a case by case basis.

**RULE 9 COORDINATION WITH GROUND WATER  
MANAGEMENT DISTRICTS**

9.1 The Commission shall request written recommendation from the board of directors of any ground water management district before issuing any orders or promulgating any regulations affecting that district and shall request written recommendations on any permit applications received from within the boundaries of that district.

9.2 The Commission shall contact each district for the purpose of developing a working agreement which sets criteria, timetables, and procedures for the referral requests set forth in Section 37-90-111(3), C.R.S. and Rule 9.1.

**RULE 10 SEVERABILITY**

10.1 If any portion of these rules is found to be invalid, the remaining portion of the rules shall remain in force and unaffected.

**RULE 11 VARIANCE**

11.1 Applicability and Exceptions

11.1.1 When the strict application of any provisions of these rules would cause unusual hardship, the Commission may grant a variance for a specific instance provided a written request for the variance is made to the Commission and the Commission finds the request justifiable in accordance with the provisions of this rule.

11.1.2 This rule is applicable to variance requests for all applications for new appropriations and for change applications for high capacity wells located in Designated

Ground Water Basins that require Commission action pursuant to Rule 5 and Rule 7.

11.1.3 This rule does not apply to variance requests made under rules other than rule 5 and rule 7. However, if an application is filed for a replacement well pursuant to Rule 6 and the application includes a variance request to allow the well to be relocated to a place greater than the distance allowed for replacement wells as specified in Rule 6, said request shall be interpreted by the Staff as a request for a change of water right and the Staff shall, consistent with Rule 6.1, evaluate such request pursuant to the provisions of Rule 7 and Section 37-90-111(1)(g), C.R.S..

11.2 Requirements for Variance Requests From Rules 5 and 7

11.2.1 Before consideration of any request for a variance from Rule 5 or Rule 7, the Staff must receive an application for a new appropriation (Rule 5) or for a change in water right (Rule 7). An applicant seeking a variance pursuant to Rule 11 may submit the variance request at the time of application for either the new appropriation or change in water right. The applicant may also submit a variance request after a new appropriation or change in water right application has been submitted, provided the Staff has not acted on the application. However, if the Staff has already acted on the application (i.e. denied the application) the applicant must file a new application and request for a variance.

11.2.2 The Executive Director of the Commission or his Staff shall have the authority to initially review all variance requests and determine whether they are complete and ready for Commission consideration. Such

determinations shall be made within 60 days of the variance filing date. If not, the variance request will be returned to the applicant with a written description of the deficiencies and the steps necessary to cure them. Once the variance request is deemed complete and ready for Commission consideration, it will be published. A copy of the variance request will be sent to the appropriate Ground Water Management District.

11.2.3 Publication of a variance request will follow the provisions of Section 37-90-112, C.R.S.

11.2.4 Any hearing scheduled on the variance request will be held at the next Commission meeting, but no earlier than 14 days after the end of the statutory objection period.

11.2.5 The Applicant requesting the variance shall be required to pay for all publication costs associated with the variance. The Commission will not hear the request for variance unless, at least seven days prior to the time set for the hearing, the applicant has paid all publication costs for the variance request.

11.3 COMPLIANCE – Failure to comply with any portion of this rule may subject the applicant to a denial of its variance request by the Commission.

#### **RULE 12 REVISION**

12.1 The Commission may revise any portion of these rules in accordance with the applicable provisions of the Ground Water Management Act, Article 37-90, C.R.S. and the Administrative Procedures Act, Article 24-4, C.R.S. Such revisions may be the result of new data and/or any

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other need to upgrade these rules in order to best serve the intended purpose of these rules.

**RULE 13 EFFECTIVE DATE**

These rules shall become effective on May 1, 1992.

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**APPENDIX I**

**Confidentiality Agreement**

**CONFIDENTIALITY AND NONDISCLOSURE AGREEMENT BY AND BETWEEN THE STATES OF COLORADO, KANSAS, NEBRASKA AND THE UNITED STATES**

**WHEREAS**, the State of Kansas, as Plaintiff, has filed a Bill of Complaint in the United States Supreme Court naming the State of Nebraska and the State of Colorado as Defendants in an Original Action (the "Action") arising out of the Republican River Compact and the United States has appeared as amicus curiae; and,

**WHEREAS**, the States of Colorado, Kansas and Nebraska and the United States have indicated a willingness to discuss resolution of issues related to the Action and the administration of the Republican River Compact; and

**WHEREAS**, the States of Colorado, Kansas and Nebraska and the United States have initiated discussions, relating to the resolution of issues related to the Action and the administration of the Republican River Compact on October 4, 2001.

**THEREFORE**, in consideration of the mutual agreement of the States of Colorado, Kansas and Nebraska and the United States that these discussions are dedicated to the purpose of resolving all disputes between the States, including but not limited to those identified in the Action; the States of Colorado, Kansas and Nebraska and the United States hereby agree, by and through their undersigned representatives, to the following terms concerning the discussions so as to encourage a frank and meaningful



exchange of information in order to facilitate the resolution of any and all disputes:

**RELEASE OF INFORMATION TO THE MEDIA**

No State nor the United States will disclose or report any substantive information, exchanged or revealed by any other State or the United States, to members of the press or other public information dissemination media. Likewise, no State nor the United States will unilaterally disclose or report any substantive information regarding the status of the discussions and any progress made or not made during the course of said discussions to members of the press or other public information dissemination media. Only upon the prior agreement of all of the States and the United States may substantive matters or reports on the progress of discussions be released to the press or other news media. The States and the United States agree to work together in good faith to agree on the extent to which any disclosure to the media will be made.

**USE OF INFORMATION OBTAINED DURING SETTLEMENT DISCUSSIONS IN THE ACTION IS PROHIBITED**

In the event the discussions should fail, no information provided, exchanged or distributed during the course of the discussions shall be used against the State [or the United States'] that provided such information or any other State [or the United States'] EXCEPT when said

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[ Added and initialed in original by CDA, DDC, JBD, AW.]

information is otherwise independently discovered through the course of discovery as provided for in the Comprehensive Case Management Plan attached to CMO 6 and as amended. Modeling information made available by the U.S.G.S. to the States in advance of release of the final report shall not be used by any State for any purpose other than settlement discussions. All information, material and data developed jointly by the States and the United States shall not be used for or against any State or the United States. Likewise, the fact that any State or the United States participated in the creation, collection, and computation of such jointly developed information, material and data shall not be used for or against any State or the United States. Neither information developed by the States or the United States for the purposes of settlement discussions nor the content of any settlement discussions shall be discoverable.

#### **RELEASE OF INFORMATION TO THE PUBLIC**

Each State and the United States has statutes which it believes are adequate to protect the confidentiality of all documents, materials and communications made for or in connection with the Republican River discussions, whether verbal, written, or electronic in form, and each State and the United States will utilize such laws to the fullest extent permitted to protect such confidentiality except as otherwise agreed by all of the States and the United States.

**EFFECTIVE DATE**

This agreement shall date back so as to include the discussion meeting held on October 4, 2001, and all subsequent meetings.

*SO AGREED TO THIS 19TH DAY OF OCTOBER, 2001.*

<u>/s/ Carol D. Angel</u> <b>On behalf of the State of Colorado</b>	<u>/s/ John B. Draper</u> <b>On behalf of the State of Kansas</b>
<u>/s/ David D. Cookson</u> <b>On behalf of the State of Nebraska</b>	<u>/s/ A.F. Walch</u> <b>On behalf of the United States of America</b>

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**APPENDIX J1**  
**STATUS OF AGREEMENT ON**  
**RRCA GROUND WATER MODEL**  
As of November 15, 2002

**DOCUMENT CONTEXT**

The purpose of this document is to summarize the status of the RRCA Ground Water Model. Agreement has been reached among the State of Colorado, State of Kansas, and State of Nebraska in consultation with the United States in the selection of model calibration targets and methods to estimate groundwater pumping and recharge. The RRCA Ground Water Model will be applied in a consistent manner with the RRCA Accounting and Reporting Procedures to ensure consumptive uses from surface water and ground water are properly accounted for. General agreement has also been reached on the process to calibrate the RRCA Ground Water Model. The States and United States agree that coordinated efforts will continue to refine data inputs and model calibration until completion, on or before July 1, 2003.

**MODEL DESCRIPTION**

The primary purpose of the RRCA Ground Water Model is to quantify within the Republican River Basin the amount, location, and timing of depletions to stream flow from ground water pumping and accretions to stream flows due to imported water supply from outside the basin. The major structural components of the model are:

- The model uses MODFLOW 2000 with the following modules: BAS1, RCH, WEL, STR, EVT, DRN, CHD, and LPF.

- The model domain extends beyond the Republican River watershed from the Platte River in the north and to the Ogallala aquifer outcrops on the southern, eastern, and western boundaries. The model domain coincides with that described in USGS Open File Report 02-175 except in the eastern portion of the Basin where it was extended eastward to the eastern edge of Kearney County, Nebraska and into Adams County, Nebraska to reflect increased water table elevations caused by imported water supplies from the Platte River. The model domain encompasses approximately 30,000 square miles.
- Constant head boundary conditions for the model were assigned along the Platte River, the eastern boundary of Kearney, Clay, Nuckolls, and Adams Counties, Nebraska; and in Cheyenne County, Colorado where the Republican River exits the domain. All other boundaries are no-flow boundaries. See attachment RRCA Ground Water Model Domain.
- The model represents the long term steady-state conditions up to 1940 and transient conditions from 1940 to 2000. Transient conditions are discretized into monthly stress periods. The model will be updated annually by the RRCA to reflect data from 1940 to the current accounting year.
- The model is discretized into one-square mile grid cells.
- The model is a single layer bounded on the bottom by the impermeable Pierre Shale.
- As an interim measure, Saturated Thickness is based upon an average saturated thickness for the period 1940-2000; values were obtained by kriging across the model domain between known data

points. The minimum saturated thickness in a model cell is 10 feet.

- Stream Network was taken from USGS File Report 02-175.
- The interim aquifer base was taken from USGS File Report 02-175, and is subject to adjustment to reflect elevation variances near streams.
- Land surface elevations were obtained from the National Elevation Dataset (NED) one arc second Digital Elevation Model (DEM).
- The aquifer is represented as confined in the present model structure, but will be changed to unconfined aquifer conditions prior to final model calibration.
- Initial hydraulic conductivity and specific yield estimates were taken from USGS File Report 02-175 and are subject to adjustment in model calibration.

## **CALIBRATION TARGETS**

### **WATER LEVEL**

Ground water levels have been measured throughout the Basin since the early 1900's, but the number of sites increased dramatically post-World War II. The source of ground water level information used in the RRCA Ground Water Model is the Ground Water Site Inventory (GWSI) maintained by the United States Geological Survey (USGS) in cooperation with all three States. The tenure of static ground water level data ranges from a single-year measurement at a discrete location to a continuum of annual measurements that began in the early 1950's and continues to date at the same well. Ground water levels

are typically measured once each year, usually in the non-irrigation season when effects from irrigation pumping are minimized. The RRCA Ground Water Model is calibrated to a ground water level data set that contains a total of 350,233 water level records at 10,835 different sites. The GWSI dataset was converted from latitude/longitude to a X-Y coordinate system. The entire dataset, including one-measurement water levels, is available for model calibration except for wells that were determined by the representative State to be clearly erroneous. Water level data from continuous recorders are not presently being applied. A procedure to weight water level targets during the calibration process may be utilized. Additional water level targets may be included upon agreement by all States.

## **BASEFLOW**

Hydrograph separation is a technique that partitions the amount of surface water and ground water that is measured as total streamflow at a river gaging station. Determining the component of total streamflow that is contributed by ground water (also called baseflow) requires professional expertise and judgment. The hydrograph separation analysis used in this application is referred to as the Pilot Point method. This procedure was adopted for application in this ground water model since it combines the increased accuracy of graphical baseflow analysis with the computational efficiency afforded by electronic spreadsheets. Daily streamflow information for one, or multiple years, is easily tabulated in a Microsoft Excel<sup>®</sup> electronic spreadsheet. Daily hydrographs are subsequently plotted using the graphics package. The analyst performing the baseflow separation uses the tools available in the electronic graphics package to select pilot or turning

points that signify the baseflow component in the total amount of streamflow measured at a river gaging station. A significant contribution of the graphics and computational package afforded by Microsoft Excel<sup>®</sup> is the flexibility to easily change the assignment of each pilot or turning point upon comparative review with other nearby streamflow hydrographs or in collaboration with another analyst. The analyst may change one or multiple pilot points using the click-and-drag tool to another turning point and instantly recalculate the amount of baseflow for a defined period of time – from a month up to decades. Use of the electronic graphical/computational Pilot Point method also dampens the objectivity criticism of the traditional hand-graphics technique performed by an individual analyst.

For the RRCA Ground Water Model, fifty-seven (57) independent baseflow analyses were performed and adopted as calibration targets. A summary of the estimated monthly baseflows of each analysis is attached. Existing baseflow targets may be revised if found to be flawed, and additional baseflow targets may be adopted upon unanimous agreement by the RRCA Ground Water Modeling Committee. Adjustments for surface water diversions may also be considered and adopted by the RRCA Ground Water Modeling Committee, upon unanimous agreement.

As a supplement to the baseflow separation information developed for selected gaging stations and stream segments, Nebraska compiled miscellaneous streamflow measurements and synoptic baseflow survey data available from the USGS and State of Nebraska into a Microsoft Access<sup>®</sup> electronic database. The data were collected periodically since 1975, except for the data provided in the USGS Water Supply Paper 779, which were collected in



the late 1920's and early 1930's. The synoptic baseflow data has not been included in model calibration to date, but is available for review and consideration in the final model calibration.

### **PUMPING**

The pumping for municipal and industrial purposes was obtained from the USGS. Each State developed its own estimate of gross irrigation pumping. The following general methodologies for estimating ground water pumping have been agreed to by the States. The States commit to mutual verification of pumping datasets, primarily by comparison to meter records (where available) and to a lesser extent by power records, and independent CIR calculations. The RRCA Ground Water Modeling Committee will continue to refine pumping estimates on commingled irrigated lands in Nebraska.

#### Colorado

The State of Colorado employed a seven-step procedure to estimate ground water pumping:

1. Total acres irrigated by surface and ground water is estimated for each county based upon data from the respective County Assessor's Office for the area contained in the RRCA Ground Water Model boundaries.
2. The acreage irrigated by surface water is identified from the County Assessor's Records
3. The acreage irrigated by ground water is calculated as the difference between the total acreage and the acreage irrigated by surface water.

4. The maximum farm efficiency for center-pivot sprinkler irrigation and flood irrigation is estimated for each year.
5. The percent of acreage irrigated by center-pivot sprinkler is estimated for each county for each year.
6. The crop water requirement is estimated for each county using the Hargreaves empirical formula calibrated to the Penman-Montieth method for reference crop evapotranspiration. The crop mix for each county is determined from County Assessor records. The effective precipitation is estimated using the procedure outlined in Irrigation Water Requirements, Technical Release No. 21, United States Department of Agriculture, April 1967 (Revised September 1970). The crop irrigation requirement is calculated as the total or potential crop water requirement minus the effective precipitation.
7. Pumping for each county is estimated as Irrigated Ground water Acreage multiplied by Crop Irrigation Requirement multiplied by Fraction of Crop Irrigation Requirement satisfied. This total is then divided by the maximum farm efficiency. The maximum farm efficiency is a weighted average based on the amount of sprinkler and flood irrigation.

#### Kansas

The State of Kansas uses the following procedure to estimate irrigation pumping for the period of 1940-1988:

1. Determine the potential evapotranspiration (PET) for the irrigated area and crops determined for the study area.

- a. Compute reference ET with the Penman-Montieth method for years when detailed climate data are available.
  - b. Develop calibration coefficients for the Hargreaves method to use prior to availability of detailed weather data.
  - c. Compute crop PET for study period.
  - d. Compute effective precipitation.
  - e. Determine crop distribution from county level crop statistics.
  - f. Compute crop demand for irrigation water (CIR) on a unit basis (inches per acre).
2. Compile a history of well development, including location, date and source. The main data source is the Kansas water right information system, including its water use database.
  3. Compile irrigated area estimates, based on county crop statistics, previous studies and water use reports.
  4. Compute the volume of crop demand for irrigation (CIR) on a countywide basis, and use this as an initial estimate of the net irrigation pumping.
  5. Compare the estimated net irrigation pumping to the water use reports for 1989-1999. This comparison was used to calculate factors by county, averaged over the period.
  6. Use the comparison of estimated to reported pumping to develop a factor to multiply by the crop demand to estimate the actual net pumping for 1940-1988.

The State of Kansas uses the following procedure to estimate irrigation pumping for the period of 1989-2000:

Kansas has received water use reports from water right holders since 1957. In 1989, the Kansas Division of Water Resources (KDWR) was given additional enforcement authority and resources to require, obtain, and review water user reports of all water right holders. As a result, for the period 1989-2000, Kansas relied on the water use reports as its basis for estimating irrigation pumping. The water use report includes the total metered quantity or hours of operation, pumping rate, irrigated acreage, and crop type. Water users with meters are expected to report metered quantity; while those without meters report hours of pumping and diversion rate. Each water use report received by KDWR is reviewed for accuracy and completeness. All wells in the alluvium of the Republican River and its tributaries have been metered since 1998.

Net pumping was determined by multiplying the total pumping by an estimated irrigation efficiency (which includes evaporative spray loss and runoff loss). Recognizing that the type of irrigation has changed over time, Kansas assumed that all irrigation was flood until 1959, with an efficiency of 65%. Center pivots (85% efficiency) and other sprinklers (75% efficiency) were in use starting in 1960, and Low-Energy Precision Application systems (LEPA, 90% efficiency) use began in 1990. For 1960 to 1993, the proportion of center pivot and other sprinklers was interpolated from zero in 1959 to the value reported in the Kansas Water Rights Information System in 1993. The same procedure was applied to LEPA for the period 1990-1993. Flood irrigation was assumed to comprise the remainder each year to bring the sum to 100%.

Nebraska

Nebraska estimates pumping by a method that uses power records to estimate the hours of pumping for irrigation wells in a given area by year. The reported pumping rate for each registered irrigation well is adjusted in accordance with an empirically derived relationship between registered rates and actual rates, as determined through field-testing. The estimated pumping rates are multiplied by scalars that are based primarily on comparisons to metered data. The scalars are required because some wells in Nebraska are supplemental to surface water, because of possible inconsistencies in the registration database, and/or where pumping capacity exceeds potential beneficial use. The hours and rates are combined with the well database to determine pumping amounts, assuming the same hours per well. Scalars are determined based on comparison of countywide pumping totals in the Upper Republican Natural Resources District. An additional scalar is proposed to account for commingled lands in the alluvium. Nebraska will continue its verification of its pumping estimates after 15 November, but does not propose to change its method.

**IRRIGATED ACREAGE ESTIMATES**

The States agree to the following methodologies for estimating irrigated acreage. The States commit to mutual verification and improving the accuracy of irrigated acreage datasets.

COLORADO

Estimates of the irrigated acreage for 1940 through 2000 in Colorado for the area covered by the RRCA

Ground Water Model include lands in Kit Carson, Yuma, and Phillips Counties and parts of Sedgwick, Logan, Washington, Lincoln, and Cheyenne Counties. A small area of Elbert County is located in the RRCA Ground Water Model area, but since there are no irrigation wells or ditches in that area, it was excluded.

The estimates are based on the County Assessors' records of irrigated acreage and well permit information contained in the Colorado Ground Water Commission's Northern High Plains Well Database with adjustments for irrigated fields set aside under federal farm programs. The results were compared to irrigated crop statistics compiled and published by the Colorado Department of Agriculture and the National Agricultural Statistics Service (NASS) and irrigated acreage records for farms participating in federally subsidized programs that were provided by local Farm Service Agency offices through the U.S. Department of Agriculture. Descriptions of these sources and procedures follow.

### **County Assessor Records**

The county assessor is an elected official in county government and their duties are prescribed by Colorado Revised Statutes. Succinctly, the county assessor must discover, list, classify, and value all taxable real and personal property within their respective county. Procedures for classifying and valuing property are set forth in the "Personal Property Valuation Manual", the "Land Valuation Manual", and other references prepared by the Colorado Division of Taxation. The assessor's appraised property values form the basis for taxing districts to set

mill levies and taxes. The county treasurer is responsible for collecting all property taxes.

For agricultural land, the assessor must determine the value of the land based on its production capability by considering soils, irrigation sources and methods, crop yields, crop values and farm sales. The assessor relies on aerial photographs, county clerk records, the county soil survey, agricultural statistics from NASS, climatological records, interviews with local farmers, and other locally available information. Since 1989, all property is appraised every other year based on sales of equivalent property during the preceding two years. Provisions are allowed to conduct interim appraisals if necessary to reflect a change in property values assessment such as conversion from irrigated cropland to dry land pasture.

The county assessors must publish an "Abstract of Assessment" by August 25 of each year that summarizes the amount and value of various categories of property as of the previous January 1. The abstracts also document the valuation, mill levy, and revenue for each taxing district in the county. Categories of property include irrigated farmland, meadow hay land, dry farm land, grazing land, and other agricultural land. Since 1993, the abstracts tabulate acreage by sprinkler and flood irrigation. The Colorado Department of Local Affairs summarizes the abstracts and submits an annual report to the Colorado General Assembly.

Irrigated land that is taken out of production due to farm programs, such as the Payment in Kind (PIK) and Conservation Reserve Program (CRP), remain classified as irrigated by the county assessor pursuant to requirements in federal authorizing legislation for these programs. They

remain classified as irrigated to assure payment to the farm owner by the federal government is commensurate with irrigated land production capability and to maintain the assignment of tax burden. The Farm Service Agency (FSA) of the US Department of Agriculture (USDA) administers the federal crop programs. Each year, program participants must report crop acreage to the local FSA office that compiles records of irrigated and non-irrigated croplands. Federal farm program acreage records for 1990 through 2000 were available and summarized for each county as CRP fields and fallow fields. Those annual values were deducted from the assessors' irrigated acreage. The PIK Program reduced irrigated acreage significantly in the 1980s. Since the USDA does not retain records for more than 10 years, Colorado estimated the PIK acreage using NASS records as described later in this document.

### **Colorado Ground Water Commission's Northern High Plains Well Database**

The Northern High Plains Well Database covers the entirety of the RRCA Ground Water Model area in Colorado. The information contained in the well database for the model area includes 3,967 ground water well records. Each record includes the well location, use of the water, place of use, pumping rate, irrigated acreage, owner, and priority date. The records for each county were sorted by use, priority date, and location. For each county and priority year, the number of irrigation wells is counted and the acreage shown on the well permits is quantified.

The irrigated acreage identified in the well permits exceeds the actual irrigated acreage identified through



County Assessor data. Review of well permit acreage information indicates most cite a square quarter-section of land, or 160 acres. Center-pivot sprinkler systems are the prevalent water application method in the model area and a typical circular quarter-section system irrigates only 130 acres. Comparison of permitted irrigated acreage with NASS data also indicates the well permit information exceeds the irrigated crop acreage reported by NASS.

#### **Estimate of Surface Water Irrigated Acreage**

Surface water irrigation in the Basin in Colorado occurs only in Yuma and Kit Carson Counties. The surface water acreage was obtained from the respective County Assessor's records that documented a total of 2,902 (Yuma) and 1,861 (Kit Carson) acres in 1940. These quantities were carried forth to date and do not reflect the small decrease in surface water irrigation that has occurred since 1940.

#### **Estimate of Irrigated Acreage by County Over Time**

The assessors' records of irrigated acreage for Kit Carson and Yuma Counties include land irrigated from surface water sources that precede 1940. Irrigation of additional acreage after 1940 can be attributed exclusively to ground water development. Review of historic county assessor records confirms there has been little change in irrigated acreage since 1979 and the Assessors' records for recent years provide the most accurate quantification of irrigated acreage in each county.

To estimate the irrigated acreage over time, the ratio of the assessors' reported acreage in 2000 to the cumulative

acreage under all well permits for irrigation is calculated. For Phillips, Sedgwick, Logan, Washington, Lincoln, and Cheyenne Counties, that ratio is multiplied by the annual cumulative well permit acreage to determine the acreage in a specific year. For Kit Carson and Yuma Counties, the ratio was multiplied by the yearly permitted acreage and the resultant was added to the previous year's acreage to account for surface-water irrigated land developed before 1940. For 1990 through 2000, the fallow irrigated fields and fields idled due to farm programs (USDA records) were deducted from the calculated acreage to determine the net irrigated acreage for those years. From 1982 through 1988, significant acreage was taken out of production through the USDA's Payment in Kind (PIK) program. The USDA represents that it does not have records of the county acreage idled by this program during the 1980's because it retains records on individual farms for only 10 years. The NASS records show significant reductions in irrigated acreage, up to 110,000 acres in 1983, in Kit Carson, Yuma, and Phillips Counties. To reflect this program, Colorado combined the NASS acreage for the three counties<sup>1</sup> and calculated the annual reduction percentage from the acreage in 1981.

<u>Year</u>	<u>Total Irrigated Acres</u>	<u>Reduction as Percent of 1981</u>
1981	507,774	0.0
1982	480,443	5.4

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<sup>1</sup> The NASS records for the other five counties were not used for these calculations because the irrigated acreage in these counties overlaps into other river basins.

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1983	392,562	22.7
1984	426,248	16.1
1985	431,243	15.1
1986	416,416	18.0
1987	465,633	8.3
1988	468,627	7.7

The annual reduction percentages were multiplied by the irrigated acreage in each county and the resultant was subtracted to determine net irrigated acreage.

**Colorado Irrigated Acres Summary**

The total irrigated acreage in the Basin in Colorado in 2000 was 572,483 acres. Surface water irrigated lands are located only in Kit Carson and Yuma Counties and account for 4,763 acres. The total for lands irrigated by ground water is the difference, or 567,720 acres in 2000. No lands were identified that were irrigated by a combination of surface water and ground water pumping.

KANSAS

For the period 1989-1999, irrigated acres from the Water Use Reports were used. Data for 1999 was used for 2000, as the 2000 data have not been compiled yet. The National Agricultural Statistics Service (NASS) Agricultural Statistics provide countywide data that is most complete in Kansas after 1972; however, some irrigated crops are not tracked individually. The Census of Agriculture data from 1987, 1992 and 1997 were used to distribute some acreage to irrigated crops from the total acreage given in the Agricultural Statistics for the years 1972 to 1988. The revised acreages were then multiplied by an estimate of the percentage of each county's irrigated

acreage in the model area, determined from the Water Use Report data, and used as the irrigated acres for 1972-1988. For the pre-1972 acreage, the annual well count was multiplied by a ratio of acres per well determined from either the Water Use Reports or the adjusted Agricultural Statistics for 1972, whichever gave a better fit to the subsequent year's estimates. Irrigated acreage for each section was calculated by multiplying the annual well count by the irrigated acres per well, with a maximum of 520 irrigated acres per section. All remaining acreage above the 520 limit was assigned pro rata to other sections with less than 416 irrigated acres (80% of 520 acres).

### **Kansas Irrigated Acres Summary**

The total irrigated acreage for Kansas's counties in 2000 is 449,891 acres.

### **NEBRASKA**

National Agricultural Statistics Service (NASS) is an agency of the US Department of Agriculture (USDA). In cooperation with the Nebraska Department of Agriculture (NDA), NASS prepares an estimate of crop acreage by county. Annually they produce "Nebraska Agricultural Statistics" which is a compilation of information about farms, crops, and livestock. Every five years, NASS produces the Census of Agriculture, which is a detailed counting of farms, crops, and livestock. For the intervening four years, the estimates are prepared using a much smaller sample than the census. Periodically, NASS presents revisions to the annual estimates based on the results of the most recent census.

Reports are prepared annually for Nebraska and the data are collected and summarized statewide and by county. Farmers are surveyed each fall following harvest. Those surveys are supplemented with surveys of grain elevators and mills for volumes of grain received, meat packing plants, and other agribusiness. Crops are added and deleted from the annual report as cropping patterns change. For example, broom corn was deleted from the surveys in the 1960s and sunflowers were added in 1990. Generally, the USDA is most interested in farm program crops such as corn and wheat and the NDA is interested in other crops such as alfalfa, grass hay, fruits, and table vegetables.

The annual reports break out irrigated and non-irrigated acreage for some crops. For other crops, such as alfalfa and corn for silage, NASS reports total acreage harvested every year but reports irrigated acreage periodically. In these cases, estimates of the irrigated acreage for the crop is based on the ratio of reported irrigated acreage and total harvested acreage in other years.

### **Nebraska Irrigated Acres Summary**

The total irrigated acreage for Nebraska counties in the ground water model domain in 2000 is 1,692,521 acres.

### **CROP IRRIGATION REQUIREMENTS (CIR)**

#### Colorado

The potential irrigation requirements for each crop for each county and year was estimated using the Hargreaves equation calibrated to the Penman-Monteith equation. The crop mix was obtained by County Assessor data. Effective

rainfall was estimated using the procedure outlined in Technical Report 21. The gain in soil moisture from winter and spring precipitation was an average of 2.0 inches (source: Republican River Basin Water Management Study, Steven J. Vandas, United States Bureau of Reclamation, March 1983). The net crop irrigation requirement is calculated as the potential consumptive use minus effective precipitation minus the gain in soil moisture from winter and spring precipitation.

#### Kansas

Using the Penman-Monteith calculations, the composite crop-weighted unit CIR was obtained for each year. Requisite data to calculate the CIR for 1945-1949 was not available, so the average for 1950-1959 was substituted for these years. The unit CIR for 1945-2000, was multiplied by the irrigated acreage described above to obtain volume of irrigation demand for each county. To account for winter soil moisture, a preliminary soil moisture factor was applied to each county in April and, if necessary, May, and was used to offset the CIR at the beginning of the irrigation season. The remaining CIR was then used as an initial estimate of net pumping.

#### **RECHARGE**

Estimated recharge is the result of two sources of water: recharge from precipitation and recharge from human activities such as irrigation. Recharge from irrigation is further segmented into two principal components based upon the source of water, surface or groundwater.

## PRECIPITATION RECHARGE

Precipitation recharge is a significant variable in the overall water budget because its effect encompasses the entire model domain of over 19 million acres. Average precipitation between 1940 and 2000 varies from approximately 16 inches per year in the western part of the study area to approximately 27 inches per year in the eastern part of the Basin. Recharge from precipitation generally increases from west to east across the domain. Recharge from precipitation is also influenced by soil type. More recharge is generated on sandy soils than clay soils for the same amount of precipitation. Therefore, STATSGO soil maps were used to locate sandy soils in the domain. These areas are commonly referred to as the *sand hills* of Colorado and western Nebraska. Different precipitation to recharge mathematical relationships are assigned to sandy and non-sandy soils.

More complex relationships may be considered, i.e. to account for additional variations in soil types, for non-linear precipitation effects, and for topography. A change in precipitation recharge over time, due to construction of farm terraces and ponds, may be considered.

## GROUNDWATER IRRIGATION RECHARGE

The following methodologies are generally agreed upon. The RRCA Ground Water Modeling Committee will develop a common set of procedures and recharge values by system type.

Colorado – Recharge from ground water pumping in Colorado is calculated for each year and for each county. Groundwater recharge from sprinkler irrigation is calculated by multiplying the product of the gross pumping for

sprinkler irrigation by the percentage that returns as deep percolation. In a similar manner, the amount of groundwater recharge from flood irrigation is calculated by multiplying the product of the gross pumping for flood irrigation by the percentage that returns to the aquifer as deep percolation. The total amount of recharge from groundwater per county and year is the sum of the returns to deep percolation from sprinkler and flood irrigation.

Kansas – Return flow from groundwater irrigation was calculated by subtracting the net pumping from the gross pumping. Once the county monthly pumping and return flow values were calculated, they were distributed to the sections within the county using the annual well count and irrigated acreage. A section's percentage of the county's total irrigated acreage was calculated and multiplied by the county pumping and return flows to obtain values for the section

Nebraska – Based on professional judgment, Nebraska has assumed recharge rates that are generally inverse to assumed farm efficiency. From 1940-1970, recharge is assumed to be 30% of pumping, a value representative of gravity irrigation. Thereafter efficiency is assumed to increase, and recharge to decrease, with implementation of sprinkler irrigation and improvements to gravity irrigation systems. The recharge rate is assumed to be 20% in 2000, and the annual values 1970-2000 are determined by interpolation.

## **SURFACE WATER IRRIGATION RECHARGE**

Estimates of surface water recharge that were used in the RRCA Ground Water Model are calculated as follows:



1. Forty (40) percent of diversions for small non-federal ditches and canals.
2. Twenty-five (25) percent for small surface water pumping plants.
3. As provided by the United States Bureau of Reclamation for federal irrigation projects (reference Section IV.A.2.c in the RRCA Accounting Procedures).

### **PHREATOPHYTES**

The potential evapotranspiration rate for the various classifications of phreatophyte vegetation (forest, woody, and marsh) was collapsed into a single ET rate obtained from CROPSIM (Martin, 1984) results for the Akron, McCook, and Red Cloud climate stations on a monthly time step. The maximum phreatophyte ET rate elevation is set at two (2) feet below ground surface and the extinction depth is at twelve (12) feet below the ground surface. For the initial ground water model runs, the change or encroachment of phreatophytes over time was adjusted in accordance with the curvilinear time-relationship developed from aerial photographic data provided by Michaela Johnson in a published Master's Thesis (Johnson, 2001). The method to quantify the aerial coverage of phreatophytes and the distribution over time is subject to review and adoption by the RRCA Ground Water Modeling Committee, upon unanimous agreement.

Colorado – The Colorado Gap Analysis Project (CO-GAP) was initiated in 1991 as a cooperative effort among federal, state, and private natural resource groups in Colorado. The major objectives of the project are to: map actual land cover as closely as possible and make all GAP Project

information available to users in a readily accessible format to institutions, agencies, and private land owners. Landsat imagery was acquired or interpreted to establish a baseline map of vegetation and land cover. Attributes were assigned to each polygon describing primary, secondary, and other land cover, crown closure for forested primary types, and the types of wetlands and/or disturbance found in the polygon, if any. Polygon attributes were assigned using image interpretation, existing maps, field reconnaissance, digital reference layers from Federal land management agencies, and literature sources.

Kansas – Landsat TM7 imagery from 2000 was obtained covering most of the RRCA Ground Water Model area, except for the far south-central and far-eastern portions. Tributaries with visible phreatophyte cover were mapped as a subset of the hydrographic drainage network available as a digital line graph from the USGS. Tributaries were then divided according to the relative width of the riparian cover. Within each of these discrete reaches, cross sections from the outside boundaries of the riparian vegetation were then mapped and the average cross section within the reach was calculated. One-half of this average cross section was used as the distance from the hydrographic channel mapped by the USGS to map a polygon to enclose the riparian phreatophyte corridor along the reach. These polygons were merged with the Nebraska polygons denoting woody phreatophytes because some areas mapped as woody phreatophytes lay well outside of the riparian corridor. For evaluation of the change in phreatophyte ET over time, Kansas is using two techniques: (1) the Normalized Difference Vegetation Index (NDVI) satellite index to evaluate the change in relative water use between 1974 and 2000 on selected major tributaries, and (2) a time series of air photos for 16

main stem and tributary locations spread throughout the basin on which the vegetation will be evaluated using intercept methods

Nebraska – the Nebraska Department of Natural Resources (NDNR), in association with the Nebraska Conservation and Survey Division maintain a collection of digitally rectified aerial photography for landscape analysis. This data has a resolution of 20-ft. and was projected in UTM, Nad83. The NDNR digitized the 1993 Digital Orthophoto Quarter Quadrangle to identify phreatophyte forests from visual examination of the black and white aerial photography at a scale of 1:15,000. Polygons were fit over the photographs in ESRI's Arc View GIS then re-projected into the RRCA Groundwater Model projection (UTM, Nad27). Approximately 100 sites were visually inspected during field reconnaissance to verify the distribution of woody phreatophytes obtained from the aerial photography. The polygon output provided by Kansas was combined with the aerial photography analysis by Nebraska to include wetland areas in the minor tributaries, with corrections to exclude polygons of irrigated croplands. To accommodate the synoptic biases due to scale, polygon correction was performed at a scale of 1:50,000. Polygons to represent the phreatophyte areas downstream of Red Cloud, Nebraska and the extended groundwater mound area in Kearney and Adams County, Nebraska were derived from aerial photography at a scale of 1:50,000.

#### **CALIBRATION PARAMETERS**

Calibration parameters are physical, climatic, and/or aquifer properties that can be adjusted to so that the mathematical representation of a ground water model

better represents actual conditions. Selection of final values for calibration parameters requires consideration of the match between model outputs and calibration targets, and whether such values are reasonable considering geologic, climatic, and other conditions in the Basin. Calibration parameters may vary in a spatial context to reflect different physical and/or geographic conditions. The two principal calibration parameters used in application to the RRCA Groundwater Model are hydraulic conductivity and precipitation recharge.

Hydraulic Conductivity: hydraulic conductivity may be defined as the measure of the ease in which water can be transmitted through a porous material, i.e. flow through an aquifer. The hydraulic conductivity values applied in the model are based upon professional expertise and vary across the model domain. The values were distributed spatially using a parameter estimation (PEST) algorithm. Hydraulic conductivity will continue to be refined and statistically distributed throughout the model domain during the calibration process.

Precipitation Recharge: the amount of precipitation that percolates into the ground water aquifer is expressed as a percentage of effective precipitation and is segmented into monthly distributions. Two general soil classifications were identified with the following preliminary precipitation recharge rates: 4% of annual precipitation for sandy soils, and 1% for non-sandy soils, distributed throughout the year. The precipitation recharge rates may change upon final model calibration. An empirical relationship to reflect the non-linear precipitation/recharge rate was developed to satisfy the physical reality that the recharge rate increases in a curvilinear function with increasing precipitation. In general, the relationship adopted for the

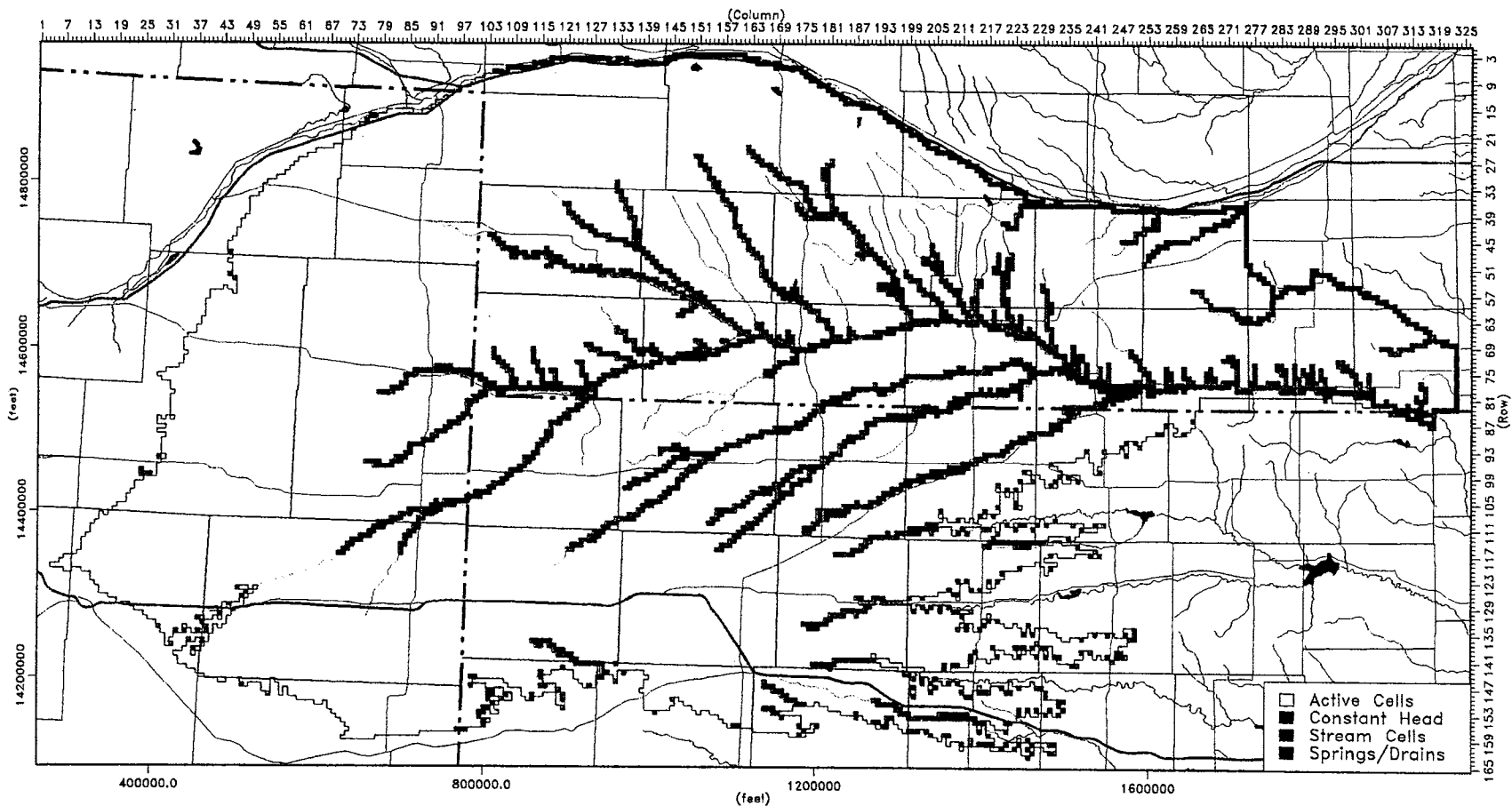
calibrated model will be expected to corroborate the basin water budget and the space and time distribution of both runoff and recharge.

Lesser calibration parameters that are used to further refine the ground water model include:

- Canal seepage: will be calculated using a water budget approach of the basic form: *Seepage is equal to Diversions minus Net Evaporation minus Other Net Outflows minus Change in Storage*, when adequate data is available. If only diversions are known, canal seepage will be estimated using the unit loss rates calculated by nearby canals that have sufficient data to employ the water budget approach.
  - Phreatophyte potential evapotranspiration rate is indexed to the Red Cloud, Nebraska and Akron, Colorado climate stations with annual rates of 18-36 inches and 30-48 inches respectively. The annual potential evapotranspiration rates were kriged across the model domain.
  - Specific yield estimates will continue to be refined during model calibration.
  - Residuals: it is recognized that the calibrated model may not perfectly match all the calibration targets, and that residuals (differences between model predictions and target values) may be positive in some sub-basins and negative in others. If necessary, the RRCA Ground Water Modeling Committee will codify a procedure that fairly distributes the residuals among contributory sub-basins and among the three States.
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J2-1

# RRCA Ground Water Model Domain



## SUMMARY OF ESTIMATED BASEFLOW (October 14, 2002 version)

stations sorted by 1) state where gage is located, and 2) name of gage

Index	USGS Station Number	Gage Name	Period of Record Used to Estimate Baseflow for MODFLOW Calibration	State Where Gage is Located	Drainage Area (mi <sup>2</sup> )	Name of Baseflow File	Major Component of Streamflow	Comments on Gage	Baseflow Represents	Surface Water Diversions NOT Accounted For in Baseflow Analysis (ac-ft/yr)	Average Baseflow for 1940-2000 or period of record (ac-ft/yr)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	6825500	Landsman Creek Near Hale, CO	5/19/1950-8/29/1976	CO	268	CO - Landsman Creek nr Hale, Co1 - 6825500.xls	Baseflow and Surface Runoff	None	Total baseflow generated from basin upstream of gage		600
2	6823000	North Fork Republican River at CO-NE Stateline	10/1/1939-9/30/2000	CO	2,370	CO - N Fork Rep at Co-Ne Stateline1 - 6823000.xls	Baseflow	Gage adjusted for Laird and Pioneer Ditch diversions	Total baseflow generated from basin upstream of gage		40,000
3	6822000	North Fork Republican River Near Wray, CO	10/1/1939-9/30/1946, 10/1/1951-9/30/1957, 10/1/1962-9/30/1964	CO	1,019	CO - N Fork nr Wray, Co1 6822000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		15,000
4	6827000	South Fork Republican River Near Co-Ks State Line	11/7/1945-7/5/1950; 5/1/1951-9/2/1956	CO	1,860	CO - S Fork near Co-Ks Stateline3 - 6827000.xls	Baseflow and Surface Runoff	Gage must be adjusted for Hale Ditch Diversions 1945-6/1950 when data becomes available. No gage below Bonny reservoir 7/1950-4/1951. First storage in Bonny 7/6/1950.	Baseflow at gage 1945-6/1950 represents total baseflow generated from basin upstream of gage. Baseflow 5/1951-1956 represents baseflow gain Bonny to Gage		25,000 before Bonny started storing; 3,000 gain Bonny to Stateline after Bonny started storing
5	6825000	South Fork Republican River Near Idalia, CO	5/19/1950-9/8/1971	CO	1,300	CO - S Fork Rep nr Idalia, Co2 - 6825000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		16,000
6	6846500	Beaver Creek at Cedar Bluffs, KS	5/13/1946-9/30/2000	KS	1,618	KS - Beaver Cr at Cedar Bluffs, Ks1 - 6846500.xls	Surface Runoff	Flows may be modified by Atwood Lake upstream. No daily records exist.	Total baseflow generated from basin upstream of gage		1,300
7	6846000	Beaver Creek at Ludell, KS	10/1/1945-9/30/1953 10/1/1995-9/30/2000	KS	1,411	KS - Beaver Cr at Ludell, Ks1 - 6846000.xls	Surface Runoff	Flows may be modified by Atwood Lake upstream. No daily records exist.	Total baseflow generated from basin upstream of gage		3,100
8	6846300	Beaver Creek near Herndon, KS	10/1/1962-9/30/1969	KS	1,535	KS - Beaver Cr nr Herndon, Ks1 - 6846300.xls	Surface Runoff	Flows may be modified by Atwood Lake upstream. No daily records exist.	Total baseflow generated from basin upstream of gage		3,000
9	6847900	Prairie Dog Creek above Keith Selbelius Lake, KS	6/12/1962-9/30/2000	KS	590	KS - Prairie Dog Crk abv KSeb Lake, Ks1 - 6847900.xls	Surface Runoff	One authorized surface diversion exists upstream. Limited surface diversions may occur during the irrigation season but no daily records exist. First storage in Keith Selbelius Lake was Oct 1964.	Total baseflow generated from basin upstream of gage		1,600
10	6848000	Prairie Dog Creek at Norton, KS	4/1/1944-10/1/1964	KS	684	KS - Prairie Dog Crk at Norton, Ks1 - 6848000.xls	Baseflow and Surface Runoff	First storage in Keith Selbelius Lake October 1964. Gage data not used in baseflow analysis after October 1964 due to upstream reservoir storage.	Total baseflow generated from basin upstream of gage		3,500
11	6848500	Prairie Dog Creek near Woodruff, Ks	5/11/1945-9/30/2000	KS	1,007	KS - Prairie Dog Crk nr Woodruff, Ks1 - 6848500.xls	Baseflow and Surface Runoff	First storage in Keith Selbelius Lake October 1964.	Baseflow at gage prior to 9/30/1964 represents total baseflow generated from basin upstream of gage. Baseflow after 9/30/1964 represents baseflow gain Norton to Woodruff		Total prior to 9/30/1964 = 3,200, Gain after = 1,600
12	6845110	Sappa Creek near Lyle, KS	10/1/1995-9/30/2000	KS	1,488	KS - Sappa Cr nr Lyle, Ks1 - 6845110.xls	Surface Runoff	Limited surface diversions may occur upstream during the irrigation season but no daily records exist.	Total baseflow generated from basin upstream of gage		8,700
13	6845000	Sappa Creek near Oberlin, KS	6/22/1944-9/30/1972; 10/1/1995-9/30/2000	KS	1,086	KS - Sappa Cr nr Oberlin, Ks1 - 6845000.xls	Surface Runoff	No authorized surface diversions exist upstream.	Total baseflow generated from basin upstream of gage		900
14	6844900	South Fork Sappa Creek Near Achilles, KS	7/1/1959-9/30/2000	KS	446	KS - South Fork Sappa Cr nr Achilles, Ks1 - 6844900.xls	Surface Runoff	No authorized surface diversions exist upstream.	Total baseflow generated from basin upstream of gage		100
15	6844700	South Fork Sappa Creek Near Brewster, KS	10/1/1967-6/30/1987	KS	74	KS - South Fork Sappa Cr nr Brewster, Ks1 - 6844700.xls	Surface Runoff	No known surface water diversions above this point.	Total baseflow generated from basin upstream of gage		0
16	6821500	Arikaree River at Haigler, NE	10/1/1939-9/30/2000	NE	1,700	NE - Arikaree at Haigler, Ne3 - 6821500.xls	Surface Runoff	None	Total baseflow generated from basin upstream of gage		5,000
17	6847000	Beaver Creek near Beaver City, NE	10/1/1939-7/31/1999	NE	2,080	NE - Beaver Cr nr Beaver City, Ne1 - 6847000.xls	Surface Runoff	None	Total baseflow generated from basin upstream of gage		1,900
18	6836000	Blackwood Creek near Culbertson, NE	6/1/1946-9/30/1986	NE	320	NE - Blackwood Cr nr Culbertson, Ne1 - 6836000.xls	Baseflow and Surface Runoff	None	Total baseflow generated from basin upstream of gage		1,000
19	6839500	Brushy Creek near Maywood, NE	5/1/1951-9/30/1958	NE	130	NE - Brushy Creek nr Maywood, Ne1 - 6839500.xls	Baseflow and Surface Runoff	None	Total baseflow generated from basin upstream of gage		300
20	6823500	Buffalo C nr Haigler, NE	10/7/1940-9/20/2000	NE	172	NE - Buffalo Cr near Haigler, Ne1 - 6823500.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		4,300

## SUMMARY OF ESTIMATED BASEFLOW (October 14, 2002 version)

stations sorted by 1) state where gage is located, and 2) name of gage

Index	USGS Station Number	Gage Name	Period of Record Used to Estimate Baseflow for MODFLOW Calibration	State Where Gage is Located	Drainage Area (mi <sup>2</sup> )	Name of Baseflow File	Major Component of Streamflow	Comments on Gage	Baseflow Represents	Surface Water Diversions NOT Accounted For in Baseflow Analysis (ac-ft/yr)	Average Baseflow for 1940-2000 or period of record (ac-ft/yr)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
21	6851000	Center Creek at Franklin, NE	4/1/1948-9/30/1956, 10/1/1968-9/21/1975, 10/6/1977-12/31/1994	NE	177	NE - Center Cr at Franklin, Ne1 - 6851000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		4,000
22	6850200	Cottonwood Creek near Bloomington, NE	4/1/1948-9/30/1956	NE	16	NE - Cottonwood Cr nr Bloomington, Ne1 - 6850200.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		3,200
23	6836500	Driftwood Creek near McCook, NE	4/17/1946-9/30/2000	NE	361	NE - Driftwood Cr nr McCook, Ne1 - 6836500.xls	Baseflow and Surface Runoff	None	Total baseflow generated from basin upstream of gage		2,500
24	6852000	Elm Creek at Amboy, NE	10/6/1948-9/14/1953, 10/8/1977-9/24/1999	NE	39	NE - Elm Creek at Amboy, Ne1 - 6852000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		9,900
25	6840000	Fox Creek at Curtis, NE	4/1/1951-9/30/1958, 10/1/1977-9/22/1991, 10/16/1992-12/31/1994	NE	75	NE - Fox Cr at Curtis, Ne1 - 6840000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		3,800
26	n/a	Frenchman Creek - Gain-Loss Enders Gage to Palisade Gage, NE	6/30/1950-12/31/1994	NE	160	NE - Frenchman Cr - Gain-Loss Enders to Palisade, Ne1	Stream Gain or Loss	None	Baseflow represents baseflow gain from Enders Gage to the Palisade Gage		Baseflow = 13,600 Total gain = 17,000
27	n/a	Frenchman Creek - Gain-Loss Palisade Gage to Culbertson Gage, NE	7/1/1950-9/15/1999	NE	1,690	NE - Frenchman Cr - Gain-Loss Palisade to Culbertson, Ne1	Stream Gain or Loss	Gage adjusted for Culbertson Canal, Riverside Canal, and Stinking Water Creek Inflow	Baseflow represents baseflow gain from Palisade Gage to the Culbertson Gage		Baseflow = 8,000 Total gain = 12,000
28	6835500	Frenchman Creek at Culbertson, NE	10/1/1939-9/30/1949	NE	2,990	NE - Frenchman Cr at Culbertson, Ne2 - 6835500.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		80,000
29	6830500	Frenchman Creek near (above) Champion, NE	10/1/1939-5/31/1940	NE	910	NE - Frenchman Cr nr Champion, Ne1 - 6830500.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		7,500
30	6833500	Frenchman Creek near Hamlet, NE	10/1/1939-9/30/1956	NE	1,270	NE - Frenchman Cr nr Hamlet, Ne1 - 6833500.xls	Baseflow	Initial storage at Frenchman Reservoir was October 23, 1950	Total baseflow generated from basin upstream of gage		65,000
31	6831500	Frenchman Creek near Imperial, NE	1/1/1941-9/30/1994	NE	1,050	NE - Frenchman Cr nr Imperial, Ne1 - 6831500.xls	Baseflow	Gage adjusted for Champion Canal diversions	Total baseflow generated from basin upstream of gage		37,000
32	6841000	Medicine Creek above Harry Strunk Lake, NE	2/1/1950-9/30/1999	NE	770	NE - Medicine Cr abv Harry Strunk Lake, Ne1 - 6841000	Baseflow	First storage in Harry Strunk Lake was August 8, 1949.	Total baseflow generated from basin upstream of gage		34,000
33	6839000	Medicine Creek at Maywood, NE	5/1/1951-9/30/1958	NE	231	NE - Medicine Cr at Maywood, Ne1 - 6839000.xls	Baseflow	First storage in Harry Strunk Lake was August 8, 1949.	Total baseflow generated from basin upstream of gage		15,000
34	6841500	Mitchell Creek above Harry Strunk Lake, NE	5/1/1950-9/30/1974	NE	52	NE - Mitchell Cr abv Harry Strunk Lake, Ne1 - 6841500	Surface Runoff	None	Total baseflow generated from basin upstream of gage		0
35	6844000	Muddy Creek at Arapahoe, NE	1/1/1951-9/30/1972, 10/1/1977-12/22/1994	NE	246	NE - Muddy Cr at Arapahoe, Ne2 - 6844000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		4,300
36	n/a	Red Willow Creek - Gain-Loss Below Hugh Butler Reservoir to Red Willow, NE	10/16/1940-5/31/1947, 10/13/1960-9/30/1993	NE	Unknown	NE - Red Willow Cr - Gain-Loss H Butler Res to Red Willow, Ne1.xls	Stream Gain or Loss	Gains are adjusted for Red Willow Canal diversions. First Storage in Hugh Butler Reservoir was September 5, 1961.	Baseflow represents baseflow gain from Below Hugh Butler Reservoir to Red Willow near Red Willow gage		2,000
37	6837300	Red Willow Creek above Hugh Butler Lake, NE	10/1/1960-9/30/2000	NE	Unknown	NE - Red Willow Cr abv Hugh Butler Lake, Ne1 - 6837300.xls	Baseflow	First Storage in Hugh Butler Reservoir was September 5, 1961.	Total baseflow generated from basin upstream of gage		12,500
38	n/a	Republican River - Gain-Loss Below Harlan to Guide Rock, NE	12/1/1952-9/30/2000	NE	1,220	NE - Republican River - Gain-Loss Blw Harlan to Guide Rock, Ne2.xls	Stream Gain or Loss	Gains are adjusted for Franklin Pump, Courtland Canal, and Superior Canal	Baseflow represents baseflow gain from below Harlan County Reservoir to the Republican River at Guide Rock gage		Baseflow = 53,000 Total Gain=107,000
39	n/a	Republican River - Gain-Loss Below Swanson Reservoir to McCook Gage, NE	10/21/1954-9/30/1993	NE	Unknown	NE - Republican River - Gain-Loss Blw Swanson Res to McCook, Ne2.xls	Stream Gain or Loss	Gain adjusted for Frenchman at Culbertson Gage and Driftwood at McCook Gage	Baseflow represents baseflow gain from below Swanson Reservoir to McCook Gage		Baseflow = 6,000 Total gain = 16,000
40	n/a	Republican River - Gain-Loss Benkleman to Swanson, NE	7/31/1950-9/30/1994	NE	Unknown	NE - Republican River - Gain-Loss Benkleman to Swanson, Ne2.xls	Stream Gain or Loss	None	Baseflow represents baseflow gain from Benkleman gages (Republican and South Fork) to Stratton gage		Baseflow = -8,100 Total gain = 1,200



## SUMMARY OF ESTIMATED BASEFLOW (October 14, 2002 version)

stations sorted by 1) state where gage is located, and 2) name of gage

Index (1)	USGS Station Number (2)	Gage Name (3)	Period of Record Used to Estimate Baseflow for MODFLOW Calibration (4)	State Where Gage is Located (5)	Drainage Area (mi <sup>2</sup> ) (6)	Name of Baseflow File (7)	Major Component of Streamflow (8)	Comments on Gage (9)	Baseflow Represents (10)	Surface Water Diversions NOT Accounted For in Baseflow Analysis (ac-ft/yr) (11)	Average Baseflow for 1940-2000 or period of record (ac-ft/yr) (12)
41	n/a	Republican River - Gain-Loss Cambridge Gage to Orleans Gage, NE	10/8/1947-9/30/2000	NE	1,120	NE - Republican River - Gain-Loss Cambridge to Orleans, Ne2.xls	Stream Gain or Loss	Gain adjusted for Cambridge Canal diversions. Gain includes inflow from several tributaries.	Baseflow represents baseflow gain from Cambridge Gage to Orleans Gage		Baseflow = 5,200 Total gain = 31,000
42	n/a	Republican River - Gain-Loss Guide Rock Gage to Hardy Gage, NE	9/3/1950-9/30/2000	NE	360	NE - Republican River - Gain-Loss Guide Rock to Hardy, Ne2.xls	Stream Gain or Loss	None	Baseflow represents baseflow gain from Guide Rock Gage to Hardy Gage		Baseflow = 16,000 Total gain = 57,000
43	n/a	Republican River - Gain-Loss McCook Gage to Cambridge Gage, NE	10/23/1954-9/11/1999	NE	2,220	NE - Republican River - Gain-Loss McCook to Cambridge, Ne2.xls	Stream Gain or Loss	Gain adjusted for Red Willow near Red Willow Gage, Medicine Creek Below Harry Strunk Lake Gage, and Bartley Canal	Baseflow represents baseflow gain from McCook Gage to Cambridge Gage		Baseflow = -3,900 Total gain = 11,000
44	6830000	Republican River at (nr) Culbertson, NE	10/1/1939-9/30/1949	NE	8,450	NE - Republican River at (nr) Culbertson, Ne1 - 6830000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		50,000
45	6824500	Republican River at Benkelman, NE	1/16/1947-9/30/1994	NE	4,880	NE - Republican Riv at Benkelman, Ne1 - 6824500.xls	Baseflow	Gage adjusted for Pioneer and Laird Canals	Total baseflow generated from basin upstream of gage		56,000
46	6828000	Republican River at Max, NE	10/1/1939-9/30/1945	NE	7,740	NE - Republican Riv at Max, Ne1 - 6828000.xls	Baseflow and Surface Runoff	None	Total baseflow generated from basin upstream of gage		77,000
47	6850500	Republican River near Bloomington, NE	10/1/1939-8/8/1949	NE	21,020	NE - Republican Riv nr Bloomington, Ne1 - 6850500.xls	Baseflow and Surface Runoff	First storage in BOR reservoirs in Republican River basin was August 8, 1949 at Harry Strunk Lake	Total baseflow generated from basin upstream of gage		270,000
48	6853500	Republican River near Hardy, NE	10/1/1939-8/8/1949	NE	22,401	NE - Republican Riv nr Hardy, Ne1 - 6853500.xls	Baseflow and Surface Runoff	First storage in BOR reservoirs in Republican River basin was August 8, 1949 at Harry Strunk Lake	Total baseflow generated from basin upstream of gage		284,000
49	6824000	Rock Creek at Parks, NE	10/7/1940-9/16/2000	NE	24	NE - Rock Creek at Parks, Ne1 - 6824000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		8,600
50	6845200	Sappa Creek near Beaver City, NE	10/1/1939-9/29/1972	NE	1,500	NE - Sappa Cr nr Beaver City, Ne2 - 6845200.xls	Baseflow and Surface Runoff	None	Total baseflow generated from basin upstream of gage		2,100
51	6847500	Sappa Creek near Stamford, NE	1/21/1946-9/30/2000	NE	3,840	NE - Sappa Cr nr Stamford, Ne1 - 6847500.xls	Surface Runoff	None	Total baseflow generated from basin upstream of gage		3,900
52	6827500	South Fork Republican River near Benkelman, NE	10/1/1939-9/30/2000	NE	2,740	NE - S Fork Rep nr Benkelman, Ne2 - 6827500.xls	Baseflow and Surface Runoff	Construction of Bonny Dam began December 8, 1948 and was completed May 4, 1951. First storage was July 8, 1950.	1940-48 baseflow is total baseflow generated from basin upstream of gage. 5/1951-2000 baseflow is baseflow gain Bonny to Benkelman		16,000 Before Bonny; 3,600 gain Bonny to Benkelman
53	6835000	Stinking Water Creek near Palisade, NE	10/7/1949-9/30/2000	NE	1,500	NE - Stinking Water Cr nr Palisade, Ne1 - 6835000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		21,000
54	6834500	Stinking Water Creek near Wauneta, NE	10/1/1940-9/30/1950	NE	1,330	NE - Stinking Water Cr nr Wauneta, Ne2 - 6834500.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		14,000
55	6851500	Thompson Creek at Riverton, NE	4/1/1948-9/23/1956, 10/6/1968-9/21/1975, 10/6/1977-9/30/1999	NE	290	NE - Thompson Cr at Riverton, Ne1 - 6851500.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		14,000
56	6844210	Turkey Creek at Edison, NE	10/15/1977-9/30/2000	NE	75	NE - Turkey Cr at Edison, Ne1 - 6844210.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		5,700
57	6850000	Turkey Creek at Naponee, NE	4/1/1948-9/30/1953	NE	129	NE - Turkey Creek at Naponee, Ne1 - 6850000.xls	Baseflow	None	Total baseflow generated from basin upstream of gage		8,200

J3-4

Estimated Baseflow - Landsman Creek near Hale, Colo. (#825500)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950									40	54	59	52	204
1951	81	81	83	87	78	85	90	79	59	72	71	87	945
1952	77	94	111	120	118	132	158	85	38	30	27	28	848
1953	38	52	72	85	96	115	104	84	59	38	23	23	801
1954	44	81	107	116	109	121	99	83	34	22	15	14	825
1955	24	43	84	84	81	81	71	68	52	28	22	32	852
1956	43	49	58	80	83	81	77	83	48	33	23	17	810
1957	35	74	86	84	83	90	84	83	74	87	80	58	895
1958	80	123	149	142	127	144	124	91	85	58	57	60	1,220
1959	72	83	88	110	109	132	114	77	48	38	34	38	854
1960	80	64	75	76	74	87	83	78	56	31	17	17	707
1961	28	46	61	86	67	81	81	82	68	39	28	28	673
1962	38	52	65	71	88	78	89	59	45	34	27	28	828
1963	36	52	63	63	58	66	57	43	27	14	16	33	530
1964	48	55	87	77	74	72	82	58	47	38	28	13	838
1965	10	14	28	44	48	53	51	52	48	45	48	58	498
1966	67	68	72	73	67	76	60	30	12	13	11	7	556
1967	16	33	47	55	53	58	54	51	37	17	7	9	438
1968	17	28	42	55	57	59	48	31	22	25	24	20	428
1969	17	14	23	45	52	82	50	28	11	7	9	15	331
1970	24	35	43	45	48	67	60	38	20	15	13	12	419
1971	13	12	19	32	33	33	27	23	18	12	10	12	244
1972	14	15	14	10	9	13	20	33	38	30	24	20	238
1973	19	20	21	21	25	41	40	25	18	17	18	16	277
1974	17	17	21	28	30	43	40	26	16	13	12	12	274
1975	18	21	22	18	12	14	14	13	15	20	21	18	202
1976	17	17	17	14	13	17	15	10	7	7			136
1977													
1978													
1979													
1980													
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1982													
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2000													
Avg 1950-1976	35	48	59	65	64	73	66	52	38	30	27	27	565
Avg 1950-1964	45	68	84	80	88	98	87	71	61	40	34	34	749
Avg 1965-1976	20	25	31	36	37	45	40	30	21	19	18	18	357

J3-5

Estimated Baseflow - North Fork of Republican River at the Colo-Neb Stateline (6823000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	3,381	3,186	3,315	3,456	3,401	3,893	3,604	3,177	2,654	2,432	2,643	2,999	38,011
1941	3,403	3,335	3,462	3,541	3,276	3,759	3,590	3,454	3,053	2,808	2,766	2,954	39,431
1942	3,405	3,702	4,044	4,053	3,598	3,821	3,580	3,565	3,315	3,260	3,335	3,545	43,203
1943	3,879	3,848	4,001	3,845	3,481	3,751	3,437	3,283	2,870	2,858	2,552	2,580	40,276
1944	2,854	2,990	3,284	3,515	3,449	3,801	3,703	3,753	3,851	3,898	4,060	4,125	43,030
1945	4,305	4,047	4,075	3,983	3,443	3,541	3,282	3,385	3,273	3,382	3,457	3,495	43,688
1946	3,853	3,464	3,538	3,533	3,175	3,485	3,290	3,255	3,069	3,156	3,442	3,908	40,967
1947	4,205	3,802	3,770	3,733	3,288	3,472	3,348	3,627	3,580	3,605	3,740	3,962	44,110
1948	4,254	4,078	4,113	3,847	3,560	3,886	3,450	3,445	3,273	3,382	3,457	3,495	44,138
1949	3,715	3,848	3,792	3,789	3,858	4,272	4,295	4,411	4,219	4,283	4,271	4,190	48,443
1950	4,340	4,151	4,256	4,207	3,795	4,105	3,870	3,858	3,757	4,159	4,325	4,227	49,999
1951	4,304	3,986	3,979	3,853	3,414	3,781	3,703	3,987	3,880	3,680	3,859	3,827	46,442
1952	4,074	4,082	4,295	4,301	4,036	4,336	4,043	3,821	3,488	3,471	3,481	3,502	46,807
1953	3,747	3,739	3,956	4,023	3,559	3,682	3,318	3,183	2,833	2,857	2,717	3,029	40,440
1954	3,582	3,948	4,283	4,219	3,811	3,598	3,168	3,048	2,858	3,009	3,198	3,410	41,839
1955	3,742	3,728	3,919	3,950	3,810	4,065	3,803	3,571	3,174	3,064	3,166	3,544	43,354
1956	3,912	3,801	3,833	3,935	3,689	3,895	3,808	3,408	3,081	3,064	3,253	3,645	43,206
1957	4,085	4,075	4,198	4,045	3,865	4,257	4,257	4,470	4,183	3,938	3,752	3,870	48,598
1958	3,906	3,864	4,268	4,426	4,089	4,089	4,301	4,131	3,774	3,762	3,892	4,165	49,248
1959	4,466	4,235	4,234	4,037	3,572	3,898	3,918	4,098	4,000	4,149	4,151	4,094	48,890
1960	4,284	4,202	4,388	4,354	4,055	4,307	4,141	4,251	4,028	4,001	3,978	3,984	49,925
1961	4,145	3,987	4,181	4,272	3,914	4,342	4,203	4,334	4,034	3,830	3,834	4,087	48,121
1962	4,324	4,053	4,091	4,033	3,621	4,021	3,920	4,100	3,980	4,085	4,033	3,828	48,089
1963	4,005	4,048	4,281	4,296	3,833	4,111	3,758	3,554	3,150	2,987	3,027	3,283	44,334
1964	3,682	3,707	3,938	3,985	3,750	4,009	3,793	3,732	3,281	2,876	2,767	2,993	42,467
1965	3,365	3,484	3,813	4,068	3,774	4,132	3,888	3,758	3,365	3,149	3,168	3,444	43,367
1966	3,828	3,840	4,058	4,099	3,698	4,039	3,603	3,138	2,831	3,450	3,675	3,566	43,830
1967	3,678	3,830	3,685	3,789	3,572	3,493	3,338	3,622	3,455	3,289	3,125	3,051	41,403
1968	3,308	3,473	3,741	3,780	3,440	3,481	3,348	3,639	3,452	3,220	3,083	3,073	41,016
1969	3,289	3,256	3,453	3,536	3,283	3,850	3,528	3,573	3,313	3,186	3,180	3,310	40,503
1970	3,717	3,842	4,178	4,018	3,829	3,846	3,573	3,440	3,010	2,896	2,682	2,997	41,629
1971	3,426	3,548	3,853	3,988	3,608	3,848	3,557	3,479	3,069	2,741	2,728	3,060	40,902
1972	3,518	3,672	3,947	3,972	3,629	3,855	3,378	3,390	3,146	3,087	3,008	2,998	41,372
1973	3,298	3,521	3,838	3,881	3,547	3,978	3,802	3,772	3,425	3,222	3,169	3,290	42,757
1974	3,634	3,745	4,041	4,146	3,784	4,081	3,846	3,281	2,739	2,468	2,504	2,813	40,830
1975	3,278	3,499	3,794	3,806	3,446	3,821	3,688	3,711	3,197	2,532	2,280	2,507	39,538
1976	2,886	3,357	3,723	3,741	3,401	3,390	3,036	2,882	2,484	2,216	2,195	2,452	35,677
1977	2,886	3,088	3,481	3,677	3,401	3,718	3,460	3,335	2,883	2,525	2,448	2,998	37,586
1978	3,062	3,186	3,382	3,382	3,013	3,254	2,986	2,888	2,529	2,250	2,129	2,184	34,203
1979	2,429	2,556	2,841	2,420	2,211	2,798	2,793	2,800	2,563	2,424	2,384	2,482	30,441
1980	2,783	3,002	3,317	3,425	3,177	3,214	2,950	2,804	2,671	2,615	2,678	2,564	35,198
1981	2,791	2,907	3,125	3,152	2,930	3,413	3,314	3,255	2,987	2,817	2,907	2,968	36,987
1982	3,178	3,135	3,224	3,125	2,757	3,003	2,959	3,230	3,109	2,985	2,930	2,964	36,599
1983	3,231	3,328	3,536	3,523	3,248	3,789	3,553	3,272	2,910	2,890	2,804	2,998	36,727
1984	2,677	2,487	2,811	3,423	3,338	3,674	3,593	3,270	2,836	2,702	2,794	3,121	37,123
1985	3,488	3,457	3,607	3,588	3,208	3,493	3,145	2,804	2,582	2,674	3,098	3,219	36,558
1986	3,463	3,390	3,537	3,564	3,192	3,435	3,162	3,028	2,720	2,818	2,819	2,740	37,467
1987	2,992	3,000	3,153	3,150	2,838	3,475	3,439	3,461	2,983	2,387	2,195	2,484	35,835
1988	2,834	2,929	3,035	2,838	2,703	3,219	3,098	2,795	2,457	2,448	2,518	2,897	33,527
1989	2,944	2,950	3,172	3,221	2,945	3,281	3,001	2,864	2,472	2,163	2,193	2,372	33,216
1990	2,870	2,757	2,984	3,108	2,849	3,128	2,809	2,753	2,429	2,397	2,212	2,384	32,349
1991	2,574	2,765	3,023	3,088	2,818	3,178	3,082	3,184	2,960	2,672	2,632	2,329	34,498
1992	2,481	2,794	3,187	3,380	3,175	3,210	2,820	2,499	2,230	2,354	2,413	2,400	32,942
1993	2,504	2,403	2,524	2,632	2,552	3,128	3,098	3,008	2,638	2,341	2,351	2,692	31,867
1994	3,044	3,033	3,136	3,047	2,685	2,911	2,706	2,624	2,338	2,161	2,153	2,328	32,162
1995	2,570	2,556	2,857	2,908	2,387	2,775	2,820	3,056	2,805	2,413	2,241	2,333	31,223
1996	2,675	2,840	3,191	3,126	2,791	2,780	2,453	2,344	2,121	2,081	2,177	2,410	31,060
1997	2,724	2,782	2,803	2,495	2,110	2,337	2,246	2,287	2,101	1,968	1,877	1,855	27,581
1998	2,041	2,181	2,368	2,384	2,197	2,522	2,421	2,357	2,102	1,941	1,843	1,828	26,185
1999	2,185	2,582	2,985	3,081	2,831	3,143	2,825	2,438	1,958	1,888	1,597	1,712	29,013
2000	1,972	2,134	2,403	2,588	2,428	2,479	2,193	1,949	1,734	1,810	1,887	1,957	25,512
Avg 1940-2000	3,362	3,393	3,590	3,610	3,294	3,596	3,389	3,323	3,032	2,930	2,933	3,054	36,505
Avg 1960-1984	4,039	3,991	4,148	4,129	3,743	4,070	3,863	3,836	3,596	3,529	3,585	3,653	46,139
Avg 1985-2000	2,843	2,749	2,944	2,951	2,707	2,989	2,818	2,695	2,390	2,234	2,195	2,291	31,618

J3-6

Estimated Baseflow - North Fork of Republican River near Wray, Co. (8922000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	1,166	1,232	1,356	1,415	1,345	1,422	1,304	1,208	1,024	605	921	1,081	14,377
1941	1,243	1,284	1,334	1,360	1,244	1,385	1,342	1,362	1,274	1,185	1,149	1,177	15,330
1942	1,274	1,276	1,369	1,415	1,285	1,389	1,306	1,312	1,178	1,094	1,041	1,121	15,037
1943	1,266	1,320	1,364	1,323	1,178	1,332	1,290	1,308	1,166	1,024	942	938	14,469
1944	1,067	1,196	1,356	1,427	1,357	1,423	1,358	1,394	1,281	1,121	1,032	1,011	15,003
1945	1,161	1,339	1,477	1,438	1,252	1,325	1,278	1,382	1,383	1,460	1,464	1,393	18,348
1946	1,431	1,394	1,397	1,299	1,118	1,208	1,171	1,247	1,107	888	793	852	13,802
1947													
1948													
1949													
1950													
1951													
1952	1,428	1,413	1,488	1,512	1,440	1,570	1,491	1,448	1,280	1,169	1,108	1,111	18,457
1953	1,298	1,397	1,519	1,482	1,328	1,477	1,404	1,367	1,241	1,135	1,058	1,023	15,709
1954	1,139	1,263	1,405	1,435	1,265	1,362	1,246	1,201	1,103	1,106	1,119	1,142	14,806
1955	1,239	1,292	1,334	1,358	1,230	1,340	1,297	1,384	1,271	1,178	1,181	1,202	15,216
1956	1,269	1,275	1,349	1,392	1,299	1,333	1,236	1,222	1,119	1,068	1,063	1,112	14,760
1957	1,243	1,301	1,397	1,368	1,267	1,498	1,496	1,539	1,433	1,369	1,291	1,213	18,405
1958													
1959													
1960													
1961													
1962													
1963	1,373	1,385	1,431	1,464	1,340	1,486	1,394	1,340	1,224	1,218	1,231	1,289	16,123
1964	1,363	1,340	1,395	1,396	1,313	1,419	1,354	1,341	1,204	1,108	1,082	1,144	15,456
1965													
1966													
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Avg 1940-2000	1,263	1,307	1,399	1,406	1,265	1,396	1,331	1,338	1,218	1,133	1,066	1,119	15,293
Avg 1950-1994	1,283	1,325	1,413	1,426	1,312	1,436	1,365	1,355	1,234	1,166	1,138	1,182	16,616

J3-7

Est Baseflow - S. Fork of Rep Riv at Co-Kn Stlne (Total prior to 7/6/1950; gain below Bonny 6/1/1951-7/6/1950)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946			2,484	2,675	2,505	2,773	2,571	2,413	2,030	1,706	1,568	1,652	22,377
1947	2,002	2,381	2,758	2,885	2,670	2,965	2,888	2,850	2,285	1,072	414	415	25,941
1948	949	1,927	2,582	2,705	2,528	2,543	2,193	1,881	1,453	1,194	963	796	21,696
1949	1,310	2,368	3,117	3,308	3,104	3,503	3,252	2,887	2,110	896	757	1,785	28,498
1950	2,518	2,671	2,964	3,130	2,881	3,063	2,688	2,528	1,938				23,770
1951								251	350	406	439	443	1,868
1952	475	474	468	461	392	358	300	276	121	-155	-193	25	3,020
1953	142	146	202	298	361	514	528	481	279	-48	-211	-183	2,513
1954	-12	318	506	522	494	563	510	370	147	-133	-171	55	3,187
1955	229	334	443	524	492	486	382	228	53	-128	-125	70	3,002
1956	181	193	267	367	408	413	322	192	195	248	248		3,015
1957													
1958													
1959													
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Avg 1946-1956	866	1,201	1,581	1,890	1,881	1,721	1,563	1,303	895	506	369	562	12,601
Avg 1950-1956	589	689	811	887	635	605	790	569	378	32	-2	62	5,771

### J3-8

Estimated Baseflow - South Fork of Republican River near Idalia, Co (8826000)  
(values in cfs-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950									415	490	648	674	2,428
1951	1,136	1,302	1,517	1,652	1,465	1,475	1,304	1,270	1,166	1,216	1,243	1,265	16,050
1952	1,316	1,226	1,371	1,639	1,735	2,021	1,857	1,551	1,012	400	400	1,054	15,593
1953	1,425	1,352	1,397	1,425	1,340	1,582	1,400	1,050	621	221	203	595	12,812
1954	1,123	1,676	2,027	1,996	1,776	1,835	1,438	578	115	162	139	45	13,008
1955	340	869	1,519	1,799	1,709	1,782	1,553	1,359	911	336	377	1,070	13,753
1956	1,515	1,544	1,665	1,727	1,853	1,788	1,367	871	262	271	281	235	12,876
1957	525	1,376	1,901	2,054	1,939	2,174	2,096	2,116	1,892	1,669	1,508	1,438	20,788
1958	1,582	1,739	1,899	1,933	1,790	2,108	2,039	1,923	1,520	1,032	858	1,130	16,523
1959	1,496	1,822	2,069	2,051	1,671	2,138	1,907	1,549	864	394	303	770	17,364
1960	1,212	1,500	1,798	1,916	1,678	2,054	1,912	1,761	1,220	448	88	222	15,996
1961	613	1,206	1,583	1,614	1,526	1,627	1,739	1,578	1,122	520	533	1,208	15,071
1962	1,729	1,905	2,126	2,206	1,951	1,978	1,671	1,413	929	355	327	888	17,475
1963	1,429	1,800	2,029	1,928	1,851	1,723	1,362	863	426	152	369	1,083	14,815
1964	1,578	1,674	1,828	1,863	1,774	1,827	1,763	1,630	1,120	396	194	568	16,331
1965	1,029	1,472	1,829	1,946	1,774	1,863	1,496	996	588	399	628	1,274	15,296
1966	1,682	1,688	1,755	1,721	1,574	1,629	1,522	936	473	249	380	674	14,692
1967	1,309	1,543	1,752	1,777	1,650	1,610	1,822	1,729	1,233	487	220	502	15,933
1968	908	1,345	1,696	1,827	1,748	1,613	1,907	1,402	864	491	366	652	14,841
1969	1,080	1,836	1,846	1,954	1,851	1,870	1,810	1,218	726	258	316	828	14,823
1970	1,467	1,778	1,999	1,950	1,799	1,998	1,832	1,619	1,202	750	578	729	17,657
1971	1,063	1,463	1,738	1,728	1,551	1,708	1,608	1,567	1,181	530	108		14,220
1972													
1973													
1974													
1975													
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1995													
1996													
1997													
1998													
1999													
2000													
Avg 1950-1971	1,222	1,521	1,778	1,836	1,704	1,861	1,664	1,370	814	510	458	829	15,060
Avg 1950-1964	1,223	1,609	1,765	1,839	1,718	1,863	1,675	1,379	816	537	469	830	14,918
Avg 1965-1971	1,221	1,546	1,802	1,829	1,677	1,856	1,642	1,352	809	452	371	826	15,366

J3-9

Estimated Baseflow - Beaver Creek at Cedar Bluffs, Kan. (8848500)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	
1940														
1941														
1942														
1943														
1944														
1945														
1946									234	222	300	433	1,199	
1947	583	663	800	864	825	848	826	842	797	590	352	115	8,424	
1948	0	0	18	55	85	128	143	148	147	181	125	41	1,050	
1949	0	0	0	0	69	242	345	409	416	423	453	507	2,888	
1950	554	525	816	473	410	482	444	443	393	345	236	77	4,880	
1951	0	0	65	201	275	378	496	711	814	894	930	918	5,981	
1952	854	823	840	912	834	877	810	788	840	182	0	0	7,748	
1953	0	0	0	0	28	103	144	184	127	48	0	0	613	
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	
1956	0	0	0	0	0	0	0	0	24	77	79	28	206	
1957	0	0	0	0	0	0	27	86	122	144	148	127	651	
1958	138	183	228	312	352	481	483	486	466	443	342	171	4,057	
1959	115	158	202	238	233	258	247	249	181	85	0	0	1,844	
1960	0	0	0	0	13	45	62	71	89	85	46	15	388	
1961	0	0	0	0	0	0	14	45	60	81	46	15	242	
1962	0	0	0	0	0	30	108	183	211	268	361	425	450	2,014
1963	486	470	441	349	270	292	256	212	136	48	36	102	3,087	
1964	157	181	227	278	303	373	364	327	222	79	0	0	2,510	
1965	0	0	0	0	0	0	73	234	358	573	725	820	2,811	
1966	869	1,111	1,231	1,234	1,118	1,240	983	538	214	76	0	0	8,736	
1967	0	0	42	128	158	181	169	153	143	180	125	41	1,288	
1968	0	0	36	109	137	143	104	37	0	0	0	0	566	
1969	0	0	0	0	0	0	0	0	0	0	0	0	0	
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	
1993	0	0	0	0	0	0	0	0	14	45	81	80	180	
1994	89	139	178	190	184	219	220	228	188	123	85	21	1,644	
1995	0	0	0	0	25	80	125	143	132	107	70	23	715	
1996	0	0	0	0	0	0	25	82	151	251	378	518	1,406	
1997	619	608	635	638	553	657	634	637	463	165	0	0	5,640	
1998	0	0	55	169	208	241	214	189	104	37	0	0	1,188	
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	
2000	0	0	0	0	20	68	68	24	0	0	0	0	180	
Avg 1946-2000	87	92	104	114	114	138	140	139	124	105	90	81	1,312	
Avg 1950-1964	160	161	174	184	183	224	234	252	228	188	152	127	2,269	
Avg 1986-2000	47	50	58	66	68	85	86	85	70	48	38	41	744	

# J3-10

Estimated Baseflow - Beaver Creek at Ludell, Kan. (8846000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946	0	0	9	27	74	180	222	220	212	227	253	288	1,711
1947	373	485	532	526	497	810	806	591	477	323	178	57	5,233
1948	0	0	0	0	0	0	25	82	124	165	138	45	581
1949	0	0	0	0	168	656	881	868	717	487	422	512	4,719
1950	592	587	543	396	374	620	681	643	654	489	336	109	6,024
1951	0	0	45	137	217	384	501	703	799	882	922	914	5,484
1952	923	831	811	779	710	754	712	704	614	203	23	8	6,972
1953	0	0	0	0	34	121	160	131	87	31	0	0	554
1954													
1955													
1956													
1957													
1958													
1959													
1960													
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1990													
1991													
1992													
1993													
1994													
1995													
1996	0	0	0	0	16	54	104	176	224	285	327	402	1,570
1997	485	517	697	582	828	583	495	422	277	98	0	0	4,532
1998	0	0	55	169	228	298	264	183	78	32	4	1	1,291
1999	0	0	0	0	33	117	152	161	143	148	111	36	690
2000	0	0	12	36	85	180	188	60	0	0	0	0	541
Avg 1940-2000	183	185	198	204	228	348	380	376	323	258	208	183	3,077
Avg 1950-1964	379	355	350	328	334	465	511	545	489	401	320	256	4,734
Avg 1986-2000	97	103	127	158	177	243	237	195	144	109	88	88	1,706



# J3-11

Estimated Baseflow - Beaver Creek near Hamdon, Kan. (6846300)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
1959													
1960													
1961													
1962													
1963	367	423	445	387	344	433	443	452	331	118	56	184	3,963
1964	232	233	250	260	297	431	428	338	209	74	0	0	2,752
1965	0	0	0	0	0	0	78	249	428	860	810	852	3,077
1966	989	1,100	1,195	1,161	1,025	1,117	920	621	331	118	0	0	6,577
1967	0	0	76	233	295	354	329	278	215	173	111	38	2,100
1968	0	0	0	0	40	135	136	48	0	0	0	0	360
1969	0	0	0	0	0	0	17	54	54	19	0	0	145
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
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1981													
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1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	227	251	281	291	286	353	336	292	224	166	140	150	2,898
Avg 1950-1964	288	328	348	323	320	432	436	395	270	98	28	82	3,358

### J3-12

Estimated Baseflow - Prairie Dog Creek above Keith Sebellus Lake, Kan. (6847800)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
1959													
1960													
1961													
1962													
1963	128	128	135	133	121	138	129	120	83	121	130	121	373
1964	48	44	82	87	108	118	95	82	21	7	0	0	854
1965	0	0	0	0	17	81	75	83	98	187	278	324	1,113
1966	379	368	428	428	390	439	341	177	70	47	43	81	3,189
1967	90	121	175	242	222	178	132	128	118	123	93	30	1,681
1968	11	32	82	158	177	172	138	101	59	24	52	143	1,148
1969	204	211	227	230	214	246	238	228	185	132	77	25	2,219
1970	28	81	123	146	183	231	225	178	108	36	0	0	1,319
1971	10	28	49	86	84	124	135	135	98	38	0	0	768
1972	0	0	0	0	15	50	58	39	21	7	14	40	242
1973	63	75	96	128	144	200	211	210	182	84	0	0	1,333
1974	15	44	87	170	200	281	211	118	45	18	0	0	1,188
1975	0	0	0	0	20	89	70	25	2	7	13	19	328
1976	31	46	109	220	255	264	234	206	136	49	0	0	1,551
1977	0	0	0	0	8	21	40	89	82	22	38	111	369
1978	161	140	128	103	93	132	138	130	91	32	0	0	1,138
1979	0	0	0	0	28	104	119	83	48	18	0	0	398
1980	0	0	0	0	21	72	95	88	73	28	0	0	385
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	27	94	121	117	83	30	0	0	471
1984	0	0	0	0	28	87	117	128	85	34	0	0	483
1985	0	0	0	0	19	85	85	83	59	21	0	0	332
1986	0	0	16	50	70	100	112	122	65	41	8	3	818
1987	15	44	74	98	108	138	148	181	154	119	84		1,288
1988	88	119	138	125	148	242	283	241	187	81	2	1	1,593
1989	17	49	77	97	105	138	118	83	28	9	0	0	893
1990	19	57	105	159	178	211	183	157	100	35	0	0	1,212
1991	0	0	0	0	17	81	82	84	82	22	0	0	329
1992	0	0	0	0	17	58	58	21	12	38	54	57	318
1993	78	108	135	148	175	285	338	378	388	412	415	395	3,252
1994	407	398	405	394	358	403	374	338	292	279	240	179	4,082
1995	211	311	385	431	441	573	598	609	470	235	92	88	4,428
1996	58	167	224	248	278	374	383	359	434	361	881	884	4,488
1997	718	825	723	733	838	742	892	858	450	184	28	81	8,358
1998	198	353	487	583	582	867	818	522	357	175	79	87	4,863
1999	145	239	328	390	391	459	428	380	285	182	130	140	3,487
2000	188	253	315	351	381	422	387	249	133	47	0	0	2,884
Avg 1840-2000	88	108	135	155	184	210	204	179	134	90	87	89	1,989
Avg 1950-1984	87	86	98	115	115	128	112	88	52	63	47	82	738
Avg 1986-2000	145	186	228	252	258	325	318	289	227	162	124	119	2,832

J3-13

Estimated Baseflow - Prairie Dog Creek at Norton, Kan. (8B48000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945	650	592	598	589	515	539	509	532	484	426	315	182	5,627
1946	109	136	181	224	220	237	218	206	179	160	161	240	2,293
1947	414	660	633	663	798	883	865	884	834	825	683	362	8,694
1948	241	260	283	283	243	211	190	221	228	234	202	133	2,728
1949	111	119	123	111	129	228	313	434	482	542	532	482	3,592
1950	472	501	507	438	367	525	534	508	490	549	608	660	6,186
1951	715	683	671	610	530	625	601	633	561	776	824	797	8,105
1952	816	780	805	816	775	837	774	711	581	401	232	78	7,587
1953	45	133	231	328	363	460	470	474	447	449	343	135	3,876
1954	64	116	182	252	278	335	352	379	318	206	107	35	2,624
1955	15	44	78	112	138	205	172	81	0	0	0	0	828
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	28	81	148	218	261	271	1,018
1958	280	253	281	279	272	329	349	394	389	380	278	81	3,556
1959	53	155	238	284	288	343	317	266	172	61	0	0	2,177
1960	0	0	15	48	78	125	151	175	157	118	70	23	853
1961	62	162	264	289	270	292	287	312	280	256	194	111	2,808
1962	101	151	176	157	148	162	207	223	233	288	274	247	2,375
1963	241	225	213	182	170	238	245	228	173	102	95	157	2,268
1964	184	182	198	221	239	301	269	178	118	114	83	27	2,118
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
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1991													
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1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1944-1984	228	259	293	304	292	345	349	356	332	321	282	220	3,500
Avg 1950-1964	204	227	256	267	263	319	317	309	277	260	225	175	3,099

J3-14

Est Baseflow - Prairie Dog Creek nr Woodruff, Kn (864800) (Total prior to 9/30/1964, after gain Norton to Woodruff)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944									817	477	297	97	1,488
1945													
1946	90	89	148	201	215	284	275	519	263	199	152	158	2,316
1947	249	405	661	678	720	929	850	951	892	894	728	407	8,359
1948	296	349	376	339	323	401	370	281	206	182	125	41	3,288
1949	30	69	93	32	87	341	514	687	714	738	877	537	4,528
1950	515	543	525	402	360	531	518	394	318	347	402	478	5,332
1951	552	556	529	415	375	545	835	742	848	1,064	1,176	1,185	8,800
1952	1,166	1,085	1,079	1,061	1,018	1,160	1,100	1,004	774	517	292	131	10,404
1953	93	165	240	305	321	382	417	471	456	426	351	233	3,872
1954	200	223	255	273	263	310	305	306	222	79	0	0	2,436
1955	0	0	0	30	91	111	123	81	32	0	0	0	478
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	28	91	125	141	148	143	875
1958	167	169	206	257	278	354	394	434	392	313	196	65	3,231
1959	27	80	129	165	183	243	237	205	136	49	0	0	1,464
1960	0	0	0	0	27	90	119	123	91	32	0	0	482
1961	0	0	27	82	128	209	251	287	251	170	93	30	1,827
1962	45	133	181	111	83	104	103	87	98	115	138	183	1,350
1963	192	201	211	202	182	210	197	179	122	44	23	67	1,828
1964	91	85	91	100	115	153	180	125	77	27	0	0	1,094
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	18	53	77	83	87	117	107	70	56	81	83	63	696
1967	84	80	100	115	140	228	298	400	430	435	382	275	2,848
1968	234	228	220	183	152	129	111	124	145	193	186	128	2,043
1969	105	101	106	109	110	147	183	187	195	210	208	189	1,827
1970	174	147	128	100	90	131	154	184	175	147	123	107	1,681
1971	127	166	204	220	202	214	202	209	174	118	77	57	1,972
1972	72	114	141	141	138	155	146	133	99	59	28	9	1,235
1973	18	53	86	138	148	179	180	137	108	87	90	120	1,328
1974	172	228	284	324	308	328	290	256	184	129	70	23	2,588
1975	15	44	89	84	71	47	42	72	87	131	123	72	898
1976	89	105	145	179	180	183	161	142	95	34	0	0	1,285
1977	0	0	0	0	10	36	49	54	41	15	0	0	204
1978	14	40	57	60	82	84	88	24	0	0	0	0	408
1979	0	0	0	0	18	83	71	45	23	8	0	0	227
1980	0	0	0	0	0	0	11	38	38	13	0	0	87
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	12	36	83	90	88	73	45	18	0	0	0	0	423
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	11	40	54	55	82	83	82	89	487
1994	113	151	178	178	150	138	118	114	82	29	0	0	1,250
1995	26	75	122	159	138	89	55	80	69	83	88	82	1,025
1996	55	69	154	243	277	312	325	370	409	466	588	673	3,980
1997	788	832	917	957	888	968	940	907	788	692	591	500	8,795
1998	554	682	766	838	768	841	770	709	634	637	600	527	8,356
1999	553	606	667	673	607	663	654	712	697	695	652	572	7,752
2000	531	457	485	511	531	639	602	509	374	254	139	45	5,057
Avg 1945-1964	193	219	245	248	252	335	351	353	331	291	240	186	3,134
Avg 1965-2000	103	119	139	150	144	162	155	154	138	129	115	97	1,604

# J3-15

Estimated Baseflow - Seppa Creek near Lyle, Kn (8848110)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
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1971													
1972													
1973													
1974													
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1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996	181	276	363	416	481	601	712	898	1,027	1,224	1,348	1,376	8,854
1997	1,327	1,803	1,720	1,717	1,543	1,693	1,592	1,531	1,152	886	376	304	15,484
1998	381	532	729	824	808	940	872	796	583	409	277	209	7,380
1999	272	436	588	687	676	769	706	627	518	483	376	268	6,390
2000	269	402	550	697	738	819	699	482	283	187	85	21	5,202
Avg 1996-2000	530	656	790	888	845	884	815	861	719	568	488	436	6,660

J3-16

Estimated Baseflow - Sappa Creek near Oberlin, Kn. (8948000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944									81	211	208	194	673
1945	189	165	178	203	205	251	289	305	236	84	3	5	2,087
1946	12	14	17	20	19	21	22	25	28	35	32	10	258
1947	13	38	60	78	81	100	102	106	96	94	72	34	874
1948	17	19	21	21	15	8	0	0	12	39	48	36	234
1949	46	70	65	22	21	73	114	155	188	237	315	415	1,721
1950	473	430	390	307	260	341	343	324	248	149	91	85	3,441
1951	77	57	37	13	28	103	243	482	821	724	789	806	3,890
1952	502	672	614	562	541	670	671	638	449	160	0	0	5,778
1953	0	0	0	0	0	0	1	4	4	1	0	0	11
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	12	39	39	14	0	0	104
1958	5	15	22	25	28	42	52	67	75	66	66	22	507
1959	0	0	0	0	13	45	45	16	0	0	0	0	119
1960	0	0	0	0	9	31	50	70	59	21	0	0	239
1961	0	0	0	0	0	0	10	31	40	38	26	8	156
1962	0	0	0	0	0	0	0	0	13	43	44	14	115
1963	0	0	18	55	84	137	128	73	31	11	0	0	537
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	39	115	155
1966	262	456	535	447	358	362	297	162	84	23	0	0	2,684
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	8	23	31	28	29	46	39	14	0	0	0	0	217
1970	13	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	11	35	35	12	0	0	83
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996	8	23	41	59	63	63	60	61	79	125	148	143	874
1997	172	214	212	141	129	225	238	163	122	44	0	0	1,590
1998	0	0	34	105	135	168	149	101	64	19	0	0	768
1999	15	44	72	93	108	145	132	87	69	63	67	49	993
2000	35	38	59	93	129	166	175	87	27	10	0	0	851
Avg 1940-2000	65	69	73	69	68	92	96	93	76	67	56	57	667
Avg 1950-1964	90	78	72	84	84	91	104	116	105	63	66	62	669
Avg 1989-2000	46	64	84	96	112	160	161	106	71	58	47	38	1,035

# J3-17

Estimated Baseflow - South Fork Sappa Creek near Achilles, Kn (6844800)  
(Values in cfs)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
1959													
1960	0	0	0	0	0	0	1	5	5	2	0	0	12
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	1	14	39	55
1966	64	85	104	114	110	128	98	35	0	0	0	0	740
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	1	1	0	0	0	4
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	5	17	18	8	48
1976	5	13	19	22	20	17	11	4	0	0	0	0	110
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	21	73	103	120	94	33	0	0	443
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	2	8	12	22	22	18	10	3	94
1988	0	0	0	0	3	11	11	4	0	0	0	0	29
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	8	19	27	41	41	34	27	25	22	19	262
1994	31	58	84	110	116	140	106	38	0	3	9	9	696
1995	12	11	12	15	14	12	13	18	15	5	0	0	129
1996	0	0	4	11	12	10	10	13	15	17	17	15	123
1997	21	33	45	56	64	91	81	46	20	7	0	0	485
1998	8	14	19	19	19	27	25	17	10	3	2	5	186
1999	10	13	18	26	24	21	18	18	13	5	0	0	185
2000	2	6	8	5	6	12	11	4	0	0	0	0	54
Avg 1940-2000	4	6	8	10	11	14	13	9	6	3	2	2	88
Avg 1950-1984	0	0	0	0	0	0	0	1	1	0	0	0	2
Avg 1986-2000	5	9	13	17	19	25	22	14	8	5	4	4	145

# J3-18

Estimated Baseflow - South Fork Sappa near Brewster, Ka (06944700)  
(values in cfs)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
1959													
1960													
1961													
1962													
1963													
1964													
1965													
1966													
1967													
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	0	0	0	0	0	0	0	0	0	0	0	0	0



J3-19

Estimated Baseflow - Arlckaree River at Halgler, Na. (6821600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	265	189	121	94	172	405	457	365	240	122	151	335	2,888
1941	386	198	164	250	385	713	838	854	667	353	285	430	5,482
1942	586	685	702	626	569	723	601	298	103	60	185	473	5,562
1943	774	1,004	1,135	1,059	847	757	593	517	348	135	28	48	7,245
1944	63	84	109	185	283	439	424	284	153	82	121	331	2,530
1945	455	440	455	456	426	505	528	591	458	170	124	340	4,946
1946	507	572	700	838	776	749	641	504	427	161	128	348	6,453
1947	578	798	879	1,165	1,146	1,287	1,233	1,225	858	330	43	84	9,719
1948	111	110	125	147	191	302	366	428	349	159	131	281	2,899
1949	382	391	347	205	425	1,210	1,544	1,562	1,143	418	229	645	8,498
1950	861	777	792	830	784	908	770	511	387	481	585	887	8,374
1951	753	688	668	624	611	841	1,003	1,250	1,118	690	667	1,081	10,004
1952	1,243	1,003	1,018	1,193	1,327	1,704	1,672	1,457	973	354	96	258	12,297
1953	296	174	339	793	967	1,188	912	365	48	25	12	12	5,109
1954	27	55	87	118	233	528	570	408	235	82	32	70	2,457
1955	88	76	80	82	104	153	188	238	208	114	188	368	1,878
1956	384	186	112	127	208	411	452	372	248	116	84	191	2,921
1957	281	274	305	327	441	818	1,103	1,441	1,342	940	610	401	8,284
1958	314	300	339	402	471	708	835	1,038	968	814	685	328	7,142
1959	296	448	635	818	845	1,347	1,255	850	459	179	33	52	7,315
1960	68	74	75	88	338	1,003	1,192	894	644	238	26	51	4,768
1961	65	81	95	163	327	717	791	625	369	180	164	426	4,035
1962	524	409	365	352	387	608	803	1,080	1,252	1,435	1,196	540	8,961
1963	380	656	870	954	901	897	853	636	352	148	213	595	7,553
1964	729	544	829	638	751	1,043	1,012	782	808	268	249	467	7,515
1965	475	212	78	50	85	220	333	462	548	658	691	638	4,448
1966	704	800	830	707	659	918	848	674	407	430	523	879	8,060
1967	782	787	806	834	775	878	680	889	670	278	153	328	8,031
1968	334	125	73	172	294	510	668	848	894	287	40	56	4,081
1969	78	96	129	188	265	321	784	1,095	845	389	81	108	4,850
1970	163	238	370	541	835	865	854	738	490	187	38	76	5,193
1971	91	73	73	83	189	472	683	697	738	270	18	34	3,622
1972	46	51	80	70	180	441	582	859	523	229	184	420	3,443
1973	571	572	652	756	840	1,542	1,863	1,515	1,056	424	197	432	10,319
1974	574	555	684	841	870	1,087	951	751	468	176	69	231	7,487
1975	256	131	84	108	209	470	589	622	490	215	82	139	3,385
1976	168	166	196	244	304	447	415	256	125	52	36	63	2,493
1977	87	67	55	55	50	55	56	64	53	27	29	60	689
1978	73	56	57	60	65	96	141	222	196	78	80	211	1,340
1979	253	177	130	94	94	168	221	290	258	153	190	375	2,402
1980	393	191	156	279	423	665	847	870	753	266	102	250	6,351
1981	359	360	482	598	771	1,279	1,541	1,768	1,540	1,032	635	406	10,803
1982	259	131	88	117	218	474	739	1,105	977	432	175	259	4,968
1983	258	131	86	110	328	857	1,094	1,043	758	334	96	96	5,222
1984	96	84	83	83	353	1,009	1,144	839	518	274	131	113	4,729
1985	90	49	94	134	195	318	346	350	253	147	189	321	2,412
1986	330	151	178	408	458	560	553	510	437	369	337	280	4,828
1987	191	102	58	48	170	514	614	517	342	138	144	375	3,209
1988	397	159	72	124	171	251	317	412	345	147	79	158	2,833
1989	189	144	108	85	87	212	254	237	173	86	79	159	1,793
1990	179	117	79	55	118	322	414	433	325	125	27	51	2,245
1991	65	61	59	54	126	331	450	528	447	253	128	83	2,556
1992	154	293	558	928	1,010	897	805	578	433	453	469	481	7,161
1993	500	482	454	429	468	807	851	725	533	354	274	311	6,186
1994	311	232	396	792	844	787	631	503	392	361	332	309	5,896
1995	241	93	23	25	65	139	254	433	417	237	122	82	2,132
1996	72	51	39	29	102	291	371	374	348	333	282	197	2,485
1997	157	138	141	154	195	338	366	319	219	98	118	285	2,532
1998	303	128	42	38	84	215	291	341	281	140	83	152	2,107
1999	148	62	22	24	81	231	307	338	282	113	78	169	1,833
2000	177	82	95	215	278	340	282	141	48	25	9	3	1,894
Avg 1940-2000	328	286	307	383	431	652	701	674	515	289	205	283	5,032
Avg 1950-1994	420	382	421	500	588	864	896	805	613	405	317	368	6,575
Avg 1988-2000	228	152	155	226	286	424	451	426	333	217	172	207	3,275

J3-20

Estimated Baseflow - Beaver Creek near Beaver City, Mo. (6847000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	3	8	18	28	28	28	28	34	35	33	35	38	312
1941	41	37	56	86	105	116	147	228	280	278	310	354	2,025
1942	394	381	383	382	336	418	443	488	488	504	482	421	5,098
1943	407	385	408	439	424	500	480	453	357	240	130	42	4,286
1944	0	0	0	0	18	83	120	204	285	398	475	510	2,071
1945	562	562	572	538	500	533	672	731	888	828	454	184	6,721
1946	49	38	44	72	95	158	184	203	171	108	118	188	1,438
1947	273	318	392	468	478	576	830	752	714	597	421	208	5,824
1948	130	185	194	200	191	207	188	164	164	311	278	91	2,312
1949	27	80	102	83	110	228	337	487	529	519	542	589	3,841
1950	881	703	878	822	418	501	520	568	531	539	501	444	6,822
1951	364	287	249	294	369	802	701	762	822	884	1,120	1,184	7,744
1952	1,301	1,310	1,381	1,413	1,334	1,431	1,382	1,352	1,087	737	389	130	13,258
1953	28	75	140	214	237	283	288	295	218	77	0	0	1,851
1954	0	0	22	68	82	88	80	77	54	18	0	0	482
1955	0	0	0	0	13	45	82	39	23	8	0	0	180
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	20	84	103	150	153	109	587
1958	115	158	180	171	182	278	318	351	358	322	262	184	2,859
1959	128	137	173	225	237	283	288	232	184	85	0	0	1,890
1960	11	31	48	57	58	61	60	61	67	84	80	54	671
1961	48	51	55	56	60	61	108	127	124	113	68	48	985
1962	41	61	77	83	98	158	214	288	363	432	509	525	2,877
1963	578	580	611	577	498	533	470	409	282	129	83	98	4,837
1964	128	137	156	175	223	351	389	330	272	97	14	40	2,362
1965	55	54	70	101	127	183	182	149	148	220	285	338	1,832
1966	399	422	456	459	407	430	383	348	295	288	211	138	4,212
1967	128	172	233	284	318	411	404	388	320	316	247	120	3,330
1968	88	131	188	178	186	230	210	155	105	78	48	15	1,888
1969	11	31	50	66	88	150	186	185	135	96	56	18	1,034
1970	18	53	85	110	125	172	182	118	88	24	0	0	837
1971	4	12	20	28	35	53	86	148	132	47	0	0	564
1972	11	31	37	25	25	46	51	48	42	43	37	24	417
1973	21	27	37	49	51	60	58	57	51	46	34	15	505
1974	12	24	33	36	34	41	41	43	32	11	0	0	308
1975	8	22	30	28	28	42	48	53	51	48	37	24	418
1976	24	36	48	52	53	60	60	61	45	18	0	0	454
1977	0	0	0	0	4	15	32	60	62	42	23	8	248
1978	3	8	13	18	28	48	48	30	15	5	0	0	210
1979	0	0	0	0	9	31	38	34	27	23	18	5	185
1980	5	15	19	15	22	48	85	80	64	23	0	0	355
1981	0	0	0	0	0	0	0	0	7	23	30	27	86
1982	25	22	20	17	23	45	51	48	39	34	23	8	351
1983	4	12	15	12	19	43	54	58	55	54	48	38	409
1984	35	38	42	42	60	112	136	145	123	84	51	28	888
1985	28	44	55	55	54	89	74	83	71	48	32	31	642
1986	35	38	45	50	51	85	70	81	69	42	24	18	537
1987	23	35	48	52	58	82	88	88	68	38	24	28	629
1988	36	42	54	67	72	83	78	63	41	16	4	12	563
1989	20	27	31	28	18	7	3	9	9	3	0	0	155
1990	0	0	0	0	8	22	27	22	14	5	0	0	86
1991	0	0	0	0	4	13	22	32	27	10	0	0	100
1992	4	12	20	27	28	20	17	20	15	5	0	0	185
1993	5	15	22	25	30	48	54	53	66	86	105	89	610
1994	88	119	135	135	140	188	200	176	131	83	42	14	1,470
1995	18	53	71	85	88	108	118	114	82	81	40	33	837
1996	34	39	45	52	58	89	89	65	88	184	335	535	1,580
1997	708	767	836	836	771	890	881	847	625	271	58	18	7,483
1998	30	86	147	196	224	327	298	238	150	83	11	31	1,771
1999	40	33	48	78	87	108	120	152	151	134			943
2000													
Avg 1940-2000	121	132	148	155	157	188	208	216	194	168	140	119	1,849
Avg 1950-1964	229	235	252	257	254	314	323	334	298	252	212	188	3,148
Avg 1986-2000	75	91	107	115	115	144	144	140	111	71	48	80	1,214

# J3-21

Estimated Baseflow - Blackwood Creek near Culbertson, Ne. (9838000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946									82	86	85	80	333
1947	88	35	19	14	10	11	24	53	81	54	53	59	459
1948	52	24	10	7	5	6	17	41	49	43	39	38	331
1949	34	21	13	8	6	10	19	38	45	45	50	62	352
1950	56	25	11	11	10	11	22	46	55	52	48	44	391
1951	41	34	31	28	21	19	24	45	54	57	57	53	464
1952	52	45	45	47	44	45	41	40	34	30	26	22	471
1953	20	17	18	18	11	4	11	36	56	75	78	80	398
1954	50	41	35	30	22	19	25	47	57	63	64	60	514
1955	54	39	33	33	28	20	24	44	50	46	48	55	473
1956	60	54	52	46	41	44	49	66	69	65	62	62	669
1957	61	51	47	45	40	47	60	91	101	99	101	107	852
1958	108	91	79	83	66	78	94	118	119	112	102	98	1,107
1959	87	84	83	75	62	64	68	87	94	96	85	83	980
1960	75	58	53	50	45	58	80	61	73	104	102	84	807
1961	50	51	52	47	39	44	43	47	58	64	62	79	686
1962	77	77	78	67	53	52	54	72	84	100	102	89	903
1963	62	69	103	92	77	83	84	97	106	122	127	120	1,203
1964	111	85	77	78	73	73	74	87	103	133	131	95	1,122
1965	84	87	90	84	72	78	88	124	143	163	166	152	1,329
1966	149	138	140	137	120	126	123	137	144	165	165	141	1,667
1967	130	118	112	110	87	105	119	165	181	187	180	160	1,661
1968	152	137	136	136	127	136	143	172	176	175	159	128	1,778
1969	113	96	91	89	78	83	100	150	178	200	211	207	1,595
1970	207	182	185	137	110	120	123	143	157	184	178	130	1,835
1971	115	114	123	132	116	112	114	148	163	176	174	157	1,645
1972	152	138	136	137	127	132	131	146	186	182	195	192	1,821
1973	210	222	228	207	174	184	179	197	215	262	279	261	2,617
1974	255	226	209	182	148	152	143	150	159	190	183	166	2,173
1975	170	181	183	187	164	176	168	177	181	204	194	150	2,147
1976	128	108	107	114	104	99	100	128	136	141	125	90	1,378
1977	85	100	114	118	101	99	104	138	153	168	160	136	1,473
1978	128	114	111	106	89	87	83	95	93	80	80	86	1,141
1979	60	54	54	54	47	46	46	57	71	87	82	54	732
1980	62	48	83	50	50	54	74	90	102	121	104	81	851
1981	36	51	58	52	45	53	64	90	84	84	88	50	746
1982	48	55	81	61	51	44	53	68	113	138	133	92	940
1983	69	54	46	41	36	42	47	60	67	79	75	58	671
1984	45	35	43	65	63	48	46	74	90	106	96	59	772
1985	44	42	41	35	31	37	47	72	73	58	41	23	543
1986	17	18	20	17	14	16	21	33	29	10	0	0	166
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	60	61	79	75	65	68	73	84	103	113	110	84	1,030
Avg 1950-1964	66	57	53	49	42	44	49	66	74	83	82	72	736
Avg 1966-2000	17	19	20	17	14	16	21	33	29	10	0	0	168

### J3-22

Estimated Baseflow - Brushy Creek near Maywood, Ne. (6938600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951								25	27	32	34	35	184
1952	38	40	43	44	41	42	37	32	23	14	15	27	394
1953	34	34	37	40	35	34	30	30	23	13	7	8	325
1954	10	18	21	17	13	15	18	27	24	8	0	0	172
1955	8	18	28	27	27	33	30	21	13	7	5	5	218
1956	10	18	21	22	23	30	29	24	15	5	0	0	196
1957	4	12	17	17	17	24	27	31	29	25	20	15	238
1958	19	31	39	40	37	41	37	33	28	20	17	17	590
1959													
1960													
1961													
1962													
1963													
1964													
1965													
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1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1951-1958	17	24	29	30	28	31	30	28	23	16	12	13	257
Avg 1950-1964	17	24	29	30	28	31	30	28	23	16	12	13	257

J3-23

Estimated Baseflow - Buffalo Creek near Haight, Nc. (8823600)  
(values in cfs)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941		544	591	598	542	601	552	504	430	392	384	412	5,549
1942	478	527	617	698	644	653	591	586	498	382	387	521	6,554
1943	628	627	659	657	595	664	643	562	491	187	85	243	6,148
1944	357	397	484	519	529	605	614	654	526	290	209	304	5,468
1945	409	478	546	594	502	519	482	432	339	228	235	372	5,084
1946	471	476	526	575	534	573	508	446	324	187	186	350	5,178
1947	488	525	578	590	542	607	575	559	459	335	275	292	5,823
1948	363	445	513	521	495	539	514	505	498	563	586	581	6,105
1949	561	510	498	488	448	588	613	624	478	223	188	418	5,621
1950	593	539	555	548	513	620	617	616	595	637	635	587	7,014
1951	596	584	604	596	548	641	631	635	584	657	551	569	7,097
1952	621	628	671	687	652	700	644	590	409	155	81	209	6,049
1953	355	481	594	645	588	608	522	444	298	123	52	101	4,810
1954	237	437	566	579	529	568	539	466	359	177	168	346	5,019
1955	465	531	691	612	582	622	532	398	241	103	88	207	4,972
1956	315	379	437	450	448	528	463	319	194	125	133	221	4,014
1957	339	447	531	544	517	620	623	640	543	399	299	142	5,604
1958	212	447	590	694	654	650	621	582	513	487	479	462	6,209
1959	523	475	485	487	467	583	573	537	384	162	108	242	5,006
1960	367	442	533	598	600	684	602	508	338	137	85	189	5,071
1961	325	430	511	523	488	570	535	486	338	140	111	267	4,727
1962	400	467	532	546	504	568	560	590	581	544	497	424	6,194
1963	437	460	530	539	494	555	437	224	78	30	89	282	4,185
1964	418	458	514	538	518	551	450	285	141	53	41	112	4,078
1965	203	292	405	514	502	528	442	344	213	83	128	349	3,998
1966	506	551	593	578	613	562	412	147	57	181	277	329	4,708
1967	415	486	558	584	524	544	488	455	318	113	73	214	4,771
1968	345	430	512	548	527	557	492	317	171	81	43	127	4,101
1969	258	411	518	535	482	511	471	463	332	118	47	139	4,286
1970	289	410	508	519	484	561	528	485	335	119	49	143	4,410
1971	282	436	546	567	515	553	522	530	387	138	39	114	4,627
1972	251	428	528	511	474	516	419	247	111	38	78	230	3,831
1973	348	389	447	482	483	541	472	341	195	69	93	274	4,112
1974	392	404	477	573	556	600	457	165	0	0	7	22	3,624
1975	149	377	517	627	479	527	438	301	163	59	0	0	3,536
1976	107	314	462	518	493	484	359	162	61	22	106	311	3,418
1977	408	350	358	399	403	505	402	163	22	8	58	170	3,247
1978	288	380	444	438	394	441	388	248	133	47	55	162	3,399
1979	254	302	364	411	400	459	398	283	181	57	0	0	3,086
1980	91	296	373	382	372	422	423	443	329	117	77	227	3,523
1981	338	367	408	423	410	506	512	518	377	134	115	337	4,443
1982	474	472	482	456	394	423	411	444	335	119	122	357	4,480
1983	478	432	435	445	420	498	485	475	345	138	75	175	4,401
1984	259	297	340	359	367	442	460	488	365	130	45	133	3,685
1985	233	321	385	390	391	416	372	302	203	106	188	463	3,716
1986	560	472	432	383	350	418	397	359	244	97	74	218	4,004
1987	328	360	408	434	398	425	372	318	207	74	85	190	3,576
1988	297	352	405	420	402	435	401	364	249	89	74	216	3,704
1989	318	344	362	336	286	308	268	222	144	51	69	202	2,906
1990	288	294	325	350	333	380	329	244	142	51	40	118	2,892
1991	208	253	355	364	341	398	367	381	274	97	82	241	3,423
1992	335	328	350	376	356	360	276	153	62	22	24	70	2,799
1993	148	248	316	325	303	346	303	231	138	49	52	151	2,612
1994	260	352	414	408	360	383	277	98	0	0	78	233	2,864
1995	324	318	332	336	306	351	348	370	277	98	40	118	3,219
1996	191	242	283	287	267	344	344	339	244	67	65	180	2,901
1997	233	227	257	261	236	241	224	237	177	93	19	57	2,234
1998	108	163	189	168	138	130	88	31	0	0	22	65	1,090
1999	101	120	169	238	246	276	269	260	207	74	46	135	2,182
2000	189	188	206	228	216	220	173	105	49	17	0	0	1,589
Avg 1841-2000	342	403	461	479	446	500	453	390	277	156	140	239	4,282
Avg 1950-1964	411	482	550	566	532	604	557	490	372	255	228	293	5,336
Avg 1966-2000	261	287	319	328	304	334	287	249	161	57	50	147	2,783

# J3-24

Estimated Baseflow - Center Creek at Franklin, Nc. (0861000)  
(Values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949	108	184	244	271	268	321	232	225	187	141	103	78	987
1950	198	228	244	228	217	285	293	290	224	122	93	147	2,568
1951	192	207	234	263	236	259	242	233	199	167	158	170	2,549
1952	228	288	357	373	355	376	301	176	88	58	86	120	2,796
1953	172	201	273	370	388	458	444	433	357	253	213	242	3,806
1954	297	343	381	377	343	390	377	379	320	251	240	291	3,988
1955	347	394	387	409	381	436	403	354	289	251	264	328	4,228
1956	391	404	434	442	413	429	388	386	328	273	241	241	4,381
1957													
1958													
1959													
1960													
1961													
1962													
1963													
1964													
1965													
1966													
1967													
1968													
1969	348	344	365	377	345	379	355	346	313	300	307	334	4,112
1970	379	397	430	440	409	472	445	411	323	225	213	294	4,439
1971	358	353	389	401	398	399	379	353	323	243	221	265	4,091
1972	316	338	362	390	337	385	358	378	348	311	287	307	4,071
1973	339	348	384	412	385	428	402	392	349	320	338	405	4,498
1974	436	378	385	399	341	393	384	387	324	238	218	271	4,088
1975	329	349	375	372	338	381	368	370	343	335	321		3,880
1976													
1977													
1978		359	384	403	378	423	402	390	344	310	298	306	3,892
1979	338	355	386	395	377	458	445	428	378	348	332	336	4,870
1980	380	356	381	399	382	407	385	379	303	187	189	229	3,848
1981	285	304	340	363	343	391	388	407	395	401	392	367	4,375
1982	358	318	314	316	296	391	365	378	359	342	341	358	4,103
1983	372	343	348	350	327	385	390	381	327	292	214	192	3,879
1984	211	244	282	331	334	371	356	342	304	284	284	308	3,858
1985	343	354	382	391	382	413	400	402	372	380	398	389	4,535
1986	418	398	385	338	288	330	336	371	370	360	385	325	4,303
1987	321	310	318	315	291	343	346	398	352	350	349	349	4,008
1988	381	397	429	436	403	408	389	347	303	280	270	275	4,299
1989	317	355	390	385	348	391	387	348	297	253	240	282	3,891
1990	313	358	389	405	388	410	393	397	359	328	317	334	4,377
1991	358	337	355	375	352	399	385	384	343	307	288	291	4,172
1992	328	352	384	385	361	388	358	329	287	273	277	302	4,022
1993	343	358	383	387	357	408	405	427	424	451	456	444	4,843
1994	480	448	458	480	403	445	415	385	358	348	346	359	4,878
1995	392	398	391										1,108
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	323	335	361	371	347	391	369	360	315	275	263	283	3,825
Avg 1950-1964	260	292	332	350	333	378	351	322	258	196	182	220	3,473
Avg 1966-2000	362	367	386	386	352	391	375	374	343	329	323	327	3,998

# J3-25

Estimated Baseflow - Cottonwood Creek near Bloomington, Nc. (6880200)  
(values in cc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948								256	282	240	223	217	1,421
1949	249	281	285	295	272	301	289	293	274	268	271	284	3,343
1950	297	272	271	267	244	280	270	266	247	246	247	250	3,158
1951	268	271	288	290	285	298	287	292	278	278	277	279	3,384
1952	297	293	298	284	281	283	270	297	244	233	230	235	3,194
1953	281	277	300	303	274	298	281	278	281	238	219	187	3,178
1954	214	243	270	271	250	288	279	276	250	237	238	256	3,071
1955	281	277	291	298	287	295	282	288	263	248	250	268	3,304
1956	283	288	300	301	280	298	283	288	281	235	218	213	3,256
1957													
1958													
1959													
1960													
1961													
1962													
1963													
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1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1948-1956	270	273	288	288	264	282	277	278	256	245	241	245	3,032

J3-26

Estimated Baseflow - Driftwood Creek near McCook, Ne. (6838600)  
(values in cu-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1941													
1942													
1943													
1944													
1945													
1946								0	0	0	6	16	24
1947	31	40	42	31	23	25	24	25	21	15	8	3	287
1948	5	14	19	19	15	10	7	7	12	23	22	7	161
1949	3	9	13	13	16	27	35	43	35	12	4	12	223
1950	14	8	8	11	12	14	16	18	21	28	28	28	203
1951	27	23	22	22	20	22	21	22	23	29	44	65	340
1952	77	69	65	58	57	75	79	80	84	39	28	34	727
1953	35	28	24	22	21	26	27	28	24	22	16	5	277
1954	0	0	0	14	13	5	4	13	13	5	0	0	72
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	5	18	17	5	44
1957	0	0	0	0	0	0	0	5	16	20	18	22	98
1958	26	27	25	17	15	25	25	19	19	26	33	34	292
1959	31	20	11	4	4	13	18	21	29	48	51	43	290
1960	38	28	28	35	41	63	55	55	55	63	66	83	674
1961	64	60	61	59	54	66	69	77	80	91	91	81	854
1962	80	79	83	83	74	78	79	92	101	120	132	136	1,138
1963	139	124	122	119	104	108	108	116	123	135	138	131	1,488
1964	132	124	128	124	116	125	122	124	123	135	135	120	1,507
1965	125	131	138	136	122	137	140	158	171	200	217	220	1,895
1966	227	211	204	184	147	139	136	169	189	217	229	223	2,278
1967	218	185	183	184	177	188	178	192	172	172	168	162	2,178
1968	177	192	213	221	197	179	156	156	164	196	213	206	2,275
1969	212	204	205	196	181	218	214	207	202	226	232	212	2,511
1970	218	222	233	230	206	228	230	297	282	279	273	244	2,982
1971	244	240	249	247	221	243	245	277	280	269	264	288	3,086
1972	277	283	298	295	270	278	277	314	312	309	307	308	3,529
1973	323	310	312	299	281	280	277	310	330	360	424	458	3,960
1974	463	443	451	464	408	405	371	390	396	441	462	455	5,167
1975	448	363	398	351	317	335	314	318	320	364	380	364	4,270
1976	377	369	365	369	356	369	350	362	357	363	364	369	4,481
1977	394	358	360	363	356	458	466	490	435	451	419	341	4,860
1978	336	360	398	377	327	338	287	269	257	288	308	284	3,837
1979	287	278	282	285	245	302	290	259	227	228	210	180	3,051
1980	200	246	293	314	312	352	331	300	278	300	283	227	3,435
1981	227	253	269	248	218	241	243	266	272	284	283	269	3,075
1982	287	302	317	301	255	281	256	297	313	342	380	424	3,738
1983	437	386	349	352	351	465	468	533	520	528	453	308	5,158
1984	247	242	298	303	304	332	329	348	329	315	280	228	3,528
1985	252	321	390	335	299	351	330	295	291	359	381	351	3,835
1986	359	329	340	359	327	348	319	313	286	311	306	280	3,585
1987	295	313	337	335	318	391	385	302	287	303	317	305	3,646
1988	324	332	355	361	335	347	311	280	274	335	361	348	3,961
1989	354	339	350	354	314	329	294	272	259	294	301	278	3,738
1990	293	278	303	333	313	343	333	349	340	348	318	253	3,795
1991	244	260	291	312	292	325	304	259	258	246	229	201	3,247
1992	218	249	285	302	293	317	282	233	215	264	277	252	3,187
1993	253	249	266	281	274	335	318	272	242	263	254	215	3,221
1994	233	278	309	298	264	290	285	242	228	290	284	238	3,170
1995	241	242	270	302	282	297	277	282	267	288	296	262	3,256
1996	273	262	272	275	255	264	249	253	286	324	368	362	3,452
1997	420	369	398	370	315	334	300	278	253	297	263	240	3,834
1998	278	335	359	310	283	307	290	268	243	251	241	213	3,356
1999	222	238	260	282	237	263	232	193	164	173	167	205	2,837
2000	225	218	236	258	251	265	228	180	178	255	247	151	2,882
Avg 1948-2000	202	201	211	211	193	213	203	198	183	210	211	196	2,418
Avg 1960-1964	44	38	38	38	35	41	42	45	47	52	53	51	528
Avg 1986-2000	281	288	309	314	289	317	291	267	250	277	280	255	3,418



# J3-27

Estimated Baseflow - Elm Creek at Amboy, Ne. (8882000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950	970	922	984	978	879	976	943	969	915	900	901	918	10,284
1951	925	893	922	922	830	910	881	921	898	832	938	813	10,885
1952	941	899	932	832	940	1,095	1,050	962	872	807	911	885	11,346
1953	919	888	942	963	886	1,004	962	947	864	832	774		9,992
1954													
1955													
1956													
1957													
1958													
1959													
1960													
1961													
1962													
1963													
1964													
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978		933	991	945	850	952	919	923	850	813	784	772	9,698
1979	818	819	898	876	833	1,007	995	973	886	858	827	806	10,969
1980	860	878	944	970	918	978	924	915	807	706	866	896	10,259
1981	767	783	832	835	790	851	802	769	693	670	638	603	9,002
1982	881	789	907	854	888	1,021	998	1,018	960	982	929	895	11,001
1983	923	895	945	885	905	894	957	989	872	716	812	576	10,373
1984	996	795	924	874	945	1,031	968	1,007	894	774	702	894	10,404
1985	750	774	827	839	778	927	831	899	823	623	586	726	9,535
1986	860	878	921	800	805	867	866	884	759	575	534	548	9,523
1987	774	819	884	884	798	884	854	880	787	675	618	629	9,488
1988	725	817	908	909	833	914	858	830	741	684	677	699	9,621
1989	745	729	778	816	762	859	820	805	740	725	699	688	9,141
1990	897	703	754	780	731	843	810	788	713	694	694	656	9,624
1991	665	665	722	738	691	808	805	835	748	641	679	575	8,522
1992	630	884	736	781	751	801	755	740	658	597	588	689	8,381
1993	738	709	730	730	676	788	814	807	819	965	979	957	9,912
1994	997	970	981	831	831	851	919	910	815	744	686	852	10,388
1995	712	779	885	891	818	801	851	837	734	839	588	592	9,207
1996	874	750	837	881	823	893	888	954	884	786	749	764	9,861
1997	872	806	971	876	864	979	916	877	772	706	655	626	10,142
1998	863	762	867	830	875	962	927	892	779	697	667	700	9,771
1999	773	792	886	918	851	942	885	887	781	681	569		8,853
2000													
Avg 1940-2000	792	821	880	895	831	933	900	896	814	753	716	729	9,851
Avg 1950-1964	839	905	937	943	879	1,003	962	930	862	878	872	891	10,778
Avg 1986-2000	756	783	844	860	796	889	856	859	773	701	662	661	9,411

J3-28

Estimated Baseflow - Fox Creek at Curtis, Ne. (#840000)  
(values in cc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951							323	381	418	479	510	502	2,811
1952	533	532	567	582	545	565	527	520	480	405	369	357	5,981
1953	395	435	488	504	487	523	488	458	389	332	305	315	5,099
1954	373	433	487	521	463	535	479	402	313	284	250	277	4,631
1955	335	352	435	454	419	454	434	417	345	264	238	273	4,459
1956	334	350	434	455	449	502	471	430	333	227	158	132	4,308
1957	199	334	429	450	421	479	462	460	410	368	338	323	4,888
1958	358	389	438	458	427	479	450	428	373	341	308	273	4,714
1959													
1961													
1962													
1963													
1964													
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978	222	262	305	328	316	380	380	385	302	188	102	117	3,288
1979	168	236	289	301	287	340	335	334	297	285	254	286	3,373
1980	299	315	348	385	360	407	394	382	297	177	121	141	3,807
1981	181	250	287	308	288	324	318	332	315	310	284	289	3,488
1982	279	287	318	345	350	380	372	378	350	271	238	237	3,783
1983	259	272	301	320	303	348	335	336	283	213	188	216	3,574
1984	258	277	317	349	345	377	372	380	345	279	240	237	3,785
1985	270	308	335	328	307	381	383	380	324	257	231	255	3,754
1986	287	293	313	317	288	355	344	328	268	208	182	202	3,381
1987	235	252	280	294	288	348	342	350	279	226	188	188	3,288
1988	231	268	306	328	323	358	350	353	311	283	242	254	3,583
1989	284	298	317	317	298	350	347	350	285	185	144	173	3,345
1990	212	234	275	314	305	359	351	350	276	170	128	155	3,132
1991	194	221	259	279	273	333	343	354	293	185	106		2,825
1992													
1993		280	301	331	321	374	371	382	387	374	384	338	3,788
1994	338	324	358	402	384	423	408	411	358	282	242	217	4,151
1995	235	284	287										795
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	282	313	354	378	358	406	381	387	332	271	238	249	3,734
Avg 1950-1984	361	412	469	490	459	507	454	437	380	336	308	307	4,581
Avg 1886-2000	252	270	300	323	311	363	367	358	305	236	200	220	3,143

J3-29

Estimated Baseflow - Franchman Creek Gain-Loss Enders to Pallasade, Ne.  
(Values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950										258	339	482	1,058
1951	735	1,080	1,350	1,433	1,341	1,503	1,437	1,426	1,380	1,491	1,804	1,707	16,486
1952	1,814	1,698	1,580	1,288	1,025	1,007	908	887	872	344	332	891	12,212
1953	1,018	1,295	1,587	1,785	1,843	1,708	1,382	874	513	418	470	878	13,377
1954	1,108	1,844	1,958	1,875	1,406	954	463	183	0	0	0	0	8,572
1955	301	893	1,365	1,657	1,587	1,575	1,270	844	584	328	404	834	11,722
1956	1,223	1,436	1,668	1,777	1,505	1,128	588	48	-15	471	813	960	11,603
1957	1,278	1,815	1,875	1,887	1,580	1,432	1,108	902	863	498	545	813	14,195
1958	1,150	1,429	1,961	1,701	1,815	1,832	1,843	1,890	1,390	1,172	1,081	1,142	17,795
1959	1,368	1,858	1,848	1,783	1,804	1,447	1,222	1,124	817	407	437	832	14,575
1960	1,290	1,388	1,608	1,882	1,956	2,235	2,158	2,058	1,553	843	538	708	18,198
1961	1,048	1,447	1,714	1,899	1,812	1,637	1,407	1,108	531	-281	1	1,322	13,177
1962	2,018	1,885	1,847	1,777	1,517	1,547	1,328	1,148	782	271	280	821	15,178
1963	1,402	1,878	2,234	2,277	2,003	2,040	1,496	708	200	71	284	834	15,428
1964	1,303	1,548	1,798	1,884	1,838	2,011	1,858	1,037	429	-81	135	1,038	14,829
1965	1,534	1,485	1,552	1,654	1,585	1,781	1,987	1,411	848	337	284	834	14,885
1966	1,263	1,434	1,845	1,752	1,568	1,584	1,107	384	128	404	866	1,488	13,609
1967	1,842	1,778	1,847	1,878	1,588	1,383	880	313	0	0	322	845	12,752
1968	1,403	1,543	1,734	1,823	1,890	1,671	1,178	418	0	0	225	861	12,348
1969	1,075	1,353	1,818	1,738	1,815	1,773	1,870	1,642	1,034	48	-208	843	13,905
1970	1,339	1,724	1,888	1,842	1,725	1,882	1,275	131	-847	-719	-403	389	10,728
1971	868	1,247	1,509	1,828	1,610	1,582	1,747	1,208	483	-382	-386	508	12,060
1972	1,203	1,584	1,777	1,611	1,343	1,245	1,036	812	612	218	322	845	12,807
1973	1,360	1,414	1,584	1,732	1,695	2,027	1,983	1,823	1,370	487	438	1,287	17,300
1974	1,813	1,814	1,937	2,002	1,812	1,941	1,731	1,543	1,188	834	801	1,117	18,534
1975	1,381	1,429	1,577	1,855	1,806	1,881	1,707	1,488	968	344	345	1,012	15,378
1976	1,481	1,530	1,685	1,774	1,865	1,781	1,830	1,248	563	-443	-481	854	12,813
1977	1,181	1,218	1,294	1,288	1,228	1,523	1,443	1,238	818	280	302	888	12,712
1978	1,314	1,438	1,510	1,378	1,243	1,520	1,548	1,584	1,175	418	225	861	14,023
1979	848	884	1,082	1,083	1,188	1,895	1,708	1,442	838	334	212	821	12,188
1980	1,053	1,387	1,818	1,884	1,548	1,811	1,833	1,571	838	-258	-377	584	13,283
1981	1,132	1,217	1,329	1,345	1,228	1,375	1,262	1,138	776	278	280	821	12,180
1982	1,242	1,407	1,581	1,621	1,483	1,842	1,517	1,410	880	348	413	1,212	14,858
1983	1,687	1,588	1,882	1,730	1,568	1,783	1,700	1,890	1,220	434	340	898	18,412
1984	1,421	1,450	1,583	1,679	1,638	1,795	1,759	1,811	1,334	474	383	1,085	16,370
1985	1,528	1,575	1,850	1,592	1,418	1,588	1,508	1,472	815	-88	-159	708	13,724
1986	1,218	1,253	1,485	1,738	1,841	1,887	1,463	1,354	833	331	257	843	14,228
1987	1,288	1,388	1,510	1,478	1,332	1,488	1,398	1,304	778	-80	-180	873	12,248
1988	1,123	1,380	1,598	1,808	1,544	1,837	1,583	1,488	1,034	388	383	1,085	14,811
1989	1,488	1,484	1,547	1,593	1,448	1,577	1,398	1,198	788	281	280	852	13,928
1990	1,224	1,271	1,442	1,814	1,508	1,800	1,451	1,387	806	-145	-292	437	12,285
1991	888	1,269	1,505	1,587	1,438	1,578	1,518	1,372	998	-118	-328	458	12,445
1992	1,067	1,401	1,888	1,718	1,804	1,858	1,485	1,271	855	432	487	1,020	14,881
1993	1,388	1,407	1,488	1,488	1,373	1,591	1,802	1,711	1,451	862	810	1,244	16,843
1994	1,504	1,512	1,588	1,578	1,488	1,735	1,808	1,374	1,018	883	888	1,082	15,828
1995	1,317	1,337	1,470										4,123
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	1,284	1,448	1,624	1,873	1,532	1,848	1,443	1,198	770	273	294	853	13,554
Avg 1950-1984	1,220	1,488	1,721	1,785	1,572	1,585	1,304	1,008	878	417	484	861	13,280
Avg 1988-2000	1,257	1,366	1,525	1,598	1,484	1,625	1,502	1,404	865	305	248	838	13,118

J3-30

Est - Frenchman Creek - Gain-Loss Palisade Gage to Culbertson Gage, Ne (gain does not include Stinking Water)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950										428	639	713	1,780
1951	767	762	732	818	582	828	1,010	1,287	1,514	1,881	1,888	1,826	13,769
1952	1,820	1,188	928	695	496	478	588	934	1,007	803	628	204	9,870
1953	118	351	848	983	987	890	906	951	877	798	835	998	9,451
1954	1,112	1,037	1,104	1,211	1,153	1,298	1,242	1,228	1,148	1,154	1,121	1,052	13,857
1955	1,029	1,004	945	778	593	556	494	454	290	103	0	0	8,265
1956	82	240	387	501	529	918	1,102	1,338	1,382	1,436	1,410	1,508	10,742
1957	1,289	1,124	971	892	592	892	1,043	1,198	1,319	1,578	1,859	1,543	13,880
1958	1,480	1,272	1,225	1,218	1,003	889	884	1,218	1,333	1,377	1,149	654	13,696
1959	398	303	205	70	183	574	712	828	422	150	178	524	4,324
1960	718	878	590	388	375	853	781	851	644	228	0	0	5,902
1961	194	568	739	841	503	483	327	118	0	0	88	257	3,975
1962	410	800	881	846	845	823	802	998	948	868	784	415	9,182
1963	364	584	688	812	548	884	851	562	539	668	788	828	7,494
1964	822	847	960	805	788	787	682	682	578	808	520	819	8,059
1965	896	865	868	832	587	727	714	873	787	1,179	1,318	1,172	9,819
1966	1,253	1,403	1,371	1,002	708	718	660	1,322	1,415	1,277	1,069	814	13,206
1967	624	426	370	467	553	753	952	1,308	1,485	1,889	1,815	1,286	11,517
1968	1,114	994	921	792	718	852	824	1,075	839	288	103	302	8,831
1969	424	422	338	114	74	280	515	901	1,038	1,031	885	643	6,854
1970	547	530	512	438	448	700	851	1,020	894	886	854	910	6,887
1971	883	597	470	423	488	778	1,013	1,320	1,478	1,654	1,443	849	11,382
1972	536	858	840	782	844	1,033	1,108	1,321	1,185	825	689	813	10,350
1973	983	1,113	1,194	1,120	1,024	1,248	1,245	1,237	1,081	853	895	1,199	13,183
1974	1,380	1,208	1,142	1,038	882	981	958	1,099	1,057	1,081	1,004	882	12,831
1975	828	897	1,011	863	787	1,058	1,140	1,224	1,153	1,071	881	603	11,718
1976	543	627	716	747	696	704	714	855	788	630	399	130	7,888
1977	130	382	488	453	473	784	1,119	1,398	1,434	744	382	421	8,404
1978	489	857	885	824	859	1,142	1,287	1,120	856	437	420	382	8,128
1979	-171	189	433	541	654	1,004	1,131	1,187	978	581	289	88	6,893
1980	38	111	185	250	384	684	844	982	781	382	74	-88	4,586
1981	0	357	560	560	558	734	858	1,072	1,128	1,159	975	588	8,537
1982	488	909	858	560	555	842	819	915	784	628	812	483	7,827
1983	559	735	838	938	884	1,042	980	883	734	808	369	130	8,798
1984	0	0	101	310	474	828	858	1,072	1,034	880	585	242	8,235
1985	174	353	438	384	388	581	708	868	770	492	250	82	5,481
1986	60	178	341	538	687	953	1,030	1,062	538	-474	-858	-518	3,510
1987	-115	389	858	848	583	857	716	900	828	688	388	269	6,503
1988	217	201	164	82	148	487	828	810	812	722	704	553	5,082
1989	884	723	782	820	882	892	989	982	700	480	318	360	8,001
1990	382	385	415	510	512	582	628	787	841	308	83	30	5,241
1991	0	0	78	233	428	828	1,081	1,320	1,188	748	360	124	6,387
1992	0	0	158	484	682	828	824	1,087	979	707	829	789	7,225
1993	831	709	887	898	739	1,073	1,244	1,443	1,421	1,348	1,229	1,079	12,499
1994	1,104	1,181	1,171	1,011	863	1,014	1,057	1,180	1,078	843	529	172	11,182
1995	157	482	724	900	788	849	898	813	837	821	804	194	7,584
1996	80	148	154	52	72	243	456	753	788	630	487	419	4,281
1997	488	597	814	488	356	342	378	554	472	188	0	0	4,423
1998	54	180	287	422	521	781	878	987	587	-318	-874	-405	3,270
1999	-174	58	178	189	172	242	386	701	812	-157	-389		1,705
2000													
Avg 1940-2000	528	578	825	808	595	771	856	991	915	728	588	513	8,180
Avg 1950-1964	745	733	749	717	682	783	809	884	858	812	784	728	8,801
Avg 1966-2000	259	367	455	487	506	582	784	940	803	457	248	234	6,206

# J3-31

Estimated Baseflow - Frenchman Creek at Culbertson, Na. (8835600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	1,766	3,210	4,937	7,237	9,122	9,238	7,628	4,410	2,462	2,268	2,507	3,149	58,600
1941	4,680	7,498	9,486	10,121	9,362	10,158	8,888	7,307	5,128	3,128	3,038	5,011	84,076
1942	6,884	7,821	9,088	9,881	9,217	9,883	9,164	8,843	6,538	3,700	3,884	8,690	91,284
1943	8,905	9,311	9,965	9,922	8,802	9,407	7,370	4,234	2,041	1,371	1,341	2,000	74,867
1944	3,911	8,888	8,844	9,075	8,779	8,572	9,050	8,679	8,934	4,724	3,224	2,889	81,988
1945	4,192	7,285	9,253	9,315	8,324	8,928	7,197	4,624	2,815	2,404	3,144	5,018	72,900
1946	6,683	7,402	8,502	9,262	9,851	9,519	8,230	8,475	4,448	2,884	3,357	5,948	81,494
1947	8,188	9,085	10,127	10,342	9,391	10,274	9,272	8,286	6,385	4,477	3,332	3,138	92,246
1948	4,684	7,400	9,831	11,215	10,810	10,758	8,284	4,889	2,504	1,874	1,615	1,789	75,622
1949	4,072	8,083	10,628	10,837	9,848	11,185	10,785	10,833	8,280	4,105	1,848	1,851	92,514
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
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Avg 1940-2000	5,417	7,359	9,044	9,722	9,144	9,900	8,583	6,834	4,747	3,092	2,709	3,738	80,288

J3-32

Estimated Baseflow - Frenchman Creek near Champion, Ne. (6930600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	848	858	973	1,077	1,033	1,045	804	765					7,514
1941													
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### J3-33

Estimated Baseflow - Frenchman Creek near Hamlet, Nc. (8833800)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	4,359	4,328	4,505	4,468	4,159	4,446	4,188	4,110	3,991	4,423	4,650	4,696	52,308
1941	5,115	5,282	5,722	5,971	5,473	5,970	5,623	5,577	5,042	4,897	4,494	4,480	63,424
1942	4,815	5,185	5,896	6,541	6,090	6,463	5,893	5,974	5,283	4,849	4,685	5,454	67,128
1943	6,351	6,604	6,819	6,613	5,641	5,784	5,214	5,060	4,715	4,774	4,680	4,446	66,820
1944	4,785	5,091	5,741	6,233	6,046	6,419	6,013	5,832	5,173	4,743	4,471	4,413	64,984
1945	4,951	5,500	6,171	6,420	5,792	6,011	5,400	5,094	4,540	4,381	4,262	4,268	62,790
1946	4,650	4,942	5,526	6,233	5,330	6,141	5,627	5,485	4,870	4,442	4,716	5,712	64,072
1947	6,505	6,296	6,487	6,387	6,889	6,126	5,801	5,890	5,358	4,910	4,802	5,081	69,258
1948	5,653	5,812	6,381	6,724	6,276	6,276	5,623	5,319	4,808	4,775	4,722	4,884	67,012
1949	5,284	5,929	6,571	6,605	5,967	6,573	6,316	6,468	5,902	5,385	5,382	5,937	72,321
1950	6,495	6,241	6,510	6,888	6,018	6,409	5,638	5,528	4,883	4,588	4,788	5,441	69,401
1951													
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Avg 1940-1990	5,370	5,553	6,035	6,282	5,721	6,055	5,804	5,487	4,961	4,704	4,665	4,963	65,412

J3-34

Estimated Baseflow - Frenchman Creek near Imperial, Ne (8831500)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941				4,078	3,592	4,121	3,875	3,992	3,231	3,282	3,273	3,269	32,282
1942	3,537	3,631	4,156	4,765	4,398	4,411	3,989	4,038	3,720	3,537	3,551	3,782	47,513
1943	4,248	4,428	4,732	4,713	4,059	4,036	3,815	3,824	3,437	3,521	3,404	3,094	48,813
1944	3,237	3,415	3,921	4,425	4,269	4,302	3,977	3,677	3,306	3,228	3,116	2,989	43,762
1945	3,228	3,419	3,813	4,068	3,668	3,780	3,318	3,075	2,831	2,989	3,171	3,330	40,879
1946	3,556	3,587	3,698	4,138	3,639	3,696	3,259	3,812	3,233	3,358	3,128	3,782	42,978
1947	4,388	4,473	4,868	4,522	3,858	3,828	3,848	3,841	3,603	3,395	3,428	3,722	47,481
1948	4,102	4,058	4,414	4,778	4,402	4,143	3,607	3,485	3,253	3,371	3,509	3,852	46,779
1949	4,183	4,514	4,967	5,065	4,409	4,307	4,043	4,366	4,057	3,820	3,858	4,199	51,428
1950	4,838	4,388	4,541	4,680	4,131	4,247	3,723	3,377	3,068	3,257	3,338	4,034	47,849
1951	4,481	4,400	4,810	4,884	4,081	4,108	3,827	4,433	4,461	4,830	4,759	4,858	53,474
1952	5,051	4,889	4,955	5,388	5,088	4,983	4,458	4,364	4,002	3,824	3,709	3,387	53,988
1953	3,896	4,084	4,373	4,109	3,595	3,999	3,829	3,848	3,817	3,833	3,529	3,317	45,597
1954	3,556	3,785	4,130	4,178	3,823	3,589	3,425	3,854	3,906	3,978	3,780	3,328	45,179
1955	3,555	4,012	4,583	4,808	4,183	3,905	3,414	3,537	3,484	3,723	3,681	3,381	48,235
1956	3,888	4,150	4,583	4,563	4,011	3,833	3,336	3,782	3,737	3,827	3,487	3,339	45,988
1957	3,798	4,217	4,638	4,559	4,005	4,248	3,950	3,949	3,890	3,871	3,983	3,441	47,884
1958	3,858	4,351	4,815	4,802	4,247	4,486	4,152	4,094	3,759	3,659	3,824	3,374	48,129
1959	3,754	4,185	4,885	4,798	4,216	4,253	3,781	3,857	3,325	3,183	3,078	3,065	48,041
1960	3,582	4,104	4,697	4,849	4,645	4,723	4,203	3,818	3,278	3,081	2,899	2,823	46,781
1961	3,283	3,618	4,387	4,584	4,151	4,389	4,020	3,666	3,560	3,605	3,501	3,260	46,414
1962	3,690	4,247	4,888	4,481	3,774	3,730	3,448	3,727	3,892	3,821	3,874	3,648	48,973
1963	4,167	4,308	4,983	4,899	4,282	4,199	3,899	4,302	4,157	3,978	3,818	3,688	50,464
1964	3,917	3,872	4,290	4,478	4,283	4,351	4,281	4,197	3,808	3,804	3,387	3,108	47,769
1965	3,337	3,837	4,105	4,378	4,031	4,340	4,102	4,185	3,857	4,012	4,037	4,036	45,138
1966	4,214	4,033	4,189	4,281	3,721	3,881	3,402	3,730	3,875	4,342	4,408	4,050	47,906
1967	4,098	4,019	4,300	4,546	3,938	3,874	3,531	4,377	4,587	4,732	4,542	4,042	50,389
1968	4,090	4,088	4,281	4,298	3,878	3,799	3,572	3,851	3,844	3,409	3,319	3,402	45,577
1969	3,684	3,641	3,824	4,154	3,848	3,821	3,222	3,739	3,870	3,831	3,403	3,511	43,487
1970	3,487	3,485	3,815	4,138	3,788	3,848	3,878	3,781	3,454	3,148	2,827	2,832	42,477
1971	3,054	3,205	3,582	3,900	3,659	4,038	3,581	3,973	3,841	3,359	3,240	3,317	42,858
1972	3,585	3,592	3,705	3,581	3,208	3,306	3,300	3,787	3,578	3,151	2,839	2,990	40,680
1973	3,232	3,255	3,431	3,431	3,041	3,225	3,184	3,825	3,321	2,955	2,780	2,776	38,118
1974	3,080	3,223	3,488	3,523	3,080	3,120	2,984	3,338	3,197	2,785	2,897	2,973	36,983
1975	2,898	2,908	3,130	3,284	2,811	2,915	2,797	3,189	3,048	2,787	2,545	2,811	34,871
1976	2,687	2,781	2,979	3,074	2,770	2,814	2,475	2,828	2,718	2,462	2,227	2,048	31,651
1977	2,102	2,118	2,314	2,483	2,380	2,705	2,683	2,808	2,590	2,281	2,080	2,051	28,525
1978	2,203	2,257	2,443	2,535	2,284	2,448	2,391	2,825	2,402	2,011	1,700	1,817	26,827
1979	1,985	1,843	1,781	1,847	1,709	1,929	1,984	2,198	2,041	1,794	1,528	1,481	21,412
1980	1,579	1,683	1,829	1,847	1,757	1,857	1,848	2,020	1,881	1,597	1,438	1,407	20,702
1981	1,487	1,514	1,602	1,608	1,568	2,010	2,188	2,417	2,282	2,042	1,833	1,681	22,231
1982	1,741	1,759	1,875	1,912	1,721	1,850	1,989	2,250	2,821	2,175	1,813	1,780	23,786
1983	1,842	1,863	2,078	2,301	2,180	2,336	2,214	2,251	2,014	1,785	1,588	1,518	23,927
1984	1,821	1,898	1,824	2,139	2,031	2,002	1,851	1,912	1,773	1,683	1,580	1,541	21,734
1985	1,844	1,880	1,810	2,171	1,982	1,982	1,824	2,020	1,835	1,548	1,388	1,442	21,422
1986	1,569	1,581	1,728	1,848	1,735	1,809	1,874	1,908	1,721	1,535	1,417	1,369	20,243
1987	1,543	1,687	1,883	1,863	1,842	2,117	2,024	1,950	1,898	1,599	1,285	1,292	20,651
1988	1,488	1,689	1,881	1,885	1,817	2,007	1,994	2,100	1,824	1,387	1,199	1,308	20,547
1989	1,478	1,527	1,834	1,843	1,809	1,720	1,858	1,837	1,434	1,238	1,120	1,111	17,703
1990	1,232	1,329	1,490	1,582	1,478	1,843	1,574	1,580	1,348	1,043	898	820	15,989
1991	903	963	1,158	1,328	1,337	1,837	1,645	1,854	1,335	1,008	762	775	14,818
1992	875	984	1,137	1,239	1,204	1,278	1,181	1,110	874	911	847	783	12,532
1993	802	1,084	1,303	1,818	1,479	1,856	1,808	1,833	1,555	1,521	1,428	1,282	18,988
1994	1,385	1,503	1,878	1,735	1,885	1,733	1,850	1,350	1,105	982	884	828	18,285
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1941-1994	2,873	3,102	3,388	3,531	3,185	3,279	3,068	3,189	2,985	2,845	2,745	2,705	36,821
Avg 1950-1984	3,905	4,182	4,576	4,665	4,152	4,201	3,856	3,825	3,704	3,889	3,812	3,486	47,892
Avg 1986-1994	1,261	1,371	1,542	1,639	1,554	1,748	1,678	1,860	1,445	1,225	1,080	1,086	17,278



J3-35

Estimated Baseflow - Medlona Creek above Harry Strunk Lake, Ne (6641000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950					3,894	4,299	3,981	3,353	2,875	2,866	2,843	2,805	26,799
1951	3,058	3,218	3,349	3,115	2,775	3,241	3,375	3,613	3,628	3,886	3,760	3,451	40,672
1952	3,577	3,676	3,907	3,870	3,661	4,004	3,770	3,955	3,073	2,754	2,461	2,239	40,826
1953	2,515	2,678	3,453	3,637	3,348	3,652	3,407	3,309	2,809	2,281	1,916	1,777	35,061
1954	2,214	2,967	3,515	3,549	3,211	3,530	3,278	3,113	2,488	1,732	1,514	1,602	33,013
1955	2,442	2,848	3,289	3,508	3,238	3,517	3,218	2,899	2,330	1,522	1,316	1,782	32,018
1956	2,206	2,334	2,571	2,688	2,760	3,384	3,233	2,763	2,206	1,902	1,726	1,715	29,482
1957	1,969	2,306	2,690	2,911	2,847	3,429	3,496	3,692	3,267	2,721	2,408	2,423	34,209
1958	2,794	3,160	3,527	3,506	3,313	4,596	3,882	3,538	3,014	2,745	2,552	2,488	39,558
1959	2,813	3,237	3,517	3,314	3,046	3,730	3,837	3,410	2,749	2,026	1,862	2,319	35,662
1960	2,882	3,208	3,548	3,568	3,503	4,102	3,698	3,793	3,134	2,445	2,078	2,106	38,362
1961	2,477	2,891	3,159	2,977	2,838	3,699	3,776	3,690	3,038	2,209	1,855	2,057	34,862
1962	2,458	2,762	2,925	2,855	2,475	3,232	3,319	3,268	3,293	3,681	3,616	3,627	37,489
1963	3,735	3,658	3,709	3,522	3,161	3,754	3,543	3,204	2,636	2,026	1,855	2,472	37,434
1964	2,988	3,144	3,471	3,858	3,607	4,090	3,797	3,342	2,521	1,696	1,499	2,004	35,603
1965	2,567	2,889	3,167	3,185	2,881	3,286	3,152	3,148	2,734	2,283	2,287	2,841	34,381
1966	3,366	3,453	3,681	3,703	3,379	3,799	3,508	3,196	2,718	2,462	2,457	2,723	36,441
1967	3,123	3,275	3,522	3,531	3,242	3,706	3,624	3,692	3,371	3,102	2,881	2,746	39,615
1968	3,025	3,336	3,709	3,602	3,563	3,622	3,633	3,631	2,987	2,079	1,719	1,968	37,322
1969	2,471	2,679	3,314	3,505	3,333	3,861	3,615	3,213	2,782	2,740	2,759	2,846	37,336
1970	3,222	3,481	3,783	3,774	3,485	4,052	3,802	3,448	2,642	1,746	1,484	1,836	36,854
1971	2,529	2,971	3,452	3,673	3,482	4,003	3,635	3,711	3,049	2,250	1,992	2,350	37,296
1972	2,859	3,177	3,528	3,590	3,412	3,703	3,504	3,388	2,813	2,154	1,931	2,208	36,267
1973	2,564	2,666	3,113	3,588	3,482	3,907	3,681	3,559	3,167	2,993	2,867	2,893	36,966
1974	3,298	3,363	3,915	3,632	3,356	3,614	3,542	3,224	2,509	1,729	1,616	1,835	35,564
1975	2,411	2,690	2,962	3,048	2,891	3,438	3,267	2,977	2,437	1,896	1,783	1,875	31,756
1976	2,163	2,394	2,902	3,462	3,458	3,578	3,262	3,064	2,568	2,131	1,961	2,161	33,120
1977	2,432	2,494	2,898	2,798	2,746	3,481	3,483	3,408	2,849	2,179	1,910	2,110	32,968
1978	2,387	2,474	2,841	2,847	2,550	3,201	3,233	3,202	2,556	1,619	1,167	1,385	29,104
1979	1,804	2,245	2,538	2,448	2,365	3,102	3,136	2,978	2,638	2,467	2,317	2,158	30,211
1980	2,407	2,789	3,112	3,152	3,000	3,261	3,100	2,967	2,278	1,354	1,025	1,376	29,812
1981	1,645	2,339	2,706	2,746	2,599	3,117	3,032	2,893	2,615	2,567	2,419	2,190	31,107
1982	2,402	2,756	3,015	2,892	2,861	3,205	3,291	3,517	3,107	2,436	2,153	2,328	33,763
1983	2,704	2,953	3,228	3,443	3,205	3,616	3,458	3,407	2,806	2,014	1,868	1,819	34,381
1984	2,198	2,532	2,847	3,193	3,106	3,320	3,161	3,153	2,740	2,281	2,016	1,999	32,647
1985	2,266	2,596	2,821	2,968	2,767	3,190	3,056	2,979	2,580	2,208	2,083	2,273	31,996
1986	2,483	2,411	2,662	3,067	2,949	3,265	3,085	3,025	2,451	1,678	1,368	1,653	30,178
1987	2,107	2,423	2,819	3,052	2,871	3,191	2,910	2,808	2,078	1,613	1,434	1,584	28,659
1988	2,011	2,476	2,934	3,128	3,024	3,242	2,989	2,757	2,283	1,889	1,782	2,002	30,518
1989	2,359	2,568	2,885	2,991	2,768	3,083	2,806	2,484	1,894	1,596	1,557	1,808	28,990
1990	2,323	2,525	2,832	2,992	2,786	3,106	2,928	2,827	2,264	1,931	1,205	1,360	28,677
1991	1,801	2,323	2,775	2,920	2,725	3,066	2,949	2,852	2,439	1,718	1,411	1,558	26,670
1992	2,007	2,490	2,918	2,922	2,784	2,876	2,724	2,677	2,159	2,069	2,044	2,043	29,470
1993	2,270	2,441	2,772	3,024	2,965	3,562	3,497	3,401	3,232	3,444	3,503	3,399	37,509
1994	3,594	3,630	3,856	3,908	3,537	3,873	3,547	3,276	2,735	2,303	2,163	2,326	38,741
1995	2,688	2,800	3,209	3,323	3,075	3,454	3,314	3,308	2,737	1,949	1,688	1,873	33,596
1996	2,362	2,611	2,832	2,777	2,693	3,159	3,104	2,695	2,764	2,798	2,847	2,913	33,875
1997	3,116	3,069	3,078	2,832	2,843	3,409	3,424	3,258	2,816	2,465	2,462	2,776	35,371
1998	3,152	3,202	3,434	3,529	3,245	3,623	3,401	3,250	2,707	2,136	1,773	1,683	35,135
1999	2,001	2,467	2,890	3,261	3,064	3,373	3,157	3,050	2,516	1,887	1,662	1,602	31,351
2000													
Avg 1950-1999	2,583	2,850	3,167	3,245	3,076	3,530	3,378	3,227	2,727	2,247	2,059	2,211	34,061
Avg 1950-1964	2,725	3,029	3,331	3,320	3,179	3,711	3,573	3,395	2,883	2,433	2,237	2,343	35,332
Avg 1966-1999	2,450	2,678	2,993	3,123	2,938	3,313	3,131	2,977	2,512	2,080	1,921	2,081	32,198

J3-36

Estimated Baseflow - Medicine Creek at Maywood, Ne. (6239000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951								1,003	1,291	1,282	1,253	1,208	6,038
1952	1,315	1,403	1,557	1,837	1,358	1,838	1,485	1,283	1,014	808	755	874	15,308
1953	1,084	1,198	1,410	1,579	1,478	1,572	1,401	1,281	1,008	781	711	818	14,278
1954	1,082	1,387	1,815	1,825	1,445	1,535	1,390	1,301	1,084	890	800	837	14,981
1955	1,029	1,255	1,483	1,588	1,459	1,587	1,382	1,224	973	778	765	852	14,447
1956	1,152	1,228	1,371	1,480	1,418	1,528	1,341	1,087	818	735	728	797	13,840
1957	1,024	1,289	1,458	1,488	1,382	1,558	1,812	1,549	1,310	1,071	981	1,068	15,928
1958	1,259	1,408	1,578	1,824	1,502	1,898	1,548	1,357	1,128	1,028	875	988	18,085
1959													
1960													
1961													
1962													
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1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1951-1956	1,132	1,310	1,500	1,572	1,484	1,586	1,448	1,258	1,078	821	871	942	13,839
Avg 1950-1964	1,132	1,310	1,500	1,572	1,484	1,586	1,448	1,258	1,078	821	871	942	13,839

# J3-37

Estimated Baseflow - Mitchell Creek above Harry Strunk Lake, Nebr.  
(Values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950								0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
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1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg 1950-1964	0	0	0	0	0	0	0	0	0	0	0	0	0

J3-38

Estimated Baseflow - Muddy Creek at Arapahoe, Ne. (6944000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951				251	228	333	379	422	418	419	389	330	3,120
1952	354	415	488	528	500	510	435	350	235	125	70	81	4,088
1953	143	244	339	403	382	394	351	331	235	83	17	20	2,953
1954	81	194	264	270	257	310	308	305	229	109	58	88	2,474
1955	158	252	304	288	253	282	255	224	183	84	54	130	2,418
1956	188	201	235	270	284	369	358	310	227	139	84	71	2,744
1957	100	181	209	228	240	328	362	406	385	345	287	219	3,267
1958	217	254	305	348	344	406	408	431	411	404	348	248	4,127
1959	235	277	297	287	281	371	389	373	310	241	200	185	3,415
1960	229	272	301	289	275	318	308	284	264	255	248	239	3,291
1961	268	300	342	363	342	389	384	401	368	326	298	289	4,068
1962	306	312	340	358	340	392	389	407	394	403	402	392	4,435
1963	418	427	440	414	385	411	395	383	345	297	298	258	4,408
1964	290	327	378	413	409	453	421	381	312	258	217	193	4,083
1965	221	274	325	347	337	405	408	422	405	410	408	400	4,383
1966	420	413	457	512	495	564	530	484	441	434	429	427	5,816
1967	462	475	525	565	518	548	504	500	467	488	459	439	5,927
1968	475	508	564	592	563	591	533	477	401	384	333	312	5,718
1969	338	369	428	471	457	530	525	541	520	533	531	515	5,786
1970	534	519	548	572	529	589	549	520	455	418	375	332	5,941
1971	364	428	500	544	505	542	509	510	481	424	384	347	5,516
1972	379	431	484	494	460	475	443	439	410	415	378	303	5,111
1973													
1974													
1975													
1976													
1977													
1978	365	395	403	348	285	313	295	290	287	262	285	276	3,763
1979	320	358	392	368	350	399	387	400	390	409	396	349	4,533
1980	365	395	421	403	373	410	396	397	342	274	243	258	4,275
1981	302	344	385	369	354	395	382	382	380	398	385	343	4,449
1982	348	351	398	385	332	381	383	413	407	417	408	384	4,559
1983	384	390	384	422	399	444	430	442	428	438	428	398	4,949
1984	385	343	353	380	387	457	478	517	484	489	410	324	4,895
1985	320	357	399	410	391	469	433	428	384	384	335	388	4,784
1986	418	421	452	468	434	490	467	456	418	404	381	350	5,186
1987	399	397	423	437	403	451	438	449	413	382	351	324	4,887
1988	358	401	451	468	447	490	452	409	387	383	384	370	4,975
1989	343	378	392	395	361	408	382	365	333	333	333	333	4,391
1990	355	356	398	418	388	429	399	377	332	309	290	278	4,315
1991	305	340	358	418	381	401	381	400	362	312	278	265	4,232
1992	303	345	390	394	372	402	381	373	331	299	284	290	4,187
1993	312	312	397	449	454	525	502	481	448	467	474	468	5,296
1994	498	507	541	551	515	602	577	549	503	512	478	387	5,230
1995	407	453											850
1996													
1997													
1998				490	543	499	459	401	385	347	294		3,418
1999	308	347	382	408	383	441	429	428	395	384	368	349	4,828
2000													
Avg 1940-2000	325	356	394	408	367	438	421	413	372	346	320	300	4,325
Avg 1950-1964	230	280	328	331	321	375	367	359	306	249	210	197	3,481
Avg 1986-2000	368	387	416	440	421	471	448	431	391	379	361	341	4,378

J3-39

Est Baseflow - Red Willow Creek - Gain-Loss Below Hugh Butler Reservoir to Red Willow, Ne.  
(Values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941		115	117	117	112	139	115	57	44	88	129	180	1,182
1942	200	223	247	251	219	221	182	177	165	180	204	238	2,515
1943	266	280	248	202	167	201	180	168	142	131	128	132	2,235
1944	107	35	28	87	107	108	110	132	133	128	156	217	1,346
1945	249	223	198	148	129	166	184	182	178	208	226	228	2,348
1946	248	250	251	223	191	218	219	228	227	250	286	361	2,655
1947	406	381	364	314	255	287	243	235					2,484
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
1959													
1960													
1961		163	192	219	215	247	241	243	177	63	14	40	1,814
1962	104	196	284	289	272	301	287	288	277	292	301	303	3,173
1963	321	314	329	335	295	302	250	194	119	42	74	217	2,792
1964	316	336	361	358	330	343	268	148	56	21	44	159	2,713
1965	195	221	255	273	261	301	300	317	270	193	181	240	3,007
1966	299	323	346	337	308	354	302	204	196	36	67	195	2,891
1967	277	280	306	327	305	338	289	216	127	45	0	0	2,508
1968	65	191	245	205	188	230	207	148	82	29	0	0	1,585
1969	26	75	159	208	248	335	329	278	181	65	60	178	2,123
1970	272	313	334	320	247	251	137	-84	-189	-181	-130	-19	1,291
1971	76	151	210	236	247	319	253	86	-37	-106	-56	107	1,486
1972	233	297	318	262	244	319	329	310	218	77	51	151	2,807
1973	233	273	301	289	267	323	278	175	88	31	36	107	2,398
1974	184	249	320	373	364	409	284	-19	-174	-195	-102	101	1,779
1975	242	300	335	317	285	334	221	-14	-178	-273	-243	-53	1,245
1976	46	154	235	275	286	338	181	-158	-356	-429	-321	-34	220
1977	138	187	204	187	164	255	240	150	39	-83	-111	-36	1,312
1978	0	0	36	108	122	107	-21	-262	-413	-610	-395	-70	-1,295
1979	100	111	117	105	127	233	265	256	181	65	18	83	1,631
1980	112	182	238	259	272	304	293	189	15	-225	-258	-88	1,342
1981	66	117	166	180	166	257	265	288	218	142	138	211	2,225
1982	255	241	287	310	299	328	284	258	129	-79	-123	15	2,193
1983	128	208	289	354	333	329	279	348	168	60	33	86	2,528
1984	158	197	242	273	284	334	328	314	154	-139	-169	25	1,982
1985	159	202	226	211	201	268	251	188	104	-15	-15	113	1,802
1986	198	218	252	217	203	253	254	231	136	-18	-41	73	1,935
1987	173	242	296	312	276	275	222	188	87	-69	-70	72	1,863
1988	161	240	288	292	261	313	301	283	209	74	42	124	2,837
1989	169	215	248	258	243	278	265	256	181	65	12	36	2,243
1990	95	181	244	286	247	268	237	205	56	-201	-254	-79	1,288
1991	47	126	184	209	208	253	233	182	56	-170	-200	-18	1,121
1992	112	182	230	237	226	244	211	160	95	34	35	102	1,686
1993	163	189	214	196	180	257	273	296	209	127	80	20	2,154
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	174	209	242	248	235	274	240	173	84	-6	-5	93	1,948
Avg 1950-1964	247	252	286	300	278	288	262	218	158	104	108	172	2,823
Avg 1988-2000	145	201	242	247	233	288	249	221	126	-20	-62	41	1,902

J3-40

Estimated Baseflow - Red Willow Creek above Hugh Butler Lake, Ne. (5837300)  
(values in sc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958													
1959													
1960													
1961	777	864	978	1,031	847	1,027	950	911	787	623	638	823	10,337
1962	955	919	841	829	848	975	958	979	942	973	1,027	1,099	11,545
1963	1,304	1,484	1,818	1,549	1,353	1,463	1,315	1,179	894	584	530	757	14,028
1964	946	988	1,085	1,140	1,114	1,238	1,172	1,097	843	522	433	664	11,282
1965	853	850	1,088	1,121	1,051	1,198	1,157	1,181	979	788	719	852	11,877
1966	1,052	1,310	1,488	1,496	1,379	1,592	1,406	1,085	856	689	670	860	14,302
1967	888	1,078	1,248	1,378	1,341	1,579	1,541	1,513	1,354	1,248	1,115	975	15,334
1968	1,037	1,170	1,330	1,398	1,353	1,473	1,351	1,206	996	868	848	847	13,974
1969	1,096	1,180	1,278	1,334	1,285	1,484	1,392	1,248	1,044	833	819	1,003	14,133
1970	1,235	1,458	1,692	1,729	1,611	1,857	1,645	1,382	825	633	594	713	15,312
1971	913	1,058	1,202	1,237	1,164	1,362	1,344	1,356	1,139	824	689	782	13,063
1972	919	985	1,084	1,180	1,180	1,331	1,296	1,280	1,067	890	788	811	12,821
1973	800	913	1,020	1,124	1,123	1,389	1,377	1,328	1,081	780	749	1,013	12,787
1974	1,288	1,360	1,519	1,608	1,514	1,724	1,594	1,433	1,121	819	697	784	15,439
1975	921	896	1,101	1,138	1,051	1,184	1,135	1,128	969	792	738	883	12,053
1976	1,029	1,068	1,181	1,281	1,254	1,422	1,333	1,192	839	709	647	778	12,812
1977	931	1,004	1,133	1,218	1,189	1,368	1,312	1,255	1,052	848	785	830	12,882
1978	929	848	1,007	1,018	822	1,018	904	788	618	546	523	556	9,782
1979	879	816	955	1,015	957	1,128	1,108	1,123	984	818	722	718	11,028
1980	806	894	999	1,029	889	1,074	994	905	705	493	454	607	9,947
1981	811	872	1,122	1,161	1,107	1,261	1,250	1,121	812	755	683	742	11,866
1982	872	877	1,089	1,140	1,081	1,277	1,251	1,234	1,078	919	905	1,049	12,881
1983	1,210	1,240	1,364	1,459	1,378	1,566	1,452	1,318	1,009	665	532	642	13,837
1984	794	884	1,030	1,115	1,140	1,348	1,315	1,241	888	681	548	617	11,709
1985	783	855	1,118	1,170	1,098	1,298	1,192	1,038	821	691	677	870	11,877
1986	1,168	1,133	1,295	1,278	1,205	1,383	1,258	1,091	807	618	586	729	12,427
1987	920	1,051	1,214	1,300	1,257	1,498	1,390	1,127	832	605	512	574	12,242
1988	781	1,044	1,240	1,281	1,209	1,337	1,231	1,087	841	615	595	799	12,040
1989	960	1,053	1,144	1,197	1,052	1,167	1,037	868	665	531	530	672	10,867
1990	832	911	1,042	1,134	1,106	1,314	1,194	983	853	465	407	530	10,578
1991	700	837	988	1,071	1,035	1,217	1,131	985	734	483	403	518	10,104
1992	739	881	1,177	1,224	1,178	1,274	1,197	1,141	1,004	927	884	914	12,947
1993	1,024	1,086	1,209	1,254	1,197	1,428	1,401	1,371	1,238	1,185	1,119	1,108	14,607
1994	1,240	1,387	1,524	1,573	1,453	1,831	1,423	1,106	814	685	675	795	14,289
1995	883	1,152	1,320	1,378	1,286	1,460	1,377	1,307	1,070	812	700	782	13,821
1996	940	1,123	1,282	1,304	1,262	1,423	1,349	1,248	1,103	1,072	1,070	1,089	14,274
1997	1,200	1,225	1,322	1,369	1,282	1,475	1,398	1,117	858	682	653	796	13,289
1998	801	877	1,074	1,092	1,011	1,159	1,070	949	781	586	504	523	10,597
1999	817	710	890	1,080	1,088	1,233	1,118	953	725	540	508	643	10,114
2000	798	880	984	1,052	1,018	1,100	955	735	534	444	374	335	9,218
Avg 1961-2000	947	1,050	1,182	1,238	1,178	1,343	1,254	1,135	918	738	684	781	12,443
Avg 1950-1964	966	1,064	1,185	1,182	1,065	1,178	1,089	1,041	861	678	682	835	11,793
Avg 1986-2000	823	1,038	1,175	1,236	1,178	1,339	1,228	1,068	844	683	635	717	12,090

J3-41

Est Bassflow - Rebuilding River - Gain-Loss Below Hartan to GuideRock, Nc. (gain includes Inflow from Turkey, Center, Thompson, and Elm Creeks)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953			1,923	2,021	2,028	2,623	2,500	2,088	812	-1,171	-1,879	-547	10,577
1954	807	2,663	3,823	4,100	3,738	3,902	3,444	3,104	2,043	525	187	1,154	28,588
1955	2,048	2,658	3,083	2,990	2,793	3,400	2,798	1,486	531	189	974	2,858	25,782
1956	3,927	3,734	3,825	3,825	3,558	3,797	2,470	72	-1,513	-2,284	-2,075	-913	18,402
1957	338	1,711	2,814	2,857	2,818	3,421	3,248	2,868	2,143	1,375	982	1,073	25,454
1958	1,903	3,288	4,253	4,453	3,929	3,548	2,848	2,452	1,867	1,370	1,588	2,387	33,931
1959	3,334	3,593	4,076	4,429	3,979	3,953	2,735	973	-304	-875	-120	2,248	27,921
1960	3,819	4,193	4,828	4,894	4,343	4,458	3,833	3,185	2,524	2,273	2,529	3,299	43,793
1961	4,041	4,277	4,598	4,571	4,220	4,824	4,576	4,031	3,391	3,166	3,338	3,913	46,043
1962	4,610	4,888	5,287	5,405	5,050	5,877	5,357	4,490	3,777	3,823	4,308	5,200	58,060
1963	6,094	6,248	6,556	6,381	5,571	5,900	5,079	4,181	3,287	2,960	2,852	3,277	58,286
1964	3,948	4,384	4,981	5,237	5,044	5,418	4,768	3,989	3,140	2,814	2,883	3,864	60,387
1965	4,184	4,032	4,192	4,286	4,059	4,909	4,850	5,075	4,710	4,474	4,393	4,498	53,743
1966	4,965	5,263	5,782	5,837	5,464	6,088	5,523	4,867	4,071	3,742	3,550	3,537	58,787
1967	3,794	3,841	4,091	4,159	3,756	4,077	3,553	2,909	2,500	2,740	3,297	4,125	42,840
1968	4,771	4,653	4,866	4,848	4,690	4,969	4,149	2,888	2,043	2,090	2,393	2,934	45,338
1969	3,729	4,323	4,920	5,073	4,897	5,305	4,707	3,816	3,078	2,993	3,149	3,544	49,523
1970	4,038	4,129	4,518	4,785	4,819	5,148	4,511	3,471	2,171	874	1,581	3,977	43,810
1971	5,468	5,417	5,845	5,806	5,164	5,987	5,614	5,069	4,382	4,196	4,182	4,304	61,927
1972	4,731	4,849	5,228	5,378	5,187	5,738	5,558	5,537	5,137	5,053	4,806	4,428	61,625
1973	5,081	6,143	7,103	7,333	6,838	7,829	7,037	5,805	4,697	4,489	4,787	5,698	72,778
1974	6,641	6,936	7,371	7,242	6,255	6,378	5,301	4,208	2,941	1,981	2,154	3,515	80,824
1975	4,984	5,064	5,883	5,955	5,591	6,378	5,870	5,205	4,315	3,841	3,881	3,825	60,028
1976	4,258	4,422	5,084	5,919	5,884	6,487	6,010	5,408	4,622	4,334	4,473	5,061	61,858
1977	5,848	5,535	5,808	5,910	5,430	6,117	5,530	4,749	4,184	4,428	4,759	5,127	63,205
1978	5,874	5,893	6,050	6,178	5,698	6,447	5,879	5,131	4,250	3,879	3,724	3,830	62,430
1979	4,133	4,108	4,407	4,819	4,381	5,118	4,978	4,887	4,218	3,850	3,824	4,281	52,806
1980	4,917	5,131	5,590	5,689	5,488	6,308	5,384	4,177	2,915	2,953	1,954	2,567	51,871
1981	3,241	3,588	4,083	4,275	4,103	4,881	4,840	4,839	4,482	4,408	4,812	5,108	52,488
1982	5,828	6,054	6,525	6,830	6,047	6,720	6,359	5,229	5,773	5,787	6,017	6,480	74,428
1983	8,930	8,548	8,730	8,825	8,170	8,735	8,335	8,257	5,861	5,952	6,251	6,745	77,339
1984	7,483	7,472	7,850	7,939	7,444	7,833	7,278	6,881	5,807	4,853	4,474	4,598	79,580
1985	5,147	5,812	6,343	6,783	6,588	7,843	7,510	6,353	6,145	6,037	6,243	6,770	77,854
1986	7,488	7,388	7,752	7,785	8,537	7,413	6,031	4,652	2,832	2,983	3,170	3,458	67,235
1987	4,284	5,208	6,041	6,250	5,830	6,887	6,439	6,383	5,944	5,933	5,621	5,924	70,824
1988	6,332	6,341	6,659	6,847	6,253	6,778	6,193	5,505	4,588	4,124	3,983	4,214	67,818
1989	4,704	4,868	5,212	5,248	4,843	4,874	4,245	3,987	3,007	2,723	2,938	3,885	49,792
1990	4,327	4,402	4,759	4,953	4,734	5,850	5,954	5,459	4,828	3,991	2,318	758	51,198
1991	0	0	97	287	360	487	257	-211	-479	-858	-454	-148	-361
1992	0	0	0	157	828	1,415	3,024	3,790	4,070	4,150	4,017	21,150	
1993	4,181	4,048	4,190	4,212	3,891	4,505	4,361	4,285	4,009	4,087	4,247	4,482	50,488
1994	4,940	5,004	5,322	5,393	4,899	5,412	5,088	4,942	4,500	4,383	4,454	4,727	59,083
1995	5,299	5,811	5,935	6,015	5,553	6,348	5,733	4,805	3,815	3,981	3,313	3,712	59,401
1996	4,728	5,802	6,708	6,848	6,528	7,107	6,789	6,677	5,990	5,538	5,212	5,077	72,998
1997	5,388	5,400	6,155	7,120	6,538	7,820	7,244	6,825	5,985	5,180	5,061	5,359	73,935
1998	6,382	7,391	8,478	8,909	8,334	8,436	8,347	6,882	5,373	5,318	5,288	5,299	85,248
1999	5,858	6,532	7,242	7,429	6,855	7,728	7,312	7,036	5,671	3,860	3,100	3,268	72,083
2000	3,937	4,838	5,235	5,254	4,909	5,214	4,728	4,234	3,547	3,188	3,134	3,417	51,437
Avg 1940-2000	4,429	4,744	5,150	5,306	4,942	5,507	5,006	4,378	3,599	3,210	3,249	3,746	53,075
Avg 1950-1994	3,178	3,783	4,135	4,247	3,914	4,285	3,642	2,738	1,807	1,185	1,323	2,314	35,829
Avg 1986-2000	4,526	4,836	5,319	5,480	5,123	5,730	5,316	4,878	4,182	3,862	3,722	3,814	56,808

J3-42

Estimated Baseflow - Gain-Loss Below Swanson Reservoir to McCook Gage, Nabr.  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955		-355	-522	-503	-537	-727	-891	-1,502	-2,011	-2,570	-2,388	-1,472	-13,778
1956	-811	-265	-208	-638	-617	-230	-434	-1,363	-2,360	-3,568	-3,853	-3,040	-17,450
1957	-2,288	-1,189	-634	-498	-196	234	-287	-1,961	-3,070	-3,894	-3,487	-1,828	-19,086
1958	-780	-114	158	54	99	350	217	-314	-1,181	-2,533	-2,474	-921	-7,419
1959	-180	-208	-218	-191	45	548	823	918	703	250	129	377	2,888
1960	585	888	587	200	105	382	354	128	0	0	85	249	3,329
1961	338	315	358	435	452	547	563	604	454	181	201	590	6,023
1962	724	516	447	489	531	825	703	250	0	0	0	0	4,465
1963	0	0	0	0	164	578	738	693	465	173	0	0	2,830
1964	118	348	469	448	541	883	1,088	1,227	1,047	643	311	101	7,202
1965	0	0	51	155	382	819	858	548	491	800	953	922	5,955
1966	1,024	1,131	1,188	1,008	847	252	188	603	778	788	781	757	9,082
1967	810	816	857	879	772	787	635	619	645	876	843	539	9,141
1968	439	479	604	774	859	1,041	988	778	485	173	141	413	7,151
1969	589	833	857	1,218	1,383	1,743	1,733	1,624	1,417	1,310	927	302	13,725
1970	278	817	983	816	482	874	883	588	388	137	0	0	5,801
1971	268	788	1,088	1,088	758	295	240	771	903	698	588	538	7,985
1972	824	758	853	222	164	350	780	823	852	882	547	530	7,281
1973	508	414	802	738	828	1,385	1,168	414	229	735	983	955	8,987
1974	1,220	1,844	1,894	1,782	1,381	1,068	883	489	254	90	191	559	11,245
1975	858	989	988	742	833	888	1,002	1,131	1,154	1,217	927	302	10,830
1976	51	181	472	1,017	1,377	1,848	1,793	1,444	907	323	0	0	9,384
1977	0	0	179	547	827	1,303	1,822	2,021	2,040	1,911	1,714	1,474	13,837
1978	1,233	812	883	712	932	1,874	1,720	1,281	795	488	213	70	10,556
1979	70	204	295	319	583	1,331	1,450	1,068	753	643	518	388	7,822
1980	494	773	800	483	521	1,084	1,245	1,185	835	287	0	0	7,895
1981	184	541	658	467	488	882	1,303	1,722	1,712	1,458	1,075	615	11,184
1982	874	1,187	1,224	705	580	1,061	1,270	1,298	918	328	212	821	10,051
1983	882	1,188	1,191	833	709	1,010	1,075	1,088	907	710	445	146	10,285
1984	101	297	820	1,882	1,882	2,184	1,912	1,827	869	479	388	704	13,012
1985	1,031	1,236	1,342	1,218	1,125	1,443	1,430	1,327	1,034	680	578	729	13,188
1986	847	828	850	828	734	800	758	781	553	187	101	297	7,556
1987	423	430	720	1,287	1,428	1,844	1,488	1,171	602	-153	-348	80	8,726
1988	472	783	883	881	899	1,122	1,111	782	435	155	145	426	7,718
1989	557	474	819	897	848	871	832	1,038	835	297	145	426	7,998
1990	728	871	1,108	1,034	842	1,144	1,029	777	218	-820	-887	-452	6,009
1991	-59	348	582	604	672	1,027	1,089	945	835	228	0	0	6,049
1992	157	482	823	588	886	1,113	1,088	785	422	150	151	444	8,870
1993	484	151	220	875	833	1,300	1,223	883	785	1,113	1,148	878	8,783
1994													
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	336	488	568	604	842	917	901	718	437	122	25	172	5,953
Avg 1950-1964	-252	-27	44	-30	54	336	274	-141	-883	-1,137	-1,148	-594	-3,190
Avg 1986-2000	448	557	702	830	881	1,128	1,073	890	562	171	60	282	7,564



J3-43

Estimated Baseflow - Republican River - Gain-Loss Benklaman to Swanson, NA.  
(Values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950											-1,548	-1,493	-3,031
1951	-1,452	-1,263	-1,106	-851	-643	-897	-813	-516	-409	-355	-294	-234	-8,434
1952	-182	-53	0	0	-193	-849	-812	-740	-587	-468	-354	-832	-5,209
1953	-1,098	-887	-803	-760	-692	-827	-819	-815	-708	-591	-801	-748	-8,350
1954	-487	-1,233	-1,236	-867	-836	-768	-824	-663	-824	-485	-574	-1,079	-10,492
1955	-1,713	-2,295	-2,387	-1,729	-1,171	-1,064	-968	-1,028	-813	-728	-663	-1,818	-16,504
1956	-1,813	-1,622	-1,280	-712	-376	-369	-478	-795	-873	-794	-874	-1,114	-11,189
1957	-1,197	-998	-775	-751	-818	-559	-363	-129	-134	-431	-817	-863	-7,980
1958	-543	-177	110	338	317	123	-226	-726	-1,037	-1,256	-1,147	-705	-4,828
1959	-633	-649	-443	-151	84	332	23	-883	-1,222	-1,060	-896	-754	-6,040
1960	-803	-840	-1,009	-607	-783	-733	-666	-659	-573	-388	-431	-709	-8,812
1961	-1,100	-1,487	-1,767	-1,786	-1,684	-2,015	-1,750	-1,203	-981	-1,285	-1,368	-1,207	-17,634
1962	-1,183	-1,077	-1,033	-920	-600	-233	-170	-544	-779	-847	-868	-504	-8,825
1963	-334	-290	-162	87	150	86	-85	-272	-536	-850	-1,132	-1,048	-4,518
1964	-658	-638	-305	-428	-353	-131	-81	-259	-299	-62	-272	-799	-4,274
1965	-1,102	-1,058	-1,181	-1,312	-1,110	-879	-604	-489	-559	-813	-1,138	-1,200	-11,525
1966	-1,064	-584	-510	-502	-730	-481	-370	-515	-799	-1,333	-1,440	-1,081	-9,720
1967	-831	-583	-446	-428	-291	-113	-57	-181	-309	-473	-844	-802	-5,137
1968	-698	-227	0	0	0	0	-170	-544	-622	-443	-654	-1,295	-4,811
1969	-1,451	-1,065	-927	-898	-835	-267	-109	-349	-619	-861	-1,468	-1,818	-10,663
1970	-1,746	-964	-584	-480	-359	-379	-520	-591	-935	-736	-857	-1,305	-9,718
1971	-1,638	-1,663	-1,452	-519	-428	-438	-487	-618	-593	-453	-620	-1,094	-10,283
1972	-1,199	-788	-600	-569	-498	-481	-709	-1,317	-1,850	-1,877	-1,711	-1,150	-12,545
1973	-832	-626	-509	-417	-257	-100	0	0	-150	-481	-578	-413	-4,362
1974	-128	313	484	250	201	305	259	82	-134	-431	-723	-878	-482
1975	-872	-284	-190	-594	-659	-839	-544	-516	-490	-837	-553	-536	-6,415
1976	-853	-538	-420	-143	231	776	526	-539	-658	-744	-857	-719	-3,737
1977	-820	-859	-809	-576	-388	-303	-181	-85	-119	-381	-571	-680	-5,711
1978	-693	-581	-530	-480	-424	-500	-381	-135	-165	-531	-633	-443	-5,496
1979	-900	-1,818	-2,252	-1,863	-917	-188	-82	-718	-780	-277	-144	-422	-10,285
1980	-534	-565	-532	-424	-137	330	103	-899	-1,258	-1,027	-1,109	-1,514	-7,816
1981	-1,687	-1,418	-1,345	-1,330	-1,150	-1,185	-816	-290	0	0	-251	-737	-10,188
1982	-873	-553	-384	-345	-197	3	-37	-376	-705	-1,098	-1,077	-619	-6,271
1983	-487	-835	-385	343	698	890	590	-113	-482	-510	-855	-1,484	-2,450
1984	-1,692	-2,121	-1,995	-1,377	-759	-282	-141	-454	-510	-343	-458	-889	-11,290
1985	-825	-538	-384	-355	-303	-301	-313	-410	-955	-822	-1,060	-1,237	-2,186
1986	-1,048	-342	0	0	44	127	-135	-556	-1,187	-1,252	-1,111	-1,254	-6,897
1987	-1,423	-1,442	-1,257	-704	-462	-714	-749	-670	-604	-642	-742	-887	-10,308
1988	-1,095	-1,205	-1,112	-679	-477	-628	-666	-689	-621	-644	-748	-1,222	-6,882
1989	-1,422	-1,174	-858	-851	-548	-850	-1,045	-1,283	-1,251	-1,080	-1,044	-1,130	-12,445
1990	-1,121	-871	-787	-787	-731	-859	-834	-813	-715	-637	-840	-1,315	-10,310
1991	-1,573	-1,428	-1,318	-1,086	-779	-598	-421	-382	-498	-623	-1,100	-1,294	-11,328
1992	-1,328	-1,024	-816	-603	-433	-402	-407	-528	-829	-788	-958	-1,117	-8,032
1993	-1,188	-1,019	-858	-691	-317	-123	0	0	-141	-454	-554	-418	-6,881
1994	-384	-344	-318	-250	-216	-291	-417	-684	-831	-1,008	-821	-288	-5,793
1995													
1996													
1997													
1998													
1999													
2000													
Avg 1940-2000	-1,034	-893	-785	-819	-437	-366	-375	-584	-693	-712	-827	-952	-8,074
Avg 1950-1984	-988	-943	-871	-874	-512	-540	-559	-683	-703	-703	-810	-808	-8,418
Avg 1986-2000	-1,174	-983	-825	-596	-435	-479	-520	-656	-720	-787	-860	-890	-9,047

J3-44

Est Baseflow - Gain-Loss Cambridge Gage to Orleans Gage, Ne. (gain includes inflow from several tributaries)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948		-391	-331	-113	0	0	-300	-862	-1,485	-2,020	-2,018	-1,447	-9,088
1949	-827	-302	280	858	1,044	1,158	1,055	852	848	231	-95	-280	4,819
1950	-387	-375	-362	-310	-197	-77	0	0	-259	-830	-1,075	-842	-4,815
1951	-815	-877	-483	-509	-360	-140	0	0	0	0	-325	-854	-4,173
1952	-1,083	-878	-286	-90	0	0	-197	-831	-943	-1,227	-1,388	-2,305	-9,015
1953	-2,319	-1,435	-802	-273	-177	-823	-889	-1,054	-1,185	-1,370	-1,831	-1,628	-13,288
1954	-1,704	-1,542	-1,463	-1,309	-915	-640	-428	-777	-915	-630	-1,098	-1,389	-13,017
1955	-1,632	-1,598	-1,635	-1,583	-1,084	-422	-185	-531	-1,232	-2,302	-2,723	-1,823	-18,980
1956	-1,831	-2,800	-3,010	-2,241	-1,323	-492	-358	-1,148	-1,588	-1,758	-1,628	-1,188	-19,439
1957	-1,298	-1,719	-1,958	-1,808	-1,348	-870	-508	-181	-119	-391	-959	-624	-11,434
1958	-818	-449	-435	-333	-334	-807	-811	-1,308	-1,806	-1,878	-1,829	-863	-11,288
1959	-781	-1,277	-1,438	-1,118	-702	-383	-340	-702	-1,312	-2,348	-2,503	-1,974	-14,875
1960	-1,492	-832	-821	-453	-184	245	217	-328	-285	369	38	-1,310	-4,519
1961	-1,723	-1,004	-607	-438	-240	-82	58	141	118	-15	-85	-21	-3,881
1962	109	320	336	114	158	858	875	1,202	1,280	1,182	1,167	1,225	8,503
1963	1,160	818	517	178	328	1,181	1,404	1,153	469	591	-1,065	-852	4,878
1964	-884	-184	0	0	87	328	-17	-888	-1,830	-2,884	-1,880	-1,327	-8,400
1965	-798	-280	0	0	149	824	854	1,323	1,874	2,138	2,329	2,215	10,177
1966	2,221	2,054	1,764	1,128	884	885	383	-69	-334	-469	-417	-138	7,436
1967	0	0	213	652	984	1,547	1,607	1,378	1,402	1,910	1,878	1,279	12,851
1968	1,010	821	970	1,068	1,180	1,498	1,207	429	0	0	-180	-470	7,832
1969	-832	-831	-563	-378	240	1,488	1,984	1,848	1,589	1,544	1,394	1,733	9,333
1970	2,107	2,265	2,801	2,587	2,405	2,780	2,130	1,012	-27	-901	-1,025	-334	18,481
1971	0	0	0	0	222	784	1,060	1,138	1,147	1,247	704	-449	5,851
1972	-881	375	754	498	598	1,224	1,558	1,764	1,581	1,181	723	238	9,918
1973	478	1,388	2,281	2,981	2,979	3,169	2,598	1,815	1,002	358	302	888	20,257
1974	1,230	1,180	1,385	1,738	1,588	1,415	704	-331	-928	-1,108	-1,237	-1,295	4,359
1975	-1,151	-844	-827	-445	83	1,109	1,428	1,024	591	143	-85	-21	1,845
1976	167	850	1,012	1,529	1,682	1,737	1,282	838	-303	-1,217	-1,419	-837	4,731
1977	-510	-348	-188	14	815	1,880	2,148	2,478	2,030	1,012	174	-362	8,524
1978	-482	-180	-174	-534	-144	1,084	1,807	1,519	939	-28	-738	-1,088	1,793
1979	-1,415	-1,814	-1,838	-1,307	-402	1,087	1,798	1,788	1,798	2,074	1,858	269	3,981
1980	-99	473	880	1,011	1,288	1,927	2,071	1,946	856	-813	-1,890	-1,413	6,528
1981	-1,144	-685	-368	-125	333	1,174	1,408	1,130	835	680	497	283	3,988
1982	469	878	1,380	1,577	1,781	2,544	2,858	3,142	2,822	2,233	1,414	481	21,641
1983	0	0	271	830	1,368	2,378	2,737	2,788	2,307	1,578	872	284	15,414
1984	345	1,012	1,782	2,508	2,630	2,842	2,488	2,552	2,140	1,495	844	275	20,871
1985	351	1,030	1,430	1,344	1,187	1,347	1,297	1,300	1,109	888	845	1,085	13,151
1986	1,108	828	865	1,490	1,763	2,540	2,859	2,538	2,012	1,345	898	742	18,873
1987	745	807	908	968	1,271	2,305	2,673	2,701	2,335	1,875	1,290	853	18,528
1988	591	933	1,219	1,323	1,310	1,449	1,230	841	611	685	515	188	10,824
1989	484	1,383	2,215	2,891	2,758	2,644	1,787	835	0	0	0	0	14,758
1990	197	577	818	859	1,121	2,031	2,182	1,781	885	-1,050	-1,555	-704	6,881
1991	-252	-78	0	0	206	728	885	103	-710	-1,828	-2,043	-1,278	-4,444
1992	-870	-871	-478	849	1,381	2,037	1,718	811	-85	-272	-449	-802	2,592
1993	-524	-171	103	315	850	2,089	2,847	2,849	3,007	3,525	3,807	3,808	22,281
1994	3,482	2,297	1,380	470	404	1,425	1,818	2,042	1,248	-364	-858	-98	13,323
1995	213	70	241	739	1,138	1,839	2,238	2,851	1,814	-134	-888	-282	8,823
1996	210	617	877	1,229	1,432	1,800	2,237	2,764	3,204	3,962	4,489	4,848	27,850
1997	4,789	4,289	3,320	1,989	1,584	2,965	3,107	2,347	915	-1,050	-1,413	-28	23,039
1998	702	718	578	197	502	1,770	2,358	1,490	853	303	0	0	9,171
1999	238	882	1,248	1,844	1,877	2,288	2,072	1,781	832	-382	-798	-280	11,830
2000	284	834	1,300	1,599	1,744	2,104	1,828	1,493	588	-703	-1,048	-342	9,783
Avg 1940-2000	-61	128	302	445	665	1,184	1,244	980	558	65	-182	-184	5,156
Avg 1950-1984	-1,003	-883	-808	-691	-433	-137	-77	-343	-614	-857	-1,118	-1,088	-8,131
Avg 1986-2000	750	854	1,000	1,102	1,298	2,005	2,075	1,774	1,158	394	128	428	12,967

J3-45

Estimated Baseflow - Gain-Loss Guide Rock Gage to Hardy Gage, Ne.  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Totals
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950												747	747
1951	1,130	1,272	1,607	2,019	2,213	2,927	2,569	1,339	703	250	337	990	17,556
1952	1,350	1,285	1,336	1,440	1,407	1,328	1,581	1,837	1,787	1,580	1,084	357	16,540
1953	124	304	583	778	839	1,052	1,033	874	868	206	86	290	6,983
1954	459	524	554	483	442	551	547	525	287	-203	-372	-196	3,591
1955	38	335	382	130	139	488	390	-160	-532	-750	-471	300	288
1956	533	174	0	0	0	0	116	372	450	382	152	-219	1,990
1957	-377	-285	-191	-65	0	0	0	0	158	499	686	823	1,026
1958	502	227	75	25	95	336	456	463	573	779	658	215	4,431
1959	0	0	0	0	0	0	219	703	1,075	1,443	1,476	1,148	6,053
1960	1,010	921	891	827	837	1,113	828	391	487	1,387	1,648	1,255	11,676
1961	995	719	597	560	523	662	675	1,319	1,819	2,599	2,560	1,859	14,688
1962	1,184	948	692	225	254	896	1,175	1,180	857	305	0	0	7,694
1963	174	510	536	182	155	547	944	1,449	1,709	1,910	1,793	1,327	11,227
1964	876	286	0	0	173	582	796	852	644	229	174	510	5,113
1965	533	174	0	0	381	1,344	1,644	1,381	1,328	1,865	1,639	1,229	11,328
1966	1,011	839	872	1,035	900	729	688	979	1,108	1,201	1,079	748	11,187
1967	628	835	879	698	698	915	984	1,080	798	284	302	888	6,572
1968	1,355	1,558	1,411	732	273	102	0	0	257	828	1,119	1,083	8,717
1969	1,008	759	700	791	743	887	680	242	0	0	327	959	7,057
1970	1,316	1,254	974	332	0	0	181	812	974	1,379	1,432	1,106	9,572
1971	1,054	1,133	1,143	965	1,104	1,865	2,389	2,592	2,531	2,634	2,290	1,520	21,280
1972	1,378	1,672	1,696	1,283	909	627	878	1,558	1,941	2,344	2,187	1,458	18,211
1973	1,244	1,384	1,534	1,817	1,627	2,108	2,089	1,912	1,728	1,783	1,866	2,320	21,310
1974	2,722	2,890	2,970	2,735	2,278	2,254	2,051	2,141	1,988	1,848	1,579	1,209	26,655
1975	1,315	1,731	1,949	1,783	1,584	1,878	1,844	1,873	1,782	1,965	1,857	1,458	20,957
1976	1,369	1,405	1,543	1,545	1,456	1,354	1,326	1,665	1,828	2,033	1,928	1,508	19,090
1977	1,178	759	447	184	381	1,305	1,734	1,810	1,838	2,065	2,273	2,436	16,392
1978	2,351	1,698	1,174	903	590	1,410	1,790	1,911	1,787	1,580	1,259	841	16,973
1979	781	915	880	551	659	1,483	1,972	2,314	2,281	2,142	1,917	1,635	17,821
1980	1,524	1,377	1,187	837	947	1,784	2,219	2,459	2,277	1,815	1,292	769	18,540
1981	994	872	873	653	483	852	1,265	1,781	2,105	2,483	2,266	1,538	19,071
1982	825	1	-442	-491	-17	1,070	1,225	435	733	2,350	3,246	3,260	12,193
1983	2,834	1,890	1,067	383	-225	-793	-603	-265	596	1,814	3,134	4,360	13,892
1984	4,849	4,293	4,173	4,175	3,996	4,477	4,486	4,768	4,485	4,218	3,482	2,287	49,788
1985	1,855	1,288	851	300	479	1,689	2,622	3,534	3,597	3,512	3,289	3,061	28,010
1986	2,860	2,296	2,443	3,095	3,048	3,252	3,423	4,278	4,498	4,605	4,523	4,559	42,590
1987	4,387	3,528	3,078	2,688	2,280	2,542	2,811	3,621	3,814	3,824	3,285	2,239	38,072
1988	1,661	1,681	1,967	1,827	1,711	1,683	1,438	1,302	1,289	1,600	1,527	1,058	19,224
1989	853	787	852	1,281	1,345	1,572	1,405	1,105	963	1,148	1,183	1,053	13,848
1990	1,171	1,392	1,434	1,145	900	896	974	1,028	996	1,007	1,169	1,443	13,645
1991	1,909	1,456	1,363	1,162	1,067	1,384	1,351	1,190	798	284	124	364	12,172
1992	807	790	970	1,056	1,047	1,119	1,075	1,082	1,018	887	964	953	11,889
1993	1,220	1,621	2,065	2,394	2,358	2,712	2,498	2,087	1,800	1,250	784	258	20,812
1994	318	828	1,415	1,682	1,268	484	315	1,012	1,620	2,310	2,118	1,014	14,490
1995	474	389	630	1,143	1,212	1,187	1,149	1,332	1,515	1,858	2,167	2,285	15,403
1996	2,343	2,038	1,803	1,425	1,150	1,230	1,251	1,425	1,749	2,485	2,892	2,959	22,730
1997	3,142	3,041	2,952	2,590	1,961	1,877	1,515	1,698	2,100	2,378	2,322	1,929	27,514
1998	2,018	2,331	2,816	2,634	2,330	2,438	2,322	2,479	2,284	2,022	1,789	1,521	28,864
1999	1,941	2,515	2,884	3,088	2,900	2,288	2,178	2,857	3,005	2,856	2,537	2,074	30,821
2000	1,843	1,587	1,527	1,720	1,659	1,752	1,656	1,849	1,508	1,436	1,330	1,207	18,944
Avg 1940-2000	1,328	1,248	1,223	1,127	1,045	1,294	1,368	1,491	1,508	1,612	1,569	1,367	15,889
Avg 1950-1964	571	519	503	473	508	763	830	820	780	757	696	601	7,319
Avg 1986-2000	1,778	1,773	1,885	1,937	1,727	1,753	1,688	1,862	1,917	2,005	1,921	1,668	21,943

J3-46

Estimated Baseflow - Gain-Loss McCook Gage to Cambridge Gage, Na.  
(values in cu-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951													
1952													
1953													
1954													
1955			-1,859	-1,635	-1,210	-950	-827	-1,101	-1,773	-3,089	-3,311	-2,315	-18,079
1956	-1,784	-1,450	-1,219	-942	-888	-601	-629	-908	-1,658	-3,126	-3,833	-3,058	-16,689
1957	-2,520	-1,882	-1,235	-1,082	-807	-657	-730	-1,227	-2,127	-3,717	-3,818	-2,329	-21,908
1958	-1,270	-414	-228	-693	-851	-253	-419	-1,343	-1,982	-2,528	-2,368	-1,482	-13,830
1959	-1,107	-1,071	-838	-278	132	438	-58	-1,440	-1,875	-1,481	-1,284	-1,418	-10,288
1960	-1,315	-812	-201	817	745	277	-182	-817	-832	-808	-1,080	-1,273	-5,571
1961	-1,236	-786	-564	-496	-321	-325	-85	-272	-629	-1,240	-1,550	-1,500	-8,503
1962	-1,188	-381	-144	-443	-415	-182	0	0	-311	-998	-1,342	-1,278	-6,843
1963	-988	-322	0	0	0	0	-113	-363	-947	-2,002	-1,868	-833	-7,554
1964	-356	-475	-384	-21	194	287	77	-477	-1,080	-1,848	-1,872	-1,397	-7,441
1965	-1,188	-1,178	-1,184	-1,088	-791	-518	-240	-85	-800	-1,823	-2,104	-1,045	-11,845
1966	-422	-138	0	0	0	0	-170	-544	-544	-184	0	0	-3,011
1967	29	84	178	304	257	100	0	0	50	159	82	-182	1,080
1968	-451	-884	-834	-218	54	180	244	264	-95	-873	-1,208	-1,025	-4,441
1969	-657	7	281	89	34	121	122	44	-141	-454	-853	-708	-1,833
1970	-472	128	331	113	102	359	241	-261	-390	-139	-172	-508	-889
1971	-400	205	218	-413	-229	834	1,267	1,132	482	-819	-1,238	-1,243	-32
1972	-827	-145	248	248	305	688	314	-235	-587	-708	-888	-1,037	-2,875
1973	-888	-289	74	228	304	402	322	115	128	404	824	758	2,180
1974	880	891	942	845	794	732	481	171	-380	-1,220	-1,247	-407	2,582
1975	0	0	115	351	437	505	381	135	-248	-788	-933	-808	-664
1976	-357	-118	82	251	312	325	335	401	81	-813	-742	-242	-273
1977	67	195	205	70	280	886	1,298	1,321	598	-838	-1,327	-748	2,110
1978	-278	158	350	273	214	243	40	-359	-1,053	-2,085	-2,414	-1,955	-8,883
1979	-1,881	-1,295	-1,187	-1,152	-500	-324	-281	-789	-1,281	-1,779	-1,727	-1,078	-13,301
1980	-524	34	242	83	118	401	514	497	138	-584	-1,078	-1,328	-1,482
1981	-1,145	-373	0	0	84	288	348	285	-25	-533	-700	-481	-2,284
1982	-401	-403	-878	-1,204	-852	-131	378	437	-103	-1,299	-1,451	-473	-8,281
1983	84	188	198	67	113	399	586	865	243	-703	-1,004	-564	222
1984	-278	-91	0	0	134	481	587	524	-203	-1,685	-2,328	-1,894	-4,803
1985	-1,451	-473	-45	-137	-95	210	354	384	215	-137	-65	479	-711
1986	666	519	500	592	578	639	472	188	-487	-1,487	-1,881	-643	-425
1987	-358	184	457	500	519	888	658	532	-123	-1,350	-1,791	-1,338	-1,438
1988	-784	9	312	108	128	428	557	557	23	-1,077	-1,247	-407	-1,388
1989	80	178	188	83	74	280	88	-473	-763	-927	-872	-624	-2,782
1990	-389	-130	110	338	504	782	780	800	-252	-1,844	-2,440	-1,801	-3,853
1991	-1,288	-423	-12	-39	60	318	481	818	80	-1,185	-1,754	-1,568	-4,887
1992	-1,188	-381	208	639	817	230	-129	-413	-745	-1,213	-1,080	-355	-3,800
1993	-181	-533	-782	-811	-388	439	835	700	-27	-1,381	-1,292	320	-3,060
1994	852	919	598	840	620	843	818	865	422	150	-147	-431	5,348
1995	-450	-147	179	547	823	1,289	1,875	1,907	1,221	-405	-1,208	-1,025	4,308
1996	-742	-242	0	0	278	828	885	498	-83	-688	-573	255	854
1997	583	387	228	78	243	856	971	844	338	119	0	0	4,455
1998	284	834	1,183	1,270	1,180	1,229	732	-175	-1,027	-1,888	-2,018	-1,325	280
1999	-888	91	518	588	842	868	885	1,153	903	321	0	0	5,413
2000													
Avg 1940-2000	-583	-223	-76	-39	79	314	310	73	-366	-1,118	-1,311	-923	-3,848
Avg 1950-1964	-1,305	-819	-687	-487	-302	-174	-298	-774	-1,321	-2,063	-2,233	-1,887	-11,858
Avg 1966-2000	-247	60	251	318	418	701	701	498	-37	-617	-1,151	-718	-72

J3-47

Estimated Baseflow - Republican River at (nr) Culbertson, Ne. (6830000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	820	1,820	3,518	5,578	6,092	6,238	4,832	2,050	454	161	212	621	31,692
1941	2,148	4,606	5,772	8,188	7,723	7,751	6,331	4,813	4,564	6,089	6,871	6,758	72,696
1942	7,208	7,361	6,684	4,288	3,288	4,812	4,906	3,682	2,495	887	801	2,352	46,140
1943	4,272	8,128	8,947	6,056	4,888	5,013	4,688	4,978	3,720	1,323	0	0	46,022
1944	348	1,021	2,113	3,558	4,828	7,325	8,237	8,898	6,487	2,306	0	0	46,018
1945	711	2,089	3,708	5,399	5,703	6,408	8,208	8,320	4,827	1,845	438	1,287	44,537
1946	2,484	3,812	5,283	6,468	6,260	6,595	6,061	5,887	4,533	3,211	1,716	558	53,322
1947	1,789	5,282	6,663	5,310	4,902	7,211	8,168	8,894	7,458	4,386	1,864	650	62,817
1948	514	1,509	2,135	2,227	2,813	4,578	5,180	5,230	4,085	2,171	835	272	31,526
1949	922	2,707	3,543	3,112	4,682	10,185	12,312	12,323	8,836	3,177	323	848	63,179
1950													
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2000													
Avg 1940-1949	2,103	3,633	4,733	5,022	5,132	6,622	6,873	6,345	4,764	2,537	1,319	1,343	50,225

Estimated Baseflow - Republican River at Benkleman, Ne. (8824800)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947					5,358	8,803	6,778	7,085	6,044	4,381	3,851	4,578	44,889
1948	5,217	5,126	5,267	5,123	4,779	5,236	5,078	5,118	4,838	4,313	4,010	3,797	87,717
1949	4,019	4,183	4,500	4,920	4,718	5,524	5,752	6,481	6,578	6,858	6,878	6,528	87,006
1950	6,459	5,881	6,628	5,740	6,456	6,589	6,745	7,210	7,032	7,122	6,988	6,588	77,238
1951	6,561	6,022	5,973	5,813	5,335	6,291	6,468	7,066	7,159	7,672	7,933	7,909	80,201
1952	7,902	8,873	6,788	8,978	6,838	7,808	7,554	7,243	5,887	4,295	3,844	4,890	76,711
1953	5,117	4,482	4,759	5,534	5,978	6,709	6,550	6,285	4,994	3,329	2,986	2,872	56,775
1954	3,173	4,833	5,614	5,614	5,137	5,947	5,283	4,459	3,489	2,847	3,013	4,005	53,862
1955	4,725	4,802	4,807	4,881	4,493	5,094	4,748	4,374	3,718	3,310	3,426	4,098	52,277
1956	4,547	4,213	4,435	4,807	4,887	5,839	5,304	4,656	4,008	3,861	4,076	4,351	64,662
1957	4,966	5,397	5,826	6,036	5,750	6,963	7,080	7,409	6,529	5,282	4,570	4,685	70,322
1958	5,148	5,588	6,195	6,404	6,408	6,371	6,252	7,399	5,876	4,525	4,276	5,245	73,888
1959	5,929	5,995	5,917	6,354	6,198	7,377	8,804	8,095	4,972	4,305	3,813	3,583	87,043
1960	3,852	4,132	4,695	5,103	5,413	6,759	6,953	9,911	5,781	4,246	3,700	4,288	81,818
1961	5,057	5,458	6,121	6,508	6,096	6,847	6,269	5,583	4,540	3,772	4,091	5,536	85,869
1962	6,508	6,217	6,250	5,876	5,251	5,768	5,483	5,503	5,248	5,440	5,353	4,993	67,991
1963	5,228	5,390	5,833	5,405	5,023	6,157	5,662	4,528	3,440	2,973	3,281	4,380	67,099
1964	5,334	5,807	6,005	6,276	6,047	6,559	6,284	6,164	5,018	3,397	2,822	3,445	62,858
1965	4,070	4,203	4,545	4,874	4,335	4,928	4,357	5,380	5,575	6,278	6,414	6,942	81,902
1966	6,095	6,083	6,274	6,046	5,466	6,310	5,840	4,518	4,042	4,909	5,356	5,326	66,066
1967	5,818	5,517	5,929	6,313	5,735	5,896	5,803	6,399	6,838	4,818	4,083	3,759	65,807
1968	4,120	4,854	5,278	5,519	5,140	5,171	5,119	5,902	5,158	3,447	2,847	3,516	55,867
1969	4,263	4,578	5,101	5,374	5,088	5,820	5,905	6,456	5,748	4,483	3,848	4,036	60,961
1970	4,940	5,092	5,733	6,058	5,748	6,971	6,285	5,772	4,627	3,499	3,144	3,677	59,941
1971	4,440	4,904	5,386	5,366	4,896	5,484	5,262	5,235	4,383	3,205	2,879	3,793	54,335
1972	4,478	4,522	4,841	4,986	4,658	4,803	4,808	4,884	4,510	4,118	4,053	4,390	54,799
1973	4,968	5,261	5,683	5,698	5,801	7,284	7,280	6,727	5,464	4,225	3,885	4,557	66,812
1974	5,128	4,983	5,432	6,059	5,885	6,737	6,041	4,927	3,947	2,785	2,479	2,813	56,878
1975	3,434	3,833	4,803	5,055	4,816	5,781	5,673	5,847	4,604	3,125	2,443	2,706	51,919
1976	3,130	3,244	3,809	4,466	4,583	5,028	4,930	4,127	3,278	2,552	2,259	2,411	43,468
1977	2,784	3,019	3,535	4,042	4,087	5,044	4,881	4,486	3,604	2,802	2,454	2,843	43,372
1978	3,165	3,640	3,994	3,850	3,322	3,468	3,179	3,147	2,743	2,331	2,118	2,148	37,100
1979	2,154	1,858	2,073	2,641	3,123	4,805	4,846	4,548	3,908	3,470	3,221	3,212	39,857
1980	3,543	3,771	4,395	5,033	5,056	5,438	5,285	5,477	4,736	3,852	3,321	3,845	53,675
1981	4,399	4,325	4,849	4,904	4,320	6,344	6,434	6,264	5,418	4,618	4,101	3,969	60,302
1982	3,984	3,964	3,728	3,852	3,571	4,033	4,026	4,335	4,048	3,970	3,815	3,628	48,051
1983	4,075	4,351	4,710	4,710	4,400	5,225	5,220	5,345	4,504	3,255	2,807	2,893	51,094
1984	2,840	2,888	2,812	2,857	3,165	4,136	4,308	4,281	3,873	3,024	2,935	3,463	40,257
1985	3,920	3,823	4,021	4,135	3,821	4,310	4,250	4,471	4,301	4,300	4,248	4,159	49,759
1986	4,306	4,134	4,334	4,487	4,204	4,814	4,577	4,370	3,687	3,029	2,781	3,010	47,743
1987	3,677	4,343	5,029	5,284	4,848	5,251	4,942	4,931	4,522	2,721	2,381	3,147	50,580
1988	3,984	4,143	4,588	4,908	4,570	4,811	4,485	4,345	3,569	2,924	2,296	2,674	46,795
1989	3,373	3,998	4,568	4,882	4,282	4,741	4,498	4,455	3,683	2,652	2,364	2,909	46,203
1990	3,420	3,483	3,957	4,602	4,472	5,022	4,537	3,804	3,203	2,828	2,485	1,935	43,876
1991	2,093	2,695	3,261	3,519	3,437	4,141	4,043	3,874	3,441	3,224	3,001	2,609	39,538
1992	3,361	4,232	5,248	5,927	5,733	5,809	4,906	3,874	3,102	3,120	3,179	3,282	51,793
1993	3,659	3,858	4,247	4,447	4,354	5,411	5,400	5,264	4,520	3,773	3,336	3,302	51,571
1994	3,910	3,909	4,150	4,252	3,938	4,453	3,978	3,185	2,428	2,110	2,040	2,249	40,232
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Avg 1947-1994	4,404	4,512	4,905	5,134	4,918	5,593	5,503	5,335	4,591	3,890	3,836	3,906	59,034
Avg 1950-1994	5,411	5,333	5,646	5,823	5,591	6,586	6,371	6,061	5,177	4,430	4,249	4,704	65,391
Avg 1986-1994	3,487	3,857	4,379	4,868	4,426	4,843	4,896	4,245	3,617	2,909	2,853	2,813	46,492

### J3-49

Estimated Baseflow - Republican River at Max, Ne. (#6228000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	1,677	3,822	5,702	8,937	7,544	9,113	7,800	4,989	2,132	759	801	2,352	53,307
1941	4,242	9,039	7,781	8,907	8,648	10,063	8,823	6,565	4,718	4,139	3,781	3,719	77,301
1942	5,023	7,122	9,439	11,284	11,154	12,595	11,030	8,800	5,718	3,358	3,178	5,415	93,894
1943	7,914	8,801	11,208	11,118	9,527	8,410	7,804	5,890	3,883	1,274	188	488	77,880
1944	1,841	4,072	6,140	7,848	8,645	10,984	11,148	10,859	8,694	8,410	4,315	2,709	83,274
1945	3,992	8,848	8,927	8,203	8,277	8,764	7,881	7,231	5,705	4,089	2,841	1,830	74,847
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Avg 1940-1945	4,065	8,284	8,198	9,168	8,965	10,156	9,044	7,269	5,092	3,331	2,480	2,719	76,787

J3-50

Estimated Baseflow - Republican River near Bloomington, Ne. (6850600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	2,359	6,924	10,389	12,058	14,308	20,398	21,289	19,672	15,673	11,461	8,902	8,498	151,912
1941	8,199	8,944	13,217	18,167	21,258	28,884	32,987	36,331	33,738	28,298	26,018	24,482	284,300
1942	25,780	26,674	28,347	31,161	28,347	33,352	31,780	30,760	25,502	19,311	16,834	18,978	318,942
1943	23,341	27,260	30,755	31,032	27,284	28,127	24,468	21,888	15,851	9,185	4,080	1,331	244,410
1944	2,288	6,658	10,822	13,512	19,082	31,958	38,124	42,069	39,453	35,081	25,888	12,775	277,468
1945	10,634	17,908	24,781	29,329	29,082	33,089	33,878	36,018	33,787	24,893	15,157	5,834	296,203
1946	3,644	6,882	15,040	21,342	23,575	29,390	30,042	30,786	28,182	19,833	20,094	28,282	258,763
1947	34,136	33,680	36,047	37,884	35,414	39,701	37,943	37,609	31,143	22,527	14,000	6,735	368,889
1948	7,570	15,587	21,351	23,288	23,459	26,788	25,787	24,495	20,600	17,877	12,917	6,579	228,559
1949	6,588	12,403	18,283	17,020	20,839	35,481	41,330	43,814	37,183	25,797			258,808
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Avg 1940-2000	12,563	16,588	20,781	23,498	24,368	30,793	31,763	32,524	27,837	21,508	15,898	12,568	288,028



# J3-51

Estimated Baseflow - Republican River near Hardy, Ne. (8863600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total
1940	832	2,441	4,022	5,344	10,281	21,628	24,695	21,767	17,845	15,581	13,945	13,227	151,806
1941	12,015	8,853	9,538	15,864	17,043	24,485	28,162	35,576	34,898	31,399	28,597	27,080	272,548
1942	28,095	28,020	29,615	30,078	27,939	32,286	32,718	35,469	32,240	26,850	25,280	27,888	358,353
1943	30,979	31,289	33,302	33,886	31,438	36,159	32,874	27,821	18,488	10,760	4,813	2,635	285,445
1944	2,734	4,759	7,469	10,451	17,270	32,327	40,392	45,981	42,835	35,325	26,208	18,437	281,986
1945	15,171	20,334	25,384	28,223	28,058	34,048	35,503	36,639	33,799	24,192	17,027	13,443	313,945
1946	13,114	14,298	19,352	27,160	28,348	31,847	29,875	27,652	22,981	18,859	17,217	18,476	285,008
1947	24,188	31,590	38,277	41,138	38,080	44,828	43,284	43,292	37,387	30,383	20,945	10,154	404,314
1948	7,358	11,316	14,997	17,272	18,075	21,197	21,862	23,740	22,868	22,247	17,197	8,133	208,382
1949	6,884	12,483	17,088	19,484	22,249	33,180	38,888	45,481	41,503	31,698			
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Avg 1940-2000	14,137	16,513	18,905	22,703	23,978	31,179	32,923	34,562	30,570	24,739	19,023	15,256	283,508

J3-52

Estimated Baseflow - Rock Creek at Parks, Ne. (8824000)  
(values in cc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941		840	917	928	825	871	827	867	823	800	790	798	9,286
1942	847	829	871	891	818	909	854	833	775	735	729	781	8,880
1943	839	859	885	828	695	708	843	851	831	868	892	870	8,755
1944	722	748	803	811	753	784	742	753	717	730	705	844	8,814
1945	882	732	803	822	744	804	781	834	795	767	723	870	8,155
1946	897	716	798	873	813	875	808	760	696	651	690	728	9,098
1947	808	800	859	847	773	863	828	831	788	738	714	703	9,508
1948	774	830	901	904	851	821	884	897	829	823	818	817	10,240
1949	883	807	875	898	810	1,007	850	828	828	788	758	808	10,713
1950	878	858	901	922	838	814	884	883	818	840	850	849	10,397
1951	885	874	903	895	808	908	878	898	850	851	858	872	10,487
1952	922	893	924	927	877	958	900	857	781	721	707	723	10,188
1953	788	797	850	885	798	909	881	823	748	733	732	745	9,943
1954	837	904	968	935	810	851	805	842	791	783	742	762	9,998
1955	828	834	884	892	818	820	899	828	841	742	707	743	10,033
1956	824	847	900	897	837	882	829	784	718	734	732	712	8,707
1957	789	805	861	858	785	939	845	987	918	850	805	788	10,315
1958	853	888	949	948	889	969	956	921	838	828	822	829	10,684
1959	888	885	924	918	827	824	889	897	788	895	817	578	9,837
1960	864	798	833	886	843	895	919	869	758	723	862	880	9,870
1961	743	788	854	868	799	908	873	870	748	800	878	885	9,317
1962	810	825	874	874	790	874	844	887	808	777	748	729	8,822
1963	759	740	780	807	758	872	821	780	856	803	806	871	8,832
1964	758	768	837	893	885	830	874	839	755	730	898	869	8,814
1965	723	769	821	789	720	828	780	784	756	811	850	888	9,512
1966	817	877	862	790	698	744	722	748	722	748	775	807	9,368
1967	888	852	885	885	781	818	772	807	775	778	729	830	9,583
1968	841	877	732	736	698	784	743	757	694	844	648	703	8,434
1969	788	804	838	869	784	858	814	828	769	738	732	785	9,595
1970	819	810	847	844	785	858	814	794	718	878	889	780	9,418
1971	877	852	867	833	732	835	818	840	783	887	868	710	9,540
1972	782	785	817	789	738	788	780	777	740	747	746	738	8,220
1973	791	802	860	884	802	870	821	824	748	698	687	723	8,512
1974	795	803	857	876	798	881	829	808	712	837	807	690	9,315
1975	770	771	818	828	735	844	828	864	781	877	831	853	9,212
1976	713	721	775	802	749	763	723	739	835	852	853	881	8,872
1977	744	718	748	788	694	748	718	744	713	718	714	701	8,724
1978	736	725	747	728	648	715	685	694	648	627	608	581	8,151
1979	818	804	832	840	588	858	648	677	634	601	587	588	7,480
1980	878	737	804	801	750	807	748	698	621	618	619	638	8,510
1981	880	868	701	720	681	738	714	738	698	880	858	635	8,286
1982	871	880	718	715	634	674	850	696	683	838	836	869	8,038
1983	718	692	690	840	578	689	691	681	592	501	478	531	7,491
1984	605	624	672	685	657	723	707	723	653	583	555	575	7,783
1985	828	827	827	827	474	528	528	575	576	608	632	850	7,007
1986	713	732	788	748	855	897	858	878	635	613	610	629	8,138
1987	898	834	860	881	814	853	805	599	581	837	837	584	7,281
1988	808	818	855	855	811	851	828	848	814	802	589	579	7,457
1989	817	824	681	684	584	642	610	625	586	603	598	577	7,409
1990	805	804	844	885	803	649	817	835	593	570	541	510	7,234
1991	533	542	590	622	583	862	853	683	631	560	542	524	7,145
1992	572	613	689	877	840	889	839	583	559	617	597	498	7,389
1993	837	850	828	858	607	875	842	838	590	883	557	515	7,187
1994	539	818	878	878	596	625	536	507	458	488	488	518	8,743
1995	577	594	629	620	557	620	591	587	537	514	498	489	8,810
1996	518	508	517	487	480	500	485	514	510	581	548	502	6,098
1997	501	479	505	533	473	471	443	488	471	450	429	412	5,855
1998	455	498	554	587	482	480	442	480	486	525	528	498	6,005
1999	538	488	508	478	388	388	341	343	315	287	303	333	4,701
2000	387	381	419	508	512	533	481	372	314	340	323	283	4,772
Avg 1941-2000	717	731	778	780	711	777	740	743	698	683	651	658	8,820
Avg 1950-1984	814	833	890	889	829	819	877	867	787	745	728	736	8,822
Avg 1988-2000	503	508	605	618	559	585	559	559	524	523	512	483	6,865

J3-53

Estimated Baseflow - Sappa Creek near Beaver City, Mo. (6848200)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	0	0	0	0	0	0	34	106	156	188	209	215	912
1942	229	222	244	274	280	354	373	399	384	378	362	338	3,837
1943	344	338	358	365	347	419	405	378	305	225	134	44	3,683
1944	0	0	9	27	90	225	307	368	398	438	459	455	2,775
1945	473	454	457	435	379	411	388	382	342	283	185	80	4,262
1946	8	22	37	49	60	91	88	94	46	49	37	12	365
1947	86	281	421	488	487	577	591	542	482	448	327	130	4,838
1948	84	116	183	186	203	225	212	196	170	157	111	39	1,850
1949	8	22	38	54	103	227	352	520	583	603	558	453	3,520
1950	415	389	383	357	329	407	408	403	372	368	354	338	4,519
1951	350	351	348	305	275	350	412	534	853	853	965	970	8,387
1952	1,025	1,001	1,033	1,021	841	888	878	780	560	360	185	80	8,814
1953	10	31	82	102	129	185	206	223	193	141	83	27	1,383
1954	8	22	47	79	92	116	102	68	38	13	0	0	583
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	7	24	37	51	59	59	237
1958	60	55	63	78	89	128	140	151	147	147	109	35	1,201
1959	0	0	7	23	40	76	77	51	27	10	0	0	311
1960	0	0	0	0	32	108	147	161	142	107	85	21	784
1961	0	0	0	0	0	0	8	27	27	10	0	0	73
1962	0	0	0	0	11	40	52	51	50	58	55	42	361
1963	48	62	71	85	59	81	54	43	27	10	8	23	528
1964	35	38	45	51	57	77	80	77	54	19	0	0	335
1965	0	0	0	0	15	54	87	80	108	223	342	447	1,314
1966	609	759	904	968	886	935	766	543	373	330	284	154	7,483
1967	118	128	178	259	235	171	140	191	221	256	231	146	2,275
1968	145	209	295	283	261	217	150	94	45	18	0	0	1,697
1969	15	44	78	107	157	284	323	313	234	115	37	12	1,718
1970	0	0	18	55	83	82	88	96	83	29	0	0	489
1971	0	0	13	41	54	69	78	96	77	27	0	0	457
1972	0	0	10	31	53	88	91	78	51	18	0	0	418
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Avg 1940-2000	123	138	159	173	173	210	211	213	193	180	156	124	2,093
Avg 1950-1964	130	130	137	136	137	189	172	172	155	143	126	105	1,714

J3-54

Estimated Baseflow - Sappa Creek near Stamford, Va. (6847500)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946					115	164	184	203	175	123	146	253	1,366
1947	407	567	763	941	971	1,167	1,136	1,091	882	857	491	413	9,478
1948	466	564	718	790	884	553	410	331	251	210	139	45	3,185
1949	23	67	83	85	84	178	241	308	351	415	518	650	2,982
1950	777	808	870	888	807	884	859	907	887	816	825	913	10,440
1951	985	1,016	1,088	1,100	1,101	1,465	1,334	1,558	1,513	1,607	1,663	1,676	18,305
1952	1,784	1,765	1,808	1,729	1,490	1,396	1,155	987	739	521	297	97	13,784
1953	91	151	285	442	504	635	840	831	644	452	297	97	4,728
1954	21	62	94	123	158	258	298	188	109	39	0	0	1,308
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	36	107	152	161	168	224	285	396	396	328	244	158	2,852
1959	138	163	199	230	284	384	392	313	195	88	0	0	2,358
1960	0	0	0	0	0	0	0	0	0	3	8	24	84
1961	81	60	64	71	95	186	253	332	357	366	276	91	2,220
1962	0	0	30	91	140	228	273	319	346	406	482	567	2,883
1963	964	690	672	537	427	485	445	392	263	94	26	75	4,770
1964	118	141	245	420	652	1,097	1,122	842	624	258	83	27	5,531
1965	0	0	15	48	94	198	259	314	378	521	625	732	3,160
1966	556	691	956	962	669	956	858	667	767	764	708	625	10,136
1967	835	653	705	727	696	738	738	815	802	802	745	637	8,693
1968	615	595	612	606	572	630	585	531	363	129	0	0	6,236
1969	81	151	218	236	268	407	483	587	487	294	166	125	3,455
1970	180	311	385	396	399	522	529	457	304	136	0	0	3,529
1971	0	0	0	0	81	178	247	273	208	74	0	0	1,033
1972	0	0	0	0	82	207	287	228	154	55	0	0	983
1973	0	0	42	128	211	368	440	479	363	129	0	0	2,161
1974	65	191	331	470	528	680	801	387	195	89	0	0	3,517
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	58	194	223	160	91	32	0	0	788
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	189	588	710	648	445	158	0	0	2,690
1985	0	0	0	0	118	417	627	488	336	119	0	0	2,002
1986	14	40	97	183	266	510	528	402	240	85	0	0	2,365
1987	28	75	186	353	405	461	436	395	272	87	0	0	2,702
1988	57	169	256	302	298	303	228	109	32	11	0	0	1,786
1989	0	0	4	14	32	72	72	38	14	5	0	0	291
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	34	121	185	160	193	230	458	659	2,230
1994	1,250	1,483	1,643	1,545	1,347	1,485	1,307	1,074	801	615	430	270	13,281
1995	304	494	732	973	1,077	1,392	1,336	1,128	836	582	384	244	9,487
1996	262	405	566	706	794	963	1,016	1,015	961	1,061	1,102	1,129	10,023
1997	1,199	1,160	1,181	1,144	948	879	671	497	328	228	204	272	6,708
1998	601	1,135	1,503	1,769	1,810	2,283	2,151	1,777	1,172	614	148	143	15,006
1999	324	682	652	1,127	1,173	1,477	1,523	1,574	1,325	630	585	253	11,898
2000	300	682	691	916	851	870	674	377	154	65	0	0	6,749
Avg 1946-2000	227	283	341	373	377	477	486	426	342	257	203	168	3,944
Avg 1950-1964	309	331	367	366	357	483	481	458	392	336	288	250	4,470
Avg 1986-2000	289	420	538	603	604	723	674	571	423	295	219	211	5,570



J3-56

Estimated Baseflow - Stinking Water Creek near Palisade, Ns. (6836000)  
(values in cc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950		1,990	2,043	1,945	1,820	2,311	2,293	2,168	1,843	1,570	1,472	1,540	21,010
1951	1,783	1,954	2,170	2,231	2,058	2,317	2,284	2,348	2,248	2,263	2,276	2,289	28,198
1952	2,483	2,488	2,675	2,778	2,839	2,874	2,593	2,142	1,821	1,254	1,139	1,310	25,984
1953	1,857	1,984	2,388	2,668	2,504	2,689	2,403	2,145	1,871	1,219	964	953	23,241
1954	1,350	2,003	2,490	2,604	2,346	2,456	2,221	2,117	1,862	1,075	851	1,047	22,221
1955	1,374	1,675	2,012	2,218	2,086	2,311	2,096	1,870	1,428	972	834	1,350	20,336
1956	1,685	1,741	1,825	2,067	1,958	2,095	1,853	1,666	1,383	1,242	1,135	1,050	19,890
1957	1,381	1,817	2,140	2,140	1,906	2,364	2,356	2,406	2,152	1,870	1,597	1,373	23,672
1958	1,555	1,851	2,288	2,380	2,246	2,680	2,534	2,288	1,949	1,867	1,788	1,727	25,212
1959	1,919	2,125	2,408	2,551	2,464	2,853	2,736	2,312	1,894	1,139	1,017	1,377	24,696
1960	1,841	2,198	2,532	2,618	2,531	2,798	2,682	2,811	2,151	1,584	1,288	1,323	28,187
1961	1,538	2,053	2,354	2,391	2,197	2,482	2,404	2,432	2,032	1,481	1,296	1,590	24,310
1962	1,962	2,179	2,448	2,533	2,389	2,738	2,703	2,837	2,982	2,819	2,481	2,327	28,829
1963	2,518	2,747	3,041	3,124	2,745	2,759	2,424	2,290	1,811	1,551	1,555	1,851	28,815
1964	2,315	2,369	2,815	2,821	2,788	3,094	2,733	2,193	1,818	1,288	1,178	1,311	28,337
1965	1,628	1,931	2,233	2,338	2,202	2,540	2,480	2,432	2,178	1,892	2,048	2,352	28,331
1966	2,885	2,714	2,871	2,884	2,614	2,903	2,556	2,078	1,873	1,615	1,710	1,858	28,282
1967	2,299	2,445	2,598	2,608	2,586	2,799	2,811	2,566	2,294	2,108	1,854	1,894	28,869
1968	2,087	2,392	2,744	2,913	2,737	2,786	2,488	2,268	1,820	1,373	1,243	1,471	28,280
1969	1,765	1,913	2,142	2,282	2,168	2,566	2,482	2,307	1,981	1,698	1,481	1,461	24,154
1970	1,758	2,171	2,550	2,873	2,518	2,802	2,647	2,256	1,733	1,342	1,190	1,315	25,058
1971	1,599	1,851	2,167	2,364	2,297	2,712	2,728	2,845	2,360	1,653	1,235	1,484	26,183
1972	1,891	2,119	2,278	2,110	1,978	2,312	2,252	2,140	1,881	1,738	1,582	1,488	23,717
1973	1,633	1,850	2,193	2,332	2,267	2,744	2,599	2,319	1,840	1,748	1,847	2,251	25,802
1974	2,551	2,430	2,623	2,896	2,687	2,872	2,582	2,370	1,869	1,329	1,104	1,244	28,553
1975	1,488	1,852	1,902	2,071	2,082	2,660	2,594	2,330	1,850	1,420	1,209	1,282	22,529
1976	1,434	1,549	1,872	2,260	2,268	2,338	2,081	1,848	1,445	1,079	926	1,024	20,121
1977	1,282	1,551	1,791	1,847	1,860	2,462	2,459	2,245	1,797	1,385	1,129	1,138	20,927
1978	1,294	1,440	1,590	1,834	1,428	1,812	1,857	1,814	1,591	1,084	801	796	17,073
1979	863	1,072	1,265	1,332	1,387	1,838	1,900	1,698	1,415	1,285	1,063	820	16,124
1980	1,050	1,352	1,601	1,658	1,658	1,950	1,803	1,770	1,389	950	781	837	16,878
1981	1,063	1,283	1,513	1,614	1,563	1,840	1,846	1,846	1,678	1,359	1,103	862	17,871
1982	1,089	1,381	1,639	1,722	1,590	1,751	1,697	1,789	1,594	1,373	1,305	1,412	18,322
1983	1,855	1,541	1,799	2,003	1,973	2,283	2,205	2,195	1,728	1,143	837	873	20,035
1984	1,037	1,208	1,472	1,718	1,798	2,088	2,149	2,313	1,998	1,436	1,077	882	18,272
1985	1,124	1,365	1,536	1,688	1,896	1,700	1,698	1,558	1,318	1,033	892	1,130	18,319
1986	1,286	1,272	1,525	1,930	1,880	1,987	1,784	1,595	1,253	913	745	783	16,843
1987	872	1,197	1,428	1,540	1,560	2,007	1,963	1,755	1,304	796	606	785	15,909
1988	1,105	1,441	1,658	1,803	1,532	1,773	1,748	1,727	1,449	1,104	905	1,153	17,287
1989	1,325	1,347	1,369	1,312	1,217	1,910	1,495	1,431	1,194	945	879	1,021	15,085
1990	1,218	1,324	1,500	1,614	1,541	1,780	1,891	1,498	1,129	708	541	870	15,183
1991	874	1,055	1,293	1,488	1,449	1,645	1,800	1,628	1,336	894	678	725	14,658
1992	818	1,139	1,389	1,492	1,451	1,542	1,378	1,179	1,013	1,038	1,069	1,106	14,691
1993	1,247	1,338	1,472	1,515	1,444	1,734	1,708	1,678	1,556	1,561	1,522	1,443	18,218
1994	1,538	1,808	1,791	1,813	1,661	1,827	1,650	1,462	1,186	1,028	930	927	17,363
1995	1,088	1,278	1,418	1,375	1,298	1,358	1,652	1,791	1,562	1,180	973	980	16,180
1996	1,121	1,257	1,379	1,338	1,331	1,566	1,535	1,406	1,234	1,201	1,254	1,388	16,055
1997	1,505	1,394	1,419	1,440	1,369	1,621	1,523	1,340	1,054	818	740	841	15,055
1998	1,038	1,202	1,387	1,470	1,398	1,517	1,374	1,210	972	801	727	786	13,628
1999	912	1,055	1,246	1,381	1,308	1,442	1,303	1,183	948	829	879	1,103	13,560
2000	1,323	1,378	1,478	1,476	1,378	1,462	1,289	1,067	791	584	481	448	13,129
Avg 1950-2000	1,821	1,721	1,883	2,053	1,955	2,234	2,113	1,978	1,638	1,321	1,188	1,272	20,817
Avg 1950-1994	1,818	2,084	2,368	2,471	2,322	2,594	2,421	2,253	1,870	1,532	1,369	1,504	24,513
Avg 1986-2000	1,164	1,285	1,447	1,520	1,452	1,668	1,576	1,490	1,198	960	868	943	15,542

# J3-57

Estimated Baseflow - Striking Water Creek near Wauneta, Ne. (6834600)  
(values in cc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941	1,057	1,229	1,448	1,537	1,473	1,566	1,367	1,184	877	838	813	819	13,836
1942	1,091	1,214	1,436	1,608	1,485	1,527	1,371	1,318	1,106	881	839	1,000	14,845
1943	1,284	1,543	1,718	1,847	1,408	1,438	1,282	1,193	908	817	487	545	14,014
1944	722	834	1,111	1,157	1,147	1,325	1,282	1,214	888	739	588	558	11,782
1945	753	1,086	1,339	1,401	1,285	1,401	1,304	1,258	1,034	787	686	847	13,171
1946	1,026	1,112	1,271	1,384	1,276	1,314	1,168	1,181	970	744	728	840	13,123
1947	1,218	1,423	1,808	1,828	1,484	1,684	1,608	1,543	1,305	1,069	901	830	16,918
1948	1,037	1,400	1,654	1,654	1,510	1,528	1,342	1,187	954	878	759	642	14,574
1949	822	1,203	1,483	1,478	1,369	1,588	1,527	1,471	1,205	888	864	1,158	15,035
1950	1,435	1,525	1,640	1,825	1,488	1,644	1,610	1,384	1,148	1,029	833	878	18,187
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2000													
Avg 1941-1950	1,042	1,287	1,469	1,518	1,391	1,502	1,378	1,284	1,052	825	741	821	14,288

J3-58

Estimated Baseflow - Thompson Creek at Riverton, Na. (8851600)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949		882	1,013	1,160	1,200	1,119	1,278	1,288	1,398	1,308	1,174	1,148	14,186
1950		1,317	1,211	1,217	1,217	1,095	1,202	1,198	1,223	1,189	1,252	1,281	14,585
1951		1,270	1,236	1,301	1,343	1,234	1,369	1,326	1,371	1,295	1,271	1,276	15,605
1952		1,433	1,459	1,537	1,521	1,372	1,370	1,239	1,201	1,102	1,098	1,083	15,480
1953		1,120	1,102	1,199	1,305	1,223	1,341	1,290	1,235	1,101	1,039	868	13,331
1954		1,196	1,187	1,262	1,241	1,108	1,221	1,190	1,254	1,178	1,112	1,071	14,084
1955		1,145	1,170	1,260	1,287	1,187	1,311	1,287	1,373	1,337	1,350	1,318	15,276
1956		1,276	1,252	1,298	1,285	1,200	1,282	1,223	1,183	1,065	984	917	12,886
1957													
1958													
1959													
1960													
1961													
1962													
1963													
1964													
1965													
1966													
1967													
1968													
1969			1,225	1,270	1,252	1,127	1,260	1,217	1,238	1,194	1,243	1,254	13,508
1970		1,291	1,285	1,358	1,374	1,243	1,351	1,301	1,328	1,214	1,128	1,035	15,083
1971		1,211	1,255	1,348	1,356	1,235	1,374	1,330	1,368	1,280	1,265	1,219	15,412
1972		1,222	1,291	1,324	1,314	1,233	1,337	1,298	1,324	1,211	1,116	1,090	14,821
1973		1,208	1,211	1,278	1,291	1,187	1,351	1,310	1,317	1,213	1,181	1,181	14,908
1974		1,349	1,383	1,483	1,511	1,387	1,489	1,387	1,344	1,200	1,121	1,071	15,789
1975		1,152	1,192	1,282	1,300	1,177	1,287	1,233	1,285	1,213	1,238	1,178	13,515
1976													
1977													
1978			1,286	1,328	1,318	1,196	1,355	1,302	1,290	1,169	1,097	1,050	13,425
1979		1,118	1,154	1,239	1,257	1,205	1,482	1,455	1,380	1,206	1,098	1,032	14,662
1980		1,103	1,109	1,195	1,230	1,200	1,292	1,226	1,202	1,028	833	748	12,973
1981		859	840	837	874	850	988	978	1,061	1,083	1,083	1,101	11,681
1982		1,121	1,087	1,145	1,185	1,122	1,322	1,338	1,419	1,377	1,389	1,386	15,281
1983		1,436	1,385	1,433	1,408	1,299	1,320	1,247	1,282	1,193	1,039	991	14,988
1984		1,179	1,284	1,418	1,452	1,391	1,524	1,505	1,580	1,417	1,193	1,024	15,905
1985		1,003	1,092	1,184	1,188	1,050	1,178	1,172	1,284	1,178	1,095	1,088	13,711
1986		1,363	1,218	1,208	1,238	1,119	1,205	1,162	1,327	1,190	919	839	13,695
1987		875	949	981	1,007	935	1,082	1,048	1,034	988	977	873	11,853
1988		1,048	1,115	1,239	1,310	1,258	1,333	1,210	1,088	838	893	805	13,308
1989		1,068	1,143	1,207	1,173	1,044	1,158	1,085	1,079	1,009	1,024	1,009	13,002
1990		1,031	1,078	1,166	1,188	1,083	1,189	1,142	1,140	1,085	1,060	1,032	13,167
1991		1,052	1,105	1,208	1,248	1,138	1,244	1,185	1,200	1,078	990	887	13,173
1992		954	1,009	1,103	1,134	1,077	1,154	1,081	1,034	848	858	851	12,333
1993		1,009	1,063	1,178	1,244	1,169	1,233	1,312	1,374	1,347	1,411	1,420	15,229
1994		1,452	1,488	1,580	1,581	1,430	1,561	1,468	1,450	1,340	1,324	1,282	17,139
1995		1,273	1,287	1,285	1,199	1,084	1,311	1,328	1,397	1,168	875	754	13,739
1996		965	1,029	1,107	1,065	1,041	1,185	1,184	1,320	1,284	1,247	1,195	13,776
1997		1,153	1,268	1,116	1,068	1,043	1,289	1,306	1,291	1,166	1,088	1,021	13,655
1998		1,005	979	1,032	1,098	1,036	1,281	1,309	1,333	1,233	1,171	1,099	13,838
1999		1,141	1,232	1,378	1,455	1,298	1,315	1,189	1,221	1,152	1,148	1,039	14,687
2000													
Avg 1940-2000	1,154	1,174	1,248	1,285	1,185	1,295	1,242	1,286	1,171	1,111	1,073	1,072	13,927
Avg 1950-1964	1,247	1,232	1,298	1,318	1,203	1,301	1,242	1,264	1,182	1,154	1,131	1,150	14,581
Avg 1965-2000	1,110	1,125	1,188	1,217	1,125	1,260	1,219	1,234	1,136	1,075	1,032	1,014	13,745



J3-59

Estimated Baseflow - Turkey Creek at Edlaon, Ne (6844210)  
(values in cc-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
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1979	55	79	98	102	131	234	268	298	247	244	211	150	2,065
1980	151	192	234	258	272	335	343	344	286	204	134	87	2,538
1981	95	148	168	211	210	257	259	263	239	221	197	172	2,457
1982	193	234	263	255	252	341	378	419	382	311	238	174	3,438
1983	178	220	269	301	301	388	385	419	393	354	278	167	3,628
1984	191	207	268	313	349	450	478	482	429	342	248	160	3,885
1985	191	290	282	295	297	351	372	417	429	398	357	318	3,864
1986	333	359	414	483	453	531	516	506	418	306	231	205	4,735
1987	229	274	335	384	398	511	533	554	520	497	428	320	4,985
1988	328	410	492	533	527	583	567	570	488	415	357	337	5,818
1989	370	410	462	488	470	568	558	533	457	389	323	287	5,290
1990	284	339	418	488	487	572	573	595	500	348	257	241	5,103
1991	278	333	395	441	449	570	555	605	454	198	88	126	4,487
1992	215	315	407	459	463	516	497	454	399	344	292	240	4,582
1993	255	305	395	494	505	588	563	631	634	684	727	759	6,569
1994	836	853	919	948	886	1,020	960	889	723	591	457	428	9,479
1995	491	588	681	719	677	774	808	828	834	817	437	320	7,889
1996	358	506	633	689	682	755	756	808	604	851	861	835	8,538
1997	850	884	965	1,008	969	1,142	1,107	1,091	878	577	428	468	10,443
1998	632	820	725	806	781	922	900	945	851	725	578	432	8,817
1999	473	643	792	854	811	923	830	1,014	892	957	880	758	10,017
2000	785	891	965	1,012	896	1,127	1,058	944	759	608	488	417	10,017
Avg 1978-2000	348	398	468	509	502	594	594	607	536	447	372	323	5,680

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Estimated Baseflow - Turkey Creek at Neponset, Ne. (6880000)  
(values in ac-ft)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1940													
1941													
1942													
1943													
1944													
1945													
1946													
1947													
1948							653	594	494	438	393	371	2,951
1949	441	549	698	739	724	655	854	677	604	739	686	596	8,510
1950	611	631	688	713	667	764	737	729	858	608	562	525	7,980
1951	584	985	738	735	664	810	814	848	777	701	663	673	8,681
1952	744	784	871	827	888	830	837	749	618	538	470	428	6,786
1953	485	580	677	718	668	740	663	685	556	441	360	328	6,906
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Avg 1948-1993	573	642	728	766	726	820	786	744	851	577	519	487	7,288