Evaluating Hydrologic Effects of Water Acquisitions on the Middle Rio Grande

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FY2004 Middle Rio Grande Endangered Species Act Collaborative Program
Water Acquisition and Management Subcommittee

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1 EXECUTIVE SUMMARY

This report came about as the result of questions raised among the staff of the New Mexico Interstate Stream Commission about how a water rights acquisition program in the Middle Rio Grande Basin might work, how water rights transfers might be effected, and the magnitude of the acquisitions that might be required. The Water Acquisition and Management Subcommittee (WAMS) of the Middle Rio Grande Endangered Species Act Collaborative Program has made estimates of the volume of water required to meet the flow targets of the 2003 Biological Opinion regarding the silvery minnow. The WAMS identified two components of water supply for any flow supplementation element – a flow component and a consumptive component. The WAMS also identified a number of measures by which water could be provided to meet the flow targets. One of these measures was acquisition of water rights from willing sellers.

Though the WAMS identified water rights acquisitions as one source of supplemental water, it provided only an initial assessment of their feasibility. The work that is the subject of this report was intended to make a more complete assessment of the utility and feasibility of using water rights acquisitions to supplement flows in the Rio Grande floodway[1]. This work addressed two principal areas: How much consumptive use would result from a flow supplementation program of the magnitude estimated by the WAMS, and how might water rights acquisitions be used to get "wet water" in the Rio Grande floodway to meet the flow targets of the Biological Opinion.

Changes in water operations of any sort intended to meet the requirements of the RPA will result in increased depletions from the basin. The basin is already over-appropriated, so any new consumptive uses of water in the basin must be offset by a reduction in existing uses. A water rights acquisition program, acquiring water rights from willing sellers, is one way to offset new consumptive uses caused by changes in water operations. We estimate that the consumptive use arising from the water operations contemplated by the WAMS analysis would average about 7,000 acre-feet per year. Based on a consumptive irrigation requirement of 2.1 feet per acre, this would require the acquisition of approximately 3,300 acres of irrigated lands and their appurtenant water rights within the Middle Rio Grande valley.

We also determined that, under current water management conditions, water rights acquisitions would not be effective in delivering "wet water" to the Rio Grande floodway. Without either strict priority administration of water rights in the Middle Rio Grande (and good measurement and reporting of diversions) or a cooperative agreement with the Middle Rio Grande Water Conservancy District, acquisition of water rights will not lead to a reduction in diversions from the River or increased storage in upstream reservoirs.

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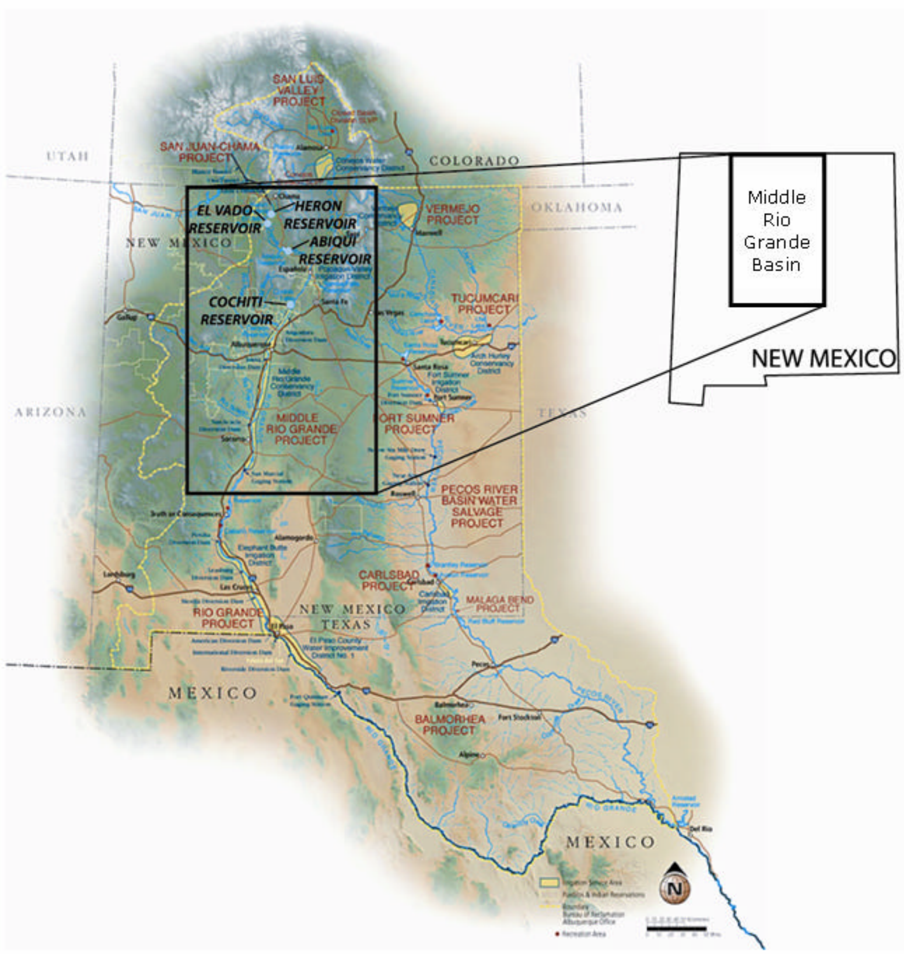
[1] This report does not address directly the water needs of the willow flycatcher, but much of the information in this report is directly applicable to the use of water rights acquisitions to meet water-related elements of the RPA that address the willow flycatcher.

2 OVERVIEW -- GUIDE TO DOCUMENT AND INTRODUCTION TO ISSUES

The Rio Grande silvery minnow (silvery minnow) and southwestern willow flycatcher (flycatcher) have been listed as endangered species with occupied habitat in the Middle Rio Grande in New Mexico. In 2002, Federal and non-Federal organizations entered into a Memorandum of Understanding (MOU) to create the *Middle Rio Grande Endangered Species Act Collaborative Program* (Program) for the purpose of improving the status of these species in the Middle Rio Grande basin while continuing existing and planned human uses of water. Figure 1 provides a map showing the upper and middle Rio Grande basin in New Mexico.

Figure 1. Study Area Location Map.



In March, 2003 the U.S. Fish and Wildlife Service issued a Biological Opinion regarding the silvery minnow, the flycatcher, and other species (*Biological Opinion*). The *Biological Opinion* set out a Reasonable and Prudent Alternative (RPA) for recovery and preservation of the listed species. Among the elements of the RPA are several Water Operation Elements, which set out flow targets ("the flow targets") intended to benefit the species. In order to meet these flow targets it will be necessary in many years to supplement the flows of the Rio Grande during summer months.

Stored water, leased water and exchanges have so far served as the primary source of water to meet the flow targets. Due to drought and associated restrictions by the Rio Grande Compact on storage on the Rio Grande above Elephant Butte Reservoir, the availability of stored and leased water is becoming more limited. Recognizing that the Rio Grande basin is fully appropriated and that New Mexico's continued compliance with the terms of the Rio Grande Compact requires that any new consumptive use of water be offset by discontinuation of an existing consumptive use, acquisition and transfer of existing water rights will be required to meet the ongoing requirements of the RPA.

This technical report describes the range of hydrologic considerations and impacts that must be addressed in acquiring and transferring water rights to supplement flows in critical habitat reaches to meet the flow targets set out in the Biological Opinion. It also describes conceptually the types of calculations necessary to quantify the effect of a transfer as needed to support a transfer application with the New Mexico Office of the State Engineer (OSE). While we cannot foresee all possible issues, we do attempt to identify those issues that are reasonably likely to be important to transfers from lands within the Middle Rio Grande Conservancy District (MRGCD) to a use of flow supplementation to aid in meeting the flow targets.

This document is organized as follows:

- We first provide additional background information on the Program (remainder of this Overview, in particular previous activities of the *Water Acquisition and Management Subcommittee* (WAMS) of the Program that helped define the context of this project, including WAMS estimates of the volume of water (as upstream storage) required to meet the target flows of the Biological Opinion; our estimates of the depletive effect of the flows estimated by the WAMS; an overview of the hydrology of flow supplementation; an overview of acquisition considerations; an overview of the water rights in the MRGCD; a listing of OSE criteria for evaluating transfers; and how to quantify transfers.

- Section 2 then provides preliminary estimates of the depletions arising from flow supplementation. Our estimates are based on previous WAMS estimates which focused solely on the required volume of stored water.

- In Section 3, we consider the hydrologic aspects of agricultural use, which is the presumed source of the water to be acquired for supplementing river flows to meet the flow targets. In any water rights transfer, the OSE will require an analysis of the historical use quantities and patterns by the previous use, and the historical consumptive use (CU) will dictate the quantity of water that can be transferred.

- Section 4 focuses on the hydrology and depletions associated with supplementing river flows. Supplementing river flows will cause an increase in the depletions in the basin. These increased depletions must be offset by acquiring and discontinuing an existing use. The legal framework for this process is a water rights transfer through the OSE. As part of reviewing a transfer application, the OSE will require an analysis of the hydrologic effects associated with the exercise of use at the new place of use. In order to approve the transfer, the OSE will require that any new depletions be fully offset by the cessation of the historical use of the acquired water rights.

- Section 5 discusses the overall hydrologic effects of water rights acquisitions for flow supplementation by synthesizing the considerations presented in Sections 3 and 4 on the hydrologic factors particular to the source of the transfers (agriculture) and the recipient of the transfers (supplemental flows.)

- Finally, we close this report (Section 6) by presenting policy considerations associated with transfers of rights within MRGCD to supplemental flows, especially the enforcement of dry-up of the lands from which those water rights would be removed.

This report came about as the result of questions raised among ISC staff about how a water acquisition program might work, how water rights transfers might be effected, and the magnitude of the acquisitions that might be required. ISC staff asked Hydrosphere to assist them in preparing a proposal for funding by the Program for work that would help answer these questions. The proposal was reviewed, ranked and eventually selected for funding as part of the FY 2003 Program funding process. The project is done under a contract with the ISC, which pays directly for the work and is subsequently reimbursed by the Program for 75 percent of the project cost.

2.1 Background on Water Acquisitions to Provide Supplemental Flows

The WAMS was established under the Program to evaluate water acquisition and management opportunities, and to develop a comprehensive water management and supply plan to assist the Program in meeting its goals. The WAMS issued a draft plan in February, 2004 (WAMS, 2004.) In this plan, the WAMS made estimates of the amount of water (as storage in upstream reservoirs) needed to meet the flow targets specified in the Biological Opinion. The Biological Opinion set out thirty two elements within the RPA. The WAMS identified sixteen of these as involving water management.

The WAMS set out for itself the following goal:

> To ensure that water is available in that portion of the Middle Rio Grande, as determined by the Program, to promote the conservation and contribute to the recovery of the Rio Grande silvery minnow and the southwestern willow flycatcher, while concurrently, to the maximum extent possible, protecting the existing and planned management and use activities dependant on the river’s water.

Under this goal, the WAMS set out five guiding objectives. The first two of these are:

> **WAMS Objective 1**. Research, develop, evaluate, and assist with implementation of alternatives to lease and/or otherwise acquire water.

> **WAMS Objective 2**. Research, develop, evaluate, and assist with implementation of water management alternatives (to include but not limited to: supplemental water, Low

Flow Conveyance Channel pumping, timing of flow, reservoir operation, groundwater pumping, storage, irrigation, Compact delivery operation and floodplain modifications.)

This report directly supports Objective 1, with several areas of overlap with Objective 2. This report is particularly responsive to Objective 2 in that almost any action taken to supplement flows for the benefit of the silvery minnow will increase overall depletions in the Rio Grande basin in New Mexico. It is the policy of the State of New Mexico that any new depletions on the Rio Grande will be offset by a reduction in other depletions so as not to impair existing water rights or jeopardize the State's position with respect to the Rio Grande Compact. Accordingly, and under State water law, an analysis of depletions arising from providing supplemental water will be required as part of any water management element. One important purpose of water rights acquisition is to provide offsetting depletion reductions.

2.2 Water Needed to Meet Water-Related Elements of the RPA

In addressing its goal, the WAMS made preliminary estimates of the quantities of water required (as upstream storage) to meet the water-related elements of the RPA, identified potential water supply alternatives, and evaluated issues related to water management alternatives.

The WAMS identified two components of water supply for any flow supplementation element, a *flow component* and a *consumptive component* (WAMS report, attachment C-4.)

Based on the requirements set out in the water management elements of the RPA, the WAMS made a preliminary quantification of the flow component (WAMS report, attachment B.) On average, the WAMS estimated that on the average about 50,000 acre-feet of supplemental water would be required to be released annually from El Vado Reservoir in the upper basin to meet the water-related elements of the RPA in the lower portion of the study area. These requirements would range from about 20,000 acre-feet in a wet year to about 100,000 acre-feet in a dry year when storage is constrained by Article VII of the Rio Grande Compact. These water requirements are set out and discussed in somewhat more detail later in this report.

The WAMS defines the consumptive component to include evaporation and evapotranspiration losses associated with water-related Program activities. The consumptive component represents the amount of water that is permanently lost from the hydrologic system. It does not include such things as seepage or recharge of alluvial groundwater, as these processes do not, in themselves, cause a permanent loss of water from the hydrologic system. A substantial fraction of seepage losses, for example, will accrue to drains or even to the river at a downstream point. Losses to alluvial groundwater, if they do not promote additional evapotranspiration from riparian plants, remain available for beneficial use and are not permanently lost to the system.

The WAMS did not quantify the consumptive component associated with supplementing river flows. We have made a preliminary estimate that the consumptive component will average about 7,000 acre-feet per year. The bases for this estimate are described in more detail in Section 4 and Appendixes B, C, D and E.

2.3 Overview of Hydrology of Flow Supplementation

The flow supplementation alternatives identified by the WAMS can be categorized roughly into four categories: manipulation of flow timing, reductions in existing diversion and/or consumptive use, reduction or interception of river seepage losses thereby increasing surface flows, and introduction of “new” water into the basin.

Manipulation of flow timing. Storage can be used to distribute flows in time from periods of high flow to periods of low flow when supplementation is desirable. One example of this would involve storing flows during spring runoff that are surplus to diversion requirements and serve to contribute to New Mexico’s delivery obligation to Texas under the Rio Grande Compact. If reservoir storage space were available during periods of surplus deliveries, some portion of that water could be stored for release during the summer months when supplementation is desired. An alternative to reservoir storage is the possibility of aquifer storage. Alluvial pumping and aquifer storage and recovery are means of using aquifers as storage vessels to support flow supplementation.

Any such alternative will increase depletions, as the volumetric unit rate of depletion is greater during the summer months. This is true due to higher temperatures and lower flows (which increase the water surface area per unit volumetric flow). It is important to note that in most cases the depletions arising from flow supplementation would be less than would be the case if the same amount of water was applied to irrigation.

Reductions in diversion and consumptive use. This category includes alternatives such as forbearance, acquisition (both involving willing sellers), and salvage. These alternatives will tend to reduce depletions. In the case of forbearance and acquisition, water that would have been put to use in irrigation would instead be released to the stream during periods when supplementation would be required. While in principle these alternatives could involve municipal or industrial water rights, they are more likely to involve agricultural rights, because these rights control the preponderance of water in the basin. These alternatives may also utilize storage to allow for better timing of supplemental flows.

It is the case with these alternatives that the depletions eliminated when a quantity of water is removed from irrigation use are greater than the depletions arising from letting that quantity of water flow down the river. When water is diverted for irrigation in the MRG, from 30 percent up to about 70 percent of the amount of water diverted is consumed by evaporation or evapotranspiration. Our preliminary estimates are that depletions attributable to flow supplementation should average about 7,000 acre-feet per year. On average, those depletions will be about 20 percent of the amount of water the WAMS has estimated would be required to be released from storage to meet the flow targets.

Reduction or interception of seepage losses. Three approaches have been suggested in this category: reconfiguration of the river channel, the use of slurry walls in selected reaches to reduce seepage losses, and pumping from the Low Flow Conveyance Channel (LFCC.) Alternatives in this category will lead to water flowing in the river channel that would otherwise be in the alluvial groundwater system, which will increase depletions.

"New" water supplies. New water can be water imported into the basin, or water resulting from weather modification. Either approach would increase river flows assuming historical diversions remain unchanged. It is not clear what net effect weather modification might have given compact constraints and how resulting flows might be quantified. In addition, flows from weather modification will most likely occur during high flow periods.

Some of these alternatives will result in a net increase in depletions while others will result in a net decrease in depletions. The waters of the Rio Grande have been considered fully appropriated with regard to depletions since the Rio Grande Compact was consummated (NM OSE, 2000). Increases in depletions within the basin would result in a chronic deficit in New Mexico's deliveries under the Rio Grande Compact. Therefore, combinations of alternatives that result in a net increase in depletions will not be sustainable. The most effective program will combine alternatives such that the net effect on depletions is neutral over the long term.

2.4 Overview of Acquisition

Constraints imposed by New Mexico water law and the Rio Grande Compact will require that any additional depletions caused by water management activities under the Program be offset by acquisition of valid water rights. The OSE is the agency responsible for assuring that a water rights transfer will result in no increase in depletions. In addition, the diversion from acquired water rights may be transferable to a use of flow maintenance (supplemental flow), which would make a direct contribution to the flow component.

New Mexico water law constrains the transfer of the diversion component of a water right based on the principle that the historical use under a water right may not be expanded, and that injury to or interference with other water rights is not allowed as a result of a transfer. In other words, the exercise of a water right at a new point of use or for a new type of use may not cause increased diversions or interfere with the ability of other water rights holders to divert their entitlement as if there had been no transfer. Non-injury protection is extended even to water rights that may be junior to the transferred right but which have come to rely on the hydrologic condition established by the exercise of the transferred right at its original use. This is most commonly the case when a junior right has come to rely on return flows from a senior right (New Mexico Statutes 72-5-30).

New Mexico water law also constrains the transfer of depletions on the basis of non-injury and non-expansion. There is an additional imperative operating in the Middle Rio Grande because that basin is considered to be fully appropriated in terms of depletions, the limit being set by the State's delivery obligation under the Rio Grande Compact.

Curtailment of existing consumptive use involves the acquisition of water rights used for irrigation of agricultural land (from willing sellers), the retirement of that land from agriculture, and the transfer of the water right to the benefit of the flow supplementation program. The transfer process puts an end to depletions from irrigation on the parcel, allowing that depletion to be used to offset the new use. A transfer also ends diversions to the parcel which, in principle, would make them available for use to supplement flows. However, in practice it is currently difficult to put the diversion to use at a new location, for reasons we will discuss later.

Acquisition of water for application to any new use, including flow supplementation, involves a water rights transfer process under New Mexico water law. The process is largely the same whether the transfer is permanent (a purchase) or temporary (a lease or water bank transaction.) For a permanent transfer, the acquisition process involves the following steps:

Purchase. A valid water right is purchased. The land on which the water right is being put to use need not be conveyed to the purchaser.

Water rights transfer. The water right is transferred to a new place of use and type of use. In this process the water right will retain its priority, but will be quantified in terms of allowable diversion (or pumping) and depletion. A requested transfer may be disallowed by the OSE or as the result of a protest. The details of the transfer process relevant to the water acquisition program are described in the *Transfer Handbook* that accompanies this report.

Cessation of original use. The original use under the water right must cease. This usually takes the form of “dry up” of irrigated lands. The land may not be irrigated unless another valid water right is transferred onto it.

Initiation of new use. The water is applied to the new use at the new point of use.

Administration of new use. Day-to-day administration of the transferred water right will be done according to its original priority and its new volumetric limits, as well as any other terms and conditions set out in the OSE permit.

2.5 Water Rights in the MRGCD

Kery, et. al. (2003) made an effort to describe the water rights in the Middle Rio Grande Conservancy District. The following discussion is excerpted from that description.

The MRGCD encompasses parts of six Pueblos and 70 pre-existing acequias. In addition to serving water to farmers in those entities, the MRGCD brought new lands under irrigation. It also developed a storage facility. As a result, Kery suggests there exist seven categories of legally recognized water rights within the District. These are:

1. Individual pre-1907 water rights. These are water rights perfected prior to when the State Engineer was given jurisdiction over water rights. These water rights are vested in the individual water rights holders. These water rights may be transferred to a new point of diversion, place of use, or type of use. Kery estimates these water rights are appurtenant to an estimated 80,785 acres of land within the District.

2. Water rights permits between 1907 and 1927. These water rights were granted through permits from the State Engineer and were perfected prior to the formation of the District in 1928.

3. MRGCD permitted surface water right. MRGCD has obtained two permits from the State Engineer for approximately 42,000 acres of land, including more than 11,000 acres

within the six Pueblos. No Proof of Beneficial Use has yet been filed for these permits, so these water rights have not been formally quantified.

4. Pueblo water rights. These are the “prior and paramount” water rights of the Pueblos which are based on their aboriginal sovereignty and cover 8,847 acres and are prior and paramount to any other water rights in the District.

5. Pre-1956 and permitted groundwater rights. Wells drilled prior to 1956, when the State Engineer asserted jurisdiction over groundwater in the Rio Grande Basin, were granted water rights at that time. Since 1956, groundwater rights are based on permits from the State Engineer. Wells with both types of groundwater rights are owned by individuals and the MRGCD within the District.

6. San Juan-Chama water. The District has a contract with the USBR for delivery of 20,900 acre-feet of water annually from the San Juan-Chama Project.

7. Storage rights. MRGCD has a right to store water in 198,110 acre-feet of El Vado Reservoir. This right is for the use of reservoir space and is not a water right.

Because of their seniority, pre-1907 water rights should be of primary interest for acquisition. Storage of acquired water is necessary to allow water to be stored for release during periods of low flows, so rights to the use of storage space would also be valuable for flow supplementation.

2.6 Criteria for Transferability

A transfer is initiated by the applicant through an application to the OSE. The application provides basic information about the water right to be transferred and the new type of use and point of use. The OSE will evaluate a water right and the proposed transfer against the following criteria.

Valid water right. This is the first step. OSE requires a valid water right. If the right has been adjudicated then this establishes validity. Otherwise, the State Engineer evaluates the water right according to a set procedure. This process will be described more thoroughly in the transfer memorandum.

Allowable quantity. Only the historical consumptive use can be transferred. Depletions associated with the new use may not exceed the historical depletions. In the Middle Rio Grande, the OSE has adopted a standard quantification of consumptive use for irrigated lands.

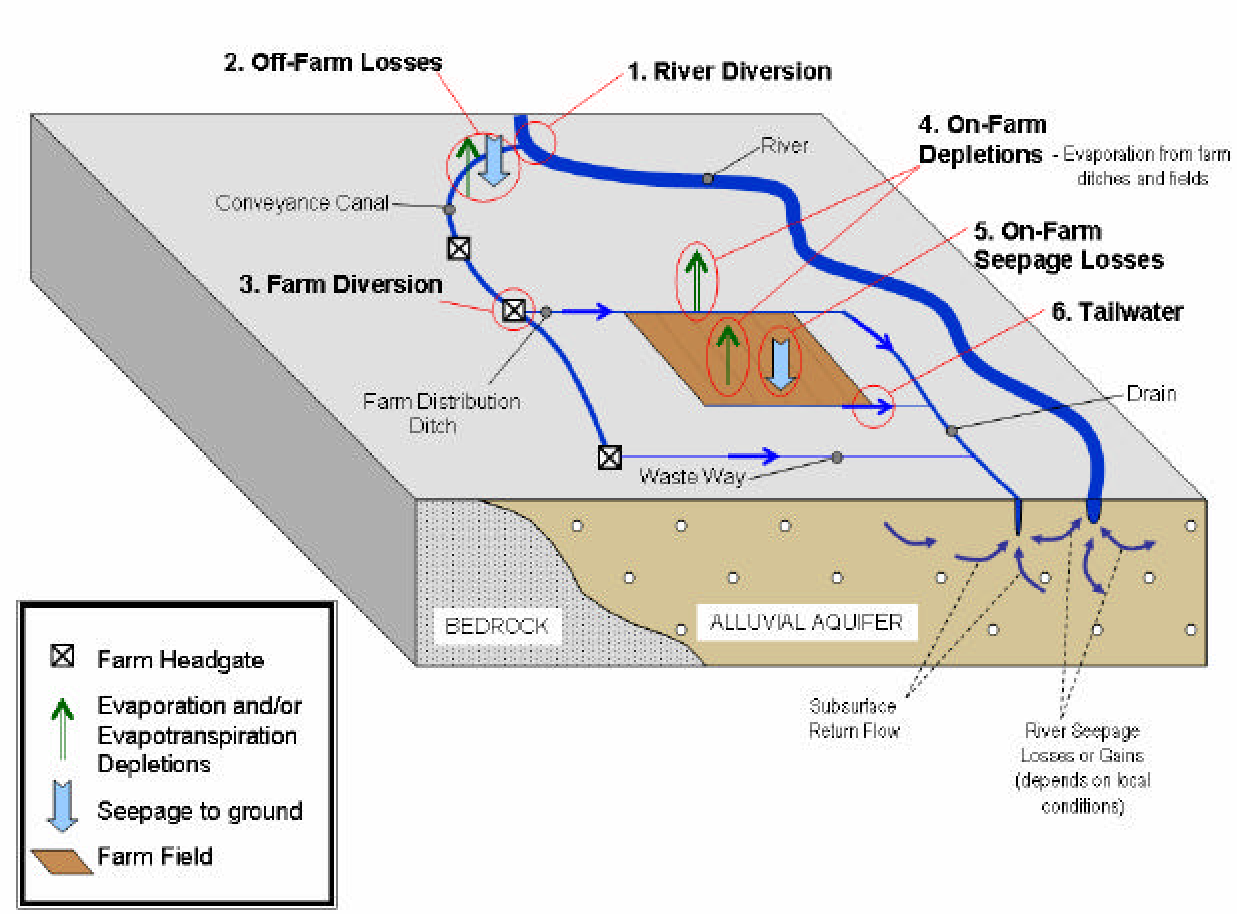
Impairment of water rights. Use of a transferred right will be limited to avoid injury to other water rights. This injury, called interference, could take the form of reduced flows in a stream or excessive reduction of groundwater levels.

Public welfare. Despite the fact that the New Mexico legislature added a public welfare criterion to the water code in 1985, the OSE has not addressed the application of the criterion by regulation and has only addressed public welfare briefly in a few decisions. There is almost no case law in New Mexico addressing this issue.

Water conservation. Water right permits that are issued include a water conservation condition stating that the permittee "shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical." OSE policy on specific water conservation requirements for water right applicants is still evolving.

2.7 Quantification of Transfer

Figure 2. Components of an Agricultural Water Right.



Six components of a water right are illustrated in Figure 2:

1. River Diversion—The amount of water diverted from the river.
2. Off-Farm Losses—Seepage and depletions that occur as water is moved from the river to the farm headgate in a canal.
3. Farm Diversion—The amount of water diverted from the canal onto the farm.
4. On-Farm Depletion—The amount of water lost from farm ditches and farm operations through evaporation and evapotranspiration.

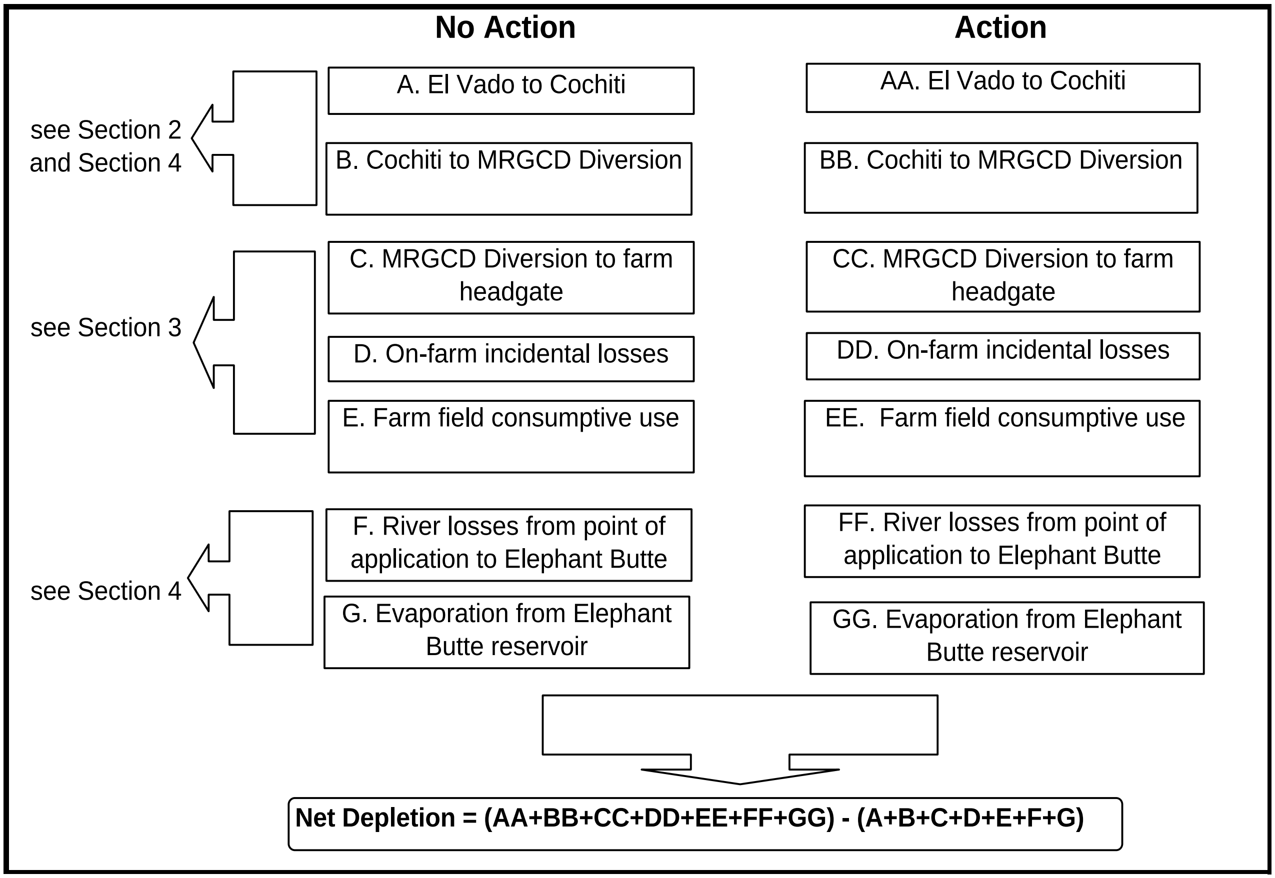
5. On-Farm Seepage Losses—The amount of water lost from farm ditches and farm operations to groundwater by seepage. This water eventually returns to the river and is not a depletion.
6. Tailwater—The amount of water that leaves the farm from the bottom of fields and eventually returns to the river.

The typical New Mexico water right is for on-farm irrigation use. It is quantified by the allowable diversion (the Farm Diversion) and the allowable consumptive use (the On-Farm Depletion.) When an agricultural water right is transferred, the amount of water transferred is limited to the historical use, and most often to the historical consumptive use.

The New Mexico State Engineer has specified standard quantities for the allowable diversion and consumptive use to be used in transfers from irrigated lands within the Middle Rio Grande basin. The allowable consumptive use is 2.1 acre-feet per acre, and the allowable farm diversion is 3.0 acre-feet per acre. In practice, the OSE allows higher diversion if the net depletions do not exceed the total allowable amount based on the acreage transferred. For example, under current practices, when an irrigation right in the Middle Rio Grande is transferred to municipal use supplied by a well, the OSE may allow the well to be pumped at a rate twice the amount of the transferred depletion (provided that a return flow plan is filed and approved by the State Engineer.)

In terms of this water acquisition project, the OSE will require that the transfer results in no net increase in depletions. This means that a quantitative analysis must be undertaken to assess the depletions under both current conditions ("No Action") and under the conditions of the transfer ("Action") scenario. Figure 3 provides a schematic illustration of the various hydrologic components that must be considered in computing the net depletion. Sections 2 through 4 below provide a detailed discussion of each of these components, and Figure 3 is annotated to indicate which Section of this report addresses each component.

Figure 3. Schematic Diagram Showing Hydrologic Components of a Depletion Analysis.



3 HYDROLOGY OF AGRICULTURAL USE

Later discussion of the benefits of water rights acquisition will address a number of concepts regarding the hydrology of agricultural use. The following discussion describes these concepts in terms commonly employed in New Mexico. This section addresses depletion components C through E in Figure 3: MRGCD Diversion to farm headgate losses, on-farm incidental losses and on-farm field consumptive use.

3.1 Off-Farm Hydrology Concepts

Project delivery requirement. In cases where farms are supplied from turnouts on a canal, the project delivery requirement is the amount of water that must be diverted from the stream into the canal (*project diversions*) to achieve the necessary farm delivery requirement and ultimately supply the necessary on-farm consumptive use. The difference between the project delivery requirement and the sum of all farm deliveries consists of losses from the conveyance system and flows to wasteways.

Project efficiency. Project efficiency is calculated as the sum of all farm deliveries divided by the total project diversion. Project efficiency can be improved by reducing conveyance losses and flows to wasteways.

In a detailed analysis of the system, one could consider all of the off-farm losses. In most cases when project deliveries to farms are reduced, project diversions will also be reduced, as will off-farm conveyance losses, though not on a one-to-one basis. Given the difficulty in knowing the precise values for each component of off-farm losses, a conservative net depletion analysis (Figure 3) should simply assume that the only difference in consumptive use between the “Action” and “No Action” scenarios is the acreage retired times the consumptive duty of water per acre (2.1 acre-feet/acre).

3.2 Off-Farm Hydrology of the MRGCD System

SSPA (2002) provides a detailed description of the MRGCD system and analyzes diversion records and crop consumptive use requirements to evaluate the MRGCD system losses and project efficiency.

3.2.1 Diversions

The MRGCD diverts flows from the Rio Grande at four locations (Cochiti, Angostura, Isleta, and San Acacia) into their network of primarily earthen canals and laterals. In addition to its direct river diversions, MRGCD also diverts water from the network of drains that cover much of the District.

A network of drains have been installed as part of the MRGCD system, which facilitates collection of return flows. These drains also intercept shallow groundwater, including some which originates from seepage from the Rio Grande floodway. In addition to its river diversions, MRGCD diverts water from the system of drains and introduces this water into its canal system. Some of the water diverted from drains originates from return flows from other, upstream MRGCD diversions, and some is water that originates from seepage from the Rio Grande floodway and has been intercepted by the drains.

In a letter from Thomas Turney, New Mexico State Engineer, to Subhas Shah, District Engineer, Middle Rio Grande Conservancy District, The New Mexico OSE established a position that a project delivery requirement of 7.2 acre-feet/acre from the Rio Grande into the MRGCD system is “sufficient and non-wasteful” (Turney, 2001. This letter is attached as Appendix F.) This quantity is based on an on-farm consumptive irrigation requirement of 2.1 acre-feet/acre and “a reasonable allowance for losses.” Measurement and accounting of MRGCD diversions from the Rio Grande is complicated because some of the water in the drains originates from seepage from the Rio Grande. The State is silent on whether diversion from the Rio Grande includes intercepted seepage.

3.2.2 Losses

Losses from the MRGCD system originate as seepage from canals and as direct diversions into wasteways. Water which seeps from canals enters the shallow aquifer. Some of this water will be intercepted by drains, and some of the intercepted water will be re-diverted to beneficial use. The remainder of the water will eventually be conveyed to the Rio Grande floodway. Water that flows into wasteways may flow directly into the Rio Grande floodway or into a drain. Water from a wasteway that enters a drain may be re-diverted.

Under relatively full water supply conditions, the MRGCD typically operates with the entire network of canals full. This operating approach reduces the direct water management costs (both for capital and labor) but it also means that more water is diverted from the Rio Grande floodway than is required to meet farm delivery requirements, resulting in higher losses to seepage and larger wasteway flows. The majority of these losses finds their way back to the Rio Grande floodway, but accrue to the river at a point some distance below the point of diversion. This operating approach will limit the effectiveness of water rights transfers in providing water in the floodway as a direct result of a transfer. This issue is discussed more fully below.

3.2.3 Depletions

Off-farm depletions on the MRGCD system arise from direct evaporation from canal surfaces or evapotranspiration.

Under relatively full water supply conditions, the MRGCD typically operates with the entire network of canals full. The nearly-rectangular or trapezoidal section geometry of the ditches leads to a situation in which small changes in flows in the ditches will not significantly affect surface area. Thus evaporative depletions from the system canals will not experience large changes for small changes in project deliveries associated with fallowing fields.

Evapotranspiration arises from vegetation growing along the canals or in areas that are sub-irrigated by canal seepage. Small changes in flows will not significantly affect canal depths (and thus heads) so seepage losses will not experience large changes.

3.3 On-Farm Hydrology and Depletions

Crop consumptive use. This is the amount of water that is taken up by the crop and that contributes to its growth. This water is lost through ET. All of crop consumptive use is a depletion. Crop consumptive use is determined by the type of crop being grown and the meteorological conditions. Crop consumptive use can be reduced by limiting water supply at the cost of crop yield.

Farm conveyance losses/depletions. Once diverted onto the farm, the water is subject to loss through seepage and/or evapotranspiration as it is conveyed to the crop. Seepage losses will contribute to groundwater and are generally only temporarily lost to the river. Evapotranspiration is a depletion. This component can be significantly reduced or eliminated with irrigation system improvements such as installing pipelines and/or lining on-farm distribution ditches.

Farm tailwater. This is the amount of water that leaves the farm field after application to the crop, and is the result of overwatering associated with poor on-farm water management. If an agricultural drain is located near the farm, tailwater can be immediately returned to the hydrologic system and is subject to minimal depletive losses. On the other hand, if no drain is nearby, tailwater is subject to seepage (which ultimately returns to the shallow alluvial aquifer) and evapotranspiration depletion. It is important to note that farmers distant from drains have a strong incentive to eliminate tailwater, as inundation by tailwater will kill the crops that provide income.

Farm delivery. This is the amount of water diverted to the farm or field through the farm headgate. In some cases the farm headgate will be a diversion from a stream, but in other cases, and in virtually all MRGCD lands, the farm headgate is a turnout from a canal. Farm delivery is the sum of crop consumptive use, farm conveyance losses/depletions and farm tailwater. The New Mexico OSE has established a value of 3.0 acre-feet/acre as the amount of on-farm delivery that may be transferred to a new location and/or use within the Middle Rio Grande Valley. (Higher levels may be allowed for higher efficiency uses subject to constraints set by interference.)

On-farm depletion. This is the sum of crop consumptive use and the depletions arising from conveyance on the farm. The New Mexico OSE has established a value of 2.1 acre-feet/acre as the amount of on-farm depletion that may be transferred to a new location and/or use within the Middle Rio Grande Valley.

Farm efficiency. Farm efficiency is calculated as the crop consumptive use divided by the farm delivery. Farm efficiency can be low if on-farm conditions require a large farm delivery. For example, a poorly leveled field with a ridge and furrow irrigation system may require excess water at the head of the furrows in order to get water to the far end of the furrows. The excess water will be lost to seepage. High-efficiency irrigation methods reduce on-farm conveyance losses and reduce the farm delivery requirement for a given on-farm depletion.

3.4 Hydrology of Water Transfers

A water rights transfer that involves cessation of irrigation on a parcel of land ("dry-up") will theoretically result in a reduction in depletions and may result in a reduction in river diversions. We caveat this as "theoretical" due to the fact that in areas with shallow water tables, non-native species such as salt cedar may become established on fallowed lands and ultimately result in depletions as high or higher than those under crop production. If invasive phreatophytes are prevented from taking root, almost all of the reduction in depletions will come from the elimination of the consumptive use of the crop. Smaller depletion reductions come from the elimination of evaporation from free water surfaces and elimination of evapotranspiration from weed growth along the on-farm irrigation system.

The on-farm depletions due to crop consumptive use are dependent on the crop type and weather. On farm depletions from the irrigation system will depend on the nature of that system. These quantities are reasonably well-understood and relatively constant for a given crop type and weather conditions. The OSE has established nominal values for the amount of depletion and farm delivery that may be transferred from a parcel. As described in Section 1.4, these values are 2.1 acre-feet/acre of depletion and 3.0 acre-feet/acre of farm delivery.

Any reduction in depletions from a water rights transfer relies on the cessation of irrigation ("dry-up") of the parcel. If this is not enforced no reduction of depletions will occur. If the parcel that is the subject of a transfer (the "from" parcel) is dried up but the water that was used to irrigate it is then applied to new lands, perhaps under the District rights, then depletions will not be reduced.

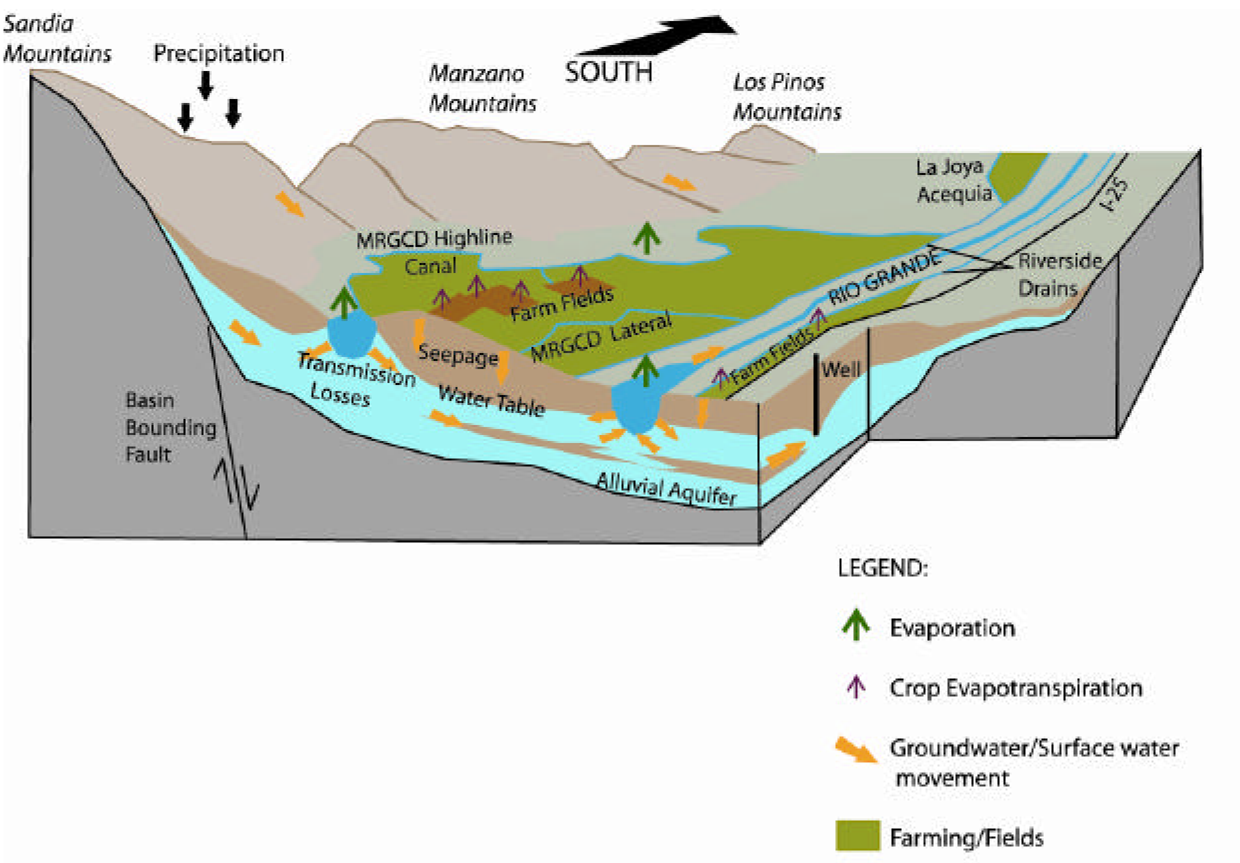
The degree to which diversions will be reduced as a result of dry-up depends on the nature and operation of the diversion and conveyance system that supplies the parcel. The quantification of the reduction in diversion is particularly complex in the MRGCD because of the District's operating approach.

4 HYDROLOGY OF RIVER REACHES IN THE MIDDLE RIO GRANDE

This section considers depletions associated with flows in the Rio Grande river channel, as represented by depletion components A, B, F, and G in Figure 3, which are the reaches of the Rio Grande from El Vado to Cochiti and Cochiti to the MRGCD diversion; and the river losses from the point of application to Elephant Butte Reservoir and evaporation from Elephant Butte Reservoir.

To quantify the hydrologic effects of transfers to supplement river flows, it is necessary to compute the difference between the depletions under the "No Action" condition (water applied to its current use) and under the "Action" of transferring the water to the new use. Because it is the Rio Grande Compact that places the constraint on depletions in the Middle Rio Grande Valley, the scope of this comparison must go beyond just river losses and consider changes to depletions from all sources regardless of their location the valley.

Figure 4. Schematic Diagram of the Hydrologic System from Belen to San Acacia.



For the purpose of this study, the current use is agriculture, so the "Action" alternative includes cessation of the agricultural use and new river depletions associates with the supplemented flows. To help illustrate hydrologic concepts described in this and subsequent sections, Figure 4 presents depletion components for the Belen reach of the Rio Grande (Figure 1), which is representative of the entire MRGCD system.

Figure 4 is a schematic diagram of the Rio Grande River and the MRGCD hydrologic system, looking south along Belen reach of the Rio Grande. This figure illustrates the key hydrologic processes discussed in Sections 2 through 4. The processes that must be addressed in a transfer are those that can reasonably be expected to be influenced by the changes brought about by a transfer. For example, because there is no reason to believe that a water rights transfer for supplemental flow would impact M&I uses, this sector is not considered in the analysis.

4.1 "No-Action" Hydrology of River Reaches

A stream or man-made conveyance is subject to gains and losses as water moves through it. Gains accrue in the form of direct precipitation on the water surface, surface water inflows from tributaries or overland flow, or inflows from groundwater where local groundwater gradients are toward the channel. Conveyance losses accrue in the form of direct evaporation from the water surface and leakage or seepage to groundwater where local groundwater gradients are away from the channel.

A portion of channel losses are permanently lost from the river, while the remainder is seepage that is only temporarily lost to the river and will return at a lower point or a later time. Permanent losses are commonly referred to as depletions. Depletions arise from three processes: One is direct evaporation of water from the river surface and from wetted sandbars and sandy channel fringe. A second process is evapotranspiration by plants of water from alluvial groundwater that originates from the river as seepage losses. The third process is movement of water from alluvial aquifers to deeper or more remote aquifers from which water cannot naturally return to the river system. From the accounting standpoint of the Rio Grande Compact such deep percolation represents a depletion, though some of this water may be returned to the Rio Grande surface system if at some future time it is ultimately captured by a well and applied to beneficial use.

Changes in water management will change the hydrologic condition of the river system (which includes the channel and connected groundwater systems.) The water management alternatives contemplated by the WAM would typically involve a change in the timing and magnitude of flows accompanied by a change in the hydrologic condition of reservoirs and a change in the timing and magnitude of flows diverted from the river and applied to agriculture. Typically, a water management action or acquisition for the Program is intended to result in increased streamflow during periods of low flows. The exception to this are spiking flows employed to trigger spawning of the silvery minnow.

In either case, the change in hydrologic condition will be additional flows in the river channel, which can affect both the seepage characteristics of the channel as well as the depletions as described in the next section.

4.2 Hydrology of Supplemented Flows

When transferring water from an existing use to the river channel to benefit the minnow, the OSE rules dictate that one must perform a hydrologic analysis to estimate the depletions associated with the new use. The basis for this analysis would be to quantify the change in hydrologic conditions caused by the change in flows. Those changes affect these elements of the riverine hydrology:

- *River seepage losses* – River losses are comprised of both seepage into the river bed and direct evaporation. When flows are supplemented, river depths and thus heads will increase, with the result that river seepage will be increased. How much seepage increases will depend greatly on the local alluvial conditions and the state of the river. Seepage from some reaches of the Rio Grande is extremely large and at low flows can represent large fractions of the flow. It is obvious from the observed state of intermittence on the lower reaches that seepage is sufficient to extinguish low flows.

  The magnitude of seepage losses varies considerably from reach to reach, but seepage is the dominant process on many reaches of the Rio Grande and largely determines the quantity of water required for flow supplementation (Hydrosphere, 2001.) Although seepage losses can be quite large, the actual depletions associated with these losses arise primarily from surface evaporation and evapotranspiration from plants in areas that are sub-irrigated by seepage losses, and will be much smaller than the seepage losses themselves.

- *Groundwater effects* – Seepage losses may be strongly related to the state of the underlying groundwater system, as seepage rates may be affected by the depth to the water table in the alluvial aquifer, which in turn is affected by groundwater pumping. Increased seepage losses will accrue to the underlying groundwater system.

  The fate of seepage from the river differs above and below a point roughly defined by the San Acacia diversion. In the reach above San Acacia, the floodway and associated bosque is roughly a quarter of a mile wide, bounded by levees and lateral drains on both sides, which return water to the river at multiple locations. The river thalweg is within a few feet of the floodplain elevation outside the floodway. The extent of bosque vegetation is limited to a zone roughly 300 ft wide on either side of the floodway. In this reach seepage losses will be either intercepted by lateral drains or will resurge to the river at lower locations or later times. The portion of the water intercepted by drains may be diverted to beneficial use (and be further depleted in the process) or be returned to the river through a wasteway. Bosque vegetation is already supplied by alluvial groundwater so the baseline depletions are high, but unlikely to be increased substantially as a result of seepage due to supplemental flows.

  Below the Bosque del Apache National Wildlife Refuge the Rio Grande floodway is perched due to aggradation at elevations from 5 to 10 feet above the surrounding floodplain, is generally wide and braided, and is bounded only on the west side by the Low Flow Conveyance Channel (LFCC) and a levee. Bosque vegetation is much more prevalent on the eastern side of the river. The groundwater table along the east side drops significantly when the river dries and so will rise in response to the introduction of supplemental flows.

- *Depletions due to surface evaporation* – Evaporation from the surface of the stream constitutes a depletion. All things being equal, evaporative depletion is a function of stream surface area. Thus, flow supplementation will generally increase evaporative depletions.

- *Depletions due to evaporation from wetted sands* – Evaporation of water that is stored in sandbars or in sand fringes of the channels constitutes a depletion. Water may be temporarily stored in sand during periods of flow decline, but even during stable flow regimes there will be some wetting of sands due to capillary action. If flow supplementation increases the wetted area of sand increased depletions will result. This is likely the case under some conditions, so evaporation from wetted sands should be considered in calculating depletions.

- *Depletions due to increased evapotranspiration* – Riparian vegetation is watered by shallow groundwater in proximity to the river. This vegetative growth thus inflicts a depletion on the groundwater system due to evapotranspiration. If increased seepage losses cause a rise in the local water table, it is arguable that an increase in evapotranspiration could result. For the reach above San Acacia, our view is that evapotranspiration is probably not greatly increased by temporary increases in groundwater surface elevation as the existing phreatophyte communities have root systems deep enough to get water under all but the most extreme conditions.

  Below San Acacia, model studies have shown that as flows increase in the floodway the groundwater elevation on the east side of the river rises sufficiently to reach the root zone of bosque plants, including salt cedar and cottonwoods (Shafike, 2005a.) These studies indicate substantial increases in depletions due to evapotranspiration will occur as a result.

Overall, the hydrologic effects of the new use are highly dependent on the stage of the river. Under relatively high stage, incremental additions of water to the channel will not significantly modify the prevailing seepage and evapotranspiration depletion regime and will not markedly increase the water surface area. The added water can be considered to "ride on top" of existing flows. At very low stage, on the other hand, the hydrologic effects of the new use are likely to be large:

- Much of the transferred water will seep into the relatively dry river channel.
- Some of the seepage will enter groundwater storage, and some, particularly in the reach below San Acacia, will enter the root zone for riparian vegetation and be subject to ET.
- The water which remains on the surface of the river channel will experience direct evaporation.
- Some of the water will wet-up previously dried sand bars or wet-up exposed river bottom, that would instead have stayed entirely dry, and as a result will be subject to direct evaporation.

Given that transfers to the river channel are most likely to occur under dry conditions to help prevent intermittence in river flows, the transferred water will typically be subject to extreme seepage losses and higher depletions.

4.3 Means of Delivering Flow Component

As described by the WAMS (WAMS, 2004), water delivered to the channel to benefit the minnow can come from a variety of sources:

- Bypass at the MRGCD Project Diversions;
- Storage water from system reservoirs;
- Groundwater pumped from wells completed in the shallow alluvial aquifer; and
- Pumping of MRGCD drainwater (system drains and LFCC) to the river channel.

Bypass at MRGCD Project Diversion. The largest portion of the water carried through MRGCD canals and delivered to MRGCD lands is first withdrawn from the Rio Grande river channel at the river diversions at Cochiti, Angostura, Isleta and San Acacia. Some portion of deliveries is direct flow and the remainder is releases from storage. Once farm diversions onto acquired lands are ceased, water previously destined for those lands could be bypassed at the MRGCD river diversions, regardless of its origin. If the MRGCD system had no wasteways, the inevitable effect of reduced diversion at a farm headgate would be a reduction in river diversions of virtually the same amount of water. The MRGCD system does have wasteways, which flow to drains and to the river, and because of this a reduction of farm delivery may not, and likely will not, result in a reduction in river diversions without the cooperation of the MRGCD. However, with the cooperation of the District and with some improvements to the MRGCD facilities it should be possible to translate acquisition of lands with an associated reduction in farm diversions into a reduction in river diversions.

It should be noted that, without the ability to store deferred direct flow river diversions, the direct flow may not come at a time when it would most benefit the silvery minnow.

Delivery from reservoirs (releases from storage.) The delivery of water from system reservoirs (e.g., Cochiti, Heron, El Vado and Abiquiu) is subject to significant losses, since this water must flow long distances from storage to the reaches below Albuquerque that require supplemented flows. Consistent with the concept described above of supplemented flows “riding on top” of natural flows, releases from storage would be most efficient when MRGCD is operating and keeping the river wet.

Some of fraction of the water supplied to MRGCD lands is first stored in El Vado Reservoir. How much water is stored in El Vado at the beginning of each irrigation season varies from year to year, depending on available snowmelt and the Rio Grande Compact Article VII storage restriction. In principle, the stored component of the supply for a parcel of land within MRGCD could be released according to a schedule that benefits the minnow. Of course, this would require the cooperation of the District.

Conveyance of Farm Delivery. If, because of facility limitations or policy, it is not possible to bypass acquired farm delivery at the appropriate MRGCD diversion, it would be possible to take delivery of water at the farm headgate and convey it to the river in a pipeline or canal. This would be expensive, and it would only provide water on the schedule of deliveries offered by MRGCD to the farm.

Delivery by wells. The use of alluvial aquifer wells to supplement flows has the advantage of minimized channel transmission losses. In other words, water from wells can be delivered to the river channel precisely, or at least very close to, where the water is needed. Of course, the closer to the site the wells are located, the fewer the losses. In this case, the only net depletions would be the incremental increase in surface evaporation, evaporation from wetted sands and evapotranspiration along the reaches where the water is applied.

The incremental increase in evapotranspiration is the difference between the evapotranspiration if the groundwater was left in place and the evapotranspiration associated with direct evaporation and riparian vegetation evapotranspiration in and adjacent to the river channel. Extraction from an alluvial well would tend to reduce evapotranspiration losses if the groundwater is removed from an area where it is supplying water to non-native phreatophytes. Water applied to the stream would tend to increase surface evaporation, evaporation from wetted sands and evapotranspiration as described in Section 3.2. When viewed in isolation (looking only at the effect of the delivery system) the net depletive effect of a well-supplied delivery system can range from negative values (or a <u>net benefit</u> to the system) if the savings in evapotranspiration is large and the increased losses due to flow supplementation are small, to large positive values if the groundwater is extracted from an aquifer system hydrologically removed from the shallow alluvial aquifer and hyporheic zone and applied to a reach where induced depletions are large.

Conceptually, any water removed from a groundwater system ultimately impacts discharges from that system. Discharges consist of springs, man-made drains, baseflows to surface water bodies, evapotranspiration by phreatophytes and other riparian vegetation, and other wells. Pumping from a well can adversely affect flows from the other discharges. If the other discharges are hydrologically poorly connected to the location of the well, then it can take months, years, or even decades for the effects of the pumping wells to be felt at the location of the discharges. In the vicinity of the well, groundwater is immediately removed from storage, which is reflected in reduced water levels in the aquifer.

If the well is near a hydrologically well-connected surface water body, then seepage losses from the surface water will be increased due to reduced groundwater levels (and consequent increased hydraulic gradients away from the surface water body). For example, seepage analyses for the Socorro to San Antonio reach of the Rio Grande (Hydrosphere, 2001; SSPA, 2002) indicate a strong hydraulic connection between the river and the shallow alluvial aquifer; thus groundwater pumping in this area to supplement river flows is likely to include a significant component of “recycling” of surface water flows and the feasibility of such pumping will be restricted by economic realities. Nonetheless, even in cases such as this with strongly connected surface water-groundwater systems, under certain circumstances it may be worthwhile to pump the groundwater system to supplement streamflows to help avoid flow intermittence in local areas that serve as refugia for the silvery minnow (or where the southwestern willow flycatcher may be nesting.)

Reduced groundwater levels will eventually rebound during subsequent periods of high river flows provided the time-integrated groundwater pumping is less than the time-integrated groundwater recharge (predominately made up of seepage losses from the river). In the best case scenario, the recharge would occur during the subsequent springtime high flows. But, if the subsequent year has low snowpack and poor spring runoff, the recharge could adversely impact low-flow regimes. For more poorly connected or "tighter" alluvial aquifers, the more time will be required for recharge to replace the pumped water.

An irrigation well with a 2,000 gpm (4.5 cfs) pumping capacity will cost approximately $32,000 ($14,000 to install the well and casing, $12,000 for the pump and $6,000 for the powerplant.) A well with a capacity of 4,000 gpm will cost approximately $64,000. On this basis, providing 50 cfs of pumping capacity would cost around one-half a million Dollars, not including design and management.

We emphasize that the primary advantage of well delivery over reservoir storage delivery will be in cases where there is a localized need for flow supplementation where the use of pumping can lead to reduced transmission losses due to localized application of water, and greater flexibility in timing of delivery of the supplementation water.

Delivery of LFCC/Drain Water. The use of drain water to supplement streamflow has many of the same advantages of pumping alluvial groundwater wells in terms of reduced transmission losses and greater flexibility in timing and location of delivery. It also possesses many of the same characteristics related to depleting groundwater storage in the vicinity of the river, although increased seepage losses tend to be distributed over a longer reach of the river due to the fact that drains collect groundwater over a large area along their length. One of the primary differences between pumping drain water versus pumping shallow groundwater is the smaller capital cost required to pump drain water, as there is no need to install a well.

The capital cost for pumping capacity from the LFCC would be less than for wells, as the cost of the well bore and casing could be avoided. A pump and powerplant with a capacity of 2,000 gpm would cost about $20,000, including an allowance for inlet works. Providing 50 cfs of pumping capacity would require a capital investment of approximately one-quarter million Dollars, not including design and management.

4.4 Methods of Quantification of In-Stream Hydrologic Effects

When quantifying the effects of supplemental flows, net impacts to the river must be determined. The overriding concern is total depletions within the middle Rio Grande, which must, over the long term, remain within the limits set by the Rio Grande Compact. Due to the annual accounting stance of the Compact and its debit/credit provisions, issues related to timing of depletions are probably not very significant. Because the analysis will probably be done many times to evaluate a variety of supplementation scenarios it should be implemented as an efficient computerized routine.

The hydrological regime in the Middle Rio Grande is too complex to be represented by simple calculations, as is clear from the preceding discussions. However, the calculation of depletions above San Acacia used herein is relatively straightforward as it is based on water surface area. Water surface area, though, will be substantially influenced by the loss regime which is dominated by seepage. Seepage, in turn, is highly variable with location, time and antecedent conditions in the local alluvial groundwater system. Further, the situation below San Acacia is more complicated. This suggests that the necessary simulation should be in a defensible modeling framework that explicitly accounts for all relevant processes.

A detailed review of appropriate modeling approaches is beyond scope of this report, but we have made a cursory evaluation of some existing tools. The only existing model that represents all of the relevant reaches of the Rio Grande is the Upper Rio Grande Water Operations Model (URGWOM.) URGWOM, however, does not adequately simulate the hydraulic interaction between surface and groundwater in the reaches below Cochiti Reservoir and it does not represent the more complicated groundwater regime below San Acacia. The San Acacia Surface Water/Groundwater Model (Shafike, 2005) does represent the groundwater regime and other numerical models are being constructed and calibrated for the Albuquerque reach. This suggests that an approach that couples URGWOM, or a modification of that model, with realistic groundwater simulations should be considered.

5 PRELIMINARY ESTIMATES OF FLOW SUPPLEMENTATION REQUIREMENTS

This section provides our preliminary estimates of the depletions caused by flow supplementation volumes required to meet flow targets in the critical habitat for the endangered species, focusing in particular on depletion components A and B in Figure 3.

5.1 Flow Requirements Quantified by WAMS

The WAMS issued a *Water Acquisition and Management Plan* (Plan) in February, 2004. The Plan summarized the Reasonable and Prudent Alternatives (RPAs) and estimated the water required for their implementation. Many of the RPAs address water management and would affect water operations and depletions.

Over the long term, the WAMS expects that collaborative water management actions on the part of participants in the Program will minimize the need for the Program to lease acquire water or water rights. In the short term, the WAMS believes that water leasing and acquisition will be necessary to meet the Program goals.

The estimated water requirements arising from the RPA's are calculated on an annual basis. Some of the RPAs were conditioned on the hydrologic conditions in the year. These conditions are categorized as "dry", "average" or "wet". Based on these categorizations, the WAMS estimated that storage requirements for flow supplementation ranged from a low of 21,000 acre-feet/year to a high of 97,000 acre-feet/year, with an average of 55,000 acre-feet/year. These values represent the volumes of water needed to be released from El Vado dam to meet flow requirements on critical habitat reaches hundreds of river miles to the south.

The WAM estimates were based on an annual analysis, and did not consider any storage carryover by MRGCD. The WAMS estimated that use and delivery by MRGCD of its San Juan/Chama allocation of 20,900 acre-feet would reduce program water requirements by approximately 10 percent on average.

5.2 Preliminary Estimates of Consumptive Component

The consumptive component of the flow requirement would result from increases in evaporation and evapotranspiration arising from increased flow. Evaporation would increase in proportion to increased water surface area and the area of capillary wetting along the river bank. Evapotranspiration would increase if the increased flow caused rising water tables which increased water transport to the root zone of plants. Flow supplementation will certainly lead to increased water surface area, but the degree to which increased flow will lead to a measurable increase in wetted bank area will depend on the channel geometry and substrate.

In well-defined channels, with relatively steep sides, such as the Rio Grande floodway from Cochiti to San Acacia, the area influenced by capillary wetting will be relatively small and its extent will not vary much with changes in flow. At the periods of low flow in flat, sandy channels there may be significant capillary wetting of sand bars. The reach from Angostura to

San Marcial, is primarily a braided stream bed with large areas of un-vegetated bars. These bars will probably become wetted as supplemental flows increase stream stage. Furthermore, while it is clear that flow supplementation will increase local water tables, it is arguable whether any water table rise will increase the rate of evapotranspiration. This is because the increase in local groundwater surface elevation is incremental and the vegetation in alluvial areas has deep root structures.

Below San Acacia these assumptions do not hold. Model results (Shafike, 2005a) indicate that there will be substantial increases in evapotranspiration due to flow supplementation.

Given these differences we adopted different approaches to estimate the depletions arising from introduction of supplemental flows in the two reaches.

5.2.1 Cochiti to San Acacia

In the reach above San Acacia we adapt and extend the WAMS methodology, which quantified only the required amount of stored water, to estimate the consumptive component arising when that stored water is released to supplement flows in the Rio Grande.

The WAMS set out a schedule for flow supplementation for nine categorical cases of hydrologic condition dependent on snowpack, reservoir storage (related to Article VII of the Compact), and monsoon season intensity, and then assigned one of these categorical cases to each of the years from 1940 through 1999. The WAMS methodology explicitly quantified the flow in some reaches and gave sufficient information to calculate the flow in other reaches. We estimated the depletions that would arise from those flows using relationships between flow and surface evaporation used in the URGWOM model (URGWOM, 2002). The URGWOM equations are shown in Appendix B. The calculations that led to the following estimates are set out in Appendix E. The depletions considered here relate to the system components A, B, and F in Figure 3.

In making these depletion estimates we adopted the following assumptions:

1) The starting point for supplementation was a flow of zero. The URGWOM evaporation equations show non-zero evaporation losses when flow in the river is zero. We considered these zero-flow depletions to be “baseline” conditions. Accordingly, we subtracted the zero-flow evaporation loss from the evaporation loss calculated at the supplemental flow rate. This assumption is consistent with the WAMS methodology except in the cases where the WAMS determined that flows are partially satisfied under baseline conditions, which is the case in wet years. In such cases we did not attempt to allocate evaporative losses to just the supplemental flow, with the result that our approach overestimates depletions.
2) Depletions arising from conveyance through the MRGCD system (C in Figure 3) were ignored. Some of the water used to supplement flows may otherwise have been diverted through the MRGCD system. Diversion and conveyance of water in the MRGCD system will result in some depletions that may be eliminated when the water is used instead for flow supplementation. The most conservative assumption for these depletions, elimination of which would offset some of the increased depletion caused by flow supplementation, is to assume they are equal in the “Action” and “No Action” scenarios (C=CC in Figure 3).

3) Pan evaporation was estimated from observed values at the nearest stations to each reach. For conservatism, and given that river depths are typically quite shallow, we have not corrected to free-water conditions.
4) As with the WAMS analysis, all supplemental water is assumed to be routed from El Vado Reservoir.
5) Depletions along the Rio Chama between El Vado Reservoir and its confluence with the Rio Grande (near Espanola) and down through Cochiti Reservoir (Figure 1) are not included in our quantification of change in depletions. Because the water would have to be routed through this reach under any operational scheme, the depletions incurred in this reach would be very nearly the same in any case. Thus referring to Figure 3, we have assumed that A=AA and the net change in depletions for this component is zero.

5.2.2 San Acacia to San Marcial

Below San Acacia we continue to rely on the work of the WAMS as the basis for the amount of water necessary to be released from storage to meet flow targets at and below San Acacia. However, due to the more complex hydrology below San Acacia we rely on the results of model studies by the ISC to estimate depletions arising from those flows.

ISC has developed the San Acacia Surface Water/Groundwater Model (Shafike, 2005) to simulate the interactions between the surface water regime in the Rio Grande Floodway and Low Flow Conveyance Channel and the alluvial aquifer. In addition to evaporation losses from the river surface and wetted channel fringes, this model represents the effect of changes in flow in the floodway on groundwater elevations in the alluvial aquifer and the resulting changes in riparian ET. This increased ET arising from increased groundwater levels is several times larger than evaporation from the river surface and wetted channel fringes.

ISC used the San Acacia Surface Water/Groundwater Model to estimate the fraction of consumptive use over a range of floodway flows. We used those results to calculate the fraction of flow at San Acacia that is depleted by evaporation and evapotranspiration. In making these calculations, we subtracted the depletions shown by the model to occur at flows of zero at San Acacia. We also maintained the flow in the Low Flow Conveyance Channel at San Acacia at zero (i.e. there were no diversions to the LFCC at San Acacia) in all model runs. The results of these analyses were used to estimate the daily depletions arising from a given flow regime at San Acacia and are shown in Appendix D.

The supplemental flow requirements estimated by the WAMS and the depletions attributable to those flows, based on the assumptions set out above for the two reaches, are shown in Appendix A. The annual depletions range from 2,000 acre-feet/year to 15,000 acre-feet/year, averaging 7,000 acre-feet/year. The Middle Rio Grande system is such that depletions will respond slowly to changes in flow. The estimates of the maximum and minimum annual depletions do not consider the damping effect of the hydrologic system and thus the range of depletions is likely overstated. These estimates should be used only as a rough guide—more precise estimates can and should be developed through model studies. Nevertheless, these estimates provide a reasonable sense of the magnitude of the depletions to be expected from a program of flow supplementation.

6 EFFECTIVENESS OF WATER RIGHTS TRANSFERS FOR FLOW SUPPLEMENTATION

The hydrologic effects of transfers from lands within the MRGCD are relatively straightforward with respect to the consumptive component, but complex when considering the flow component.

6.1 Methods of Quantification of In-Stream Hydrologic Effects

A transfer of water rights from lands within MRGCD should result in dry-up of those irrigated lands. This will in principle result in a reduction in depletions, although (as described above) such a reduction may not be realized if a stand of salt cedar or some other phreatophyte is allowed to establish itself on “dried-up” land, if land is re-irrigated under a different water right, or if the foregone deliveries to the acquired parcel are used to irrigate new lands. The physical effects on depletions will vary from field to field (and from year to year), but cannot be precisely known. For the purpose of the Program, the nominal value set by the OSE will likely serve as the basis for a transfer. This value is 2.1 acre-feet/acre and it is this amount that will be legally available to offset increased depletions arising from water management practices.

Recalling the WAMS analysis presented in Section 2, water requirements for the flow component have been estimated to range between 21,000 acre-feet and 97,000 acre-feet and average 55,000 acre-feet. In Section 4 we estimated that depletions resulting from these increased flows will amount, on average, to about 14 percent of the flow component.

The depletion reduction that occurs as a result of a transfer is concrete and relatively well-quantified. Acquisitions can be made to offset the depletions caused by flow management actions that contribute to the flow component. Based on the estimates of depletions in Section 4, and using the OSE’s allowable depletion of 2.1 acre-feet/acre, roughly 3,300 acres, would need to be acquired to support the average consumptive component induced by the supplemental flows estimated by the WAMS, and roughly twice that acreage would be required to support the maximum consumptive component.

6.2 Flow Component

With regard to transfer of irrigation diversions, the amount of water diverted at MRGCD headgates is primarily controlled by the District and a transfer of water rights from lands within the District may not result in a reduction in those diversions. It is likely the District will elect to maintain diversions at a fixed level due to hydraulic considerations in their conveyance system, or for policy reasons. Should diversions not be reduced after a transfer, and assuming that no new lands are put under irrigation, the expected result would be an increase in wasteway flows.[†]

[†] If diversions to the canals are kept constant while farm deliveries are reduced (which would be the case if no new land is brought into production to replace acquired lands) then there must be an increase in outflows from the MRGCD system to keep it in balance. These increased outflows can come in the form of increased seepage losses

The location at which wasteway flows will accrue to the river can be controlled to some degree by the District.

The nature and operation of the MRGCD conveyance system and the policies of the District can be expected to change over time. As these changes occur the effect on diversions of transfers of water rights out of the District will also change. It is also difficult to characterize the current operations of the District system precisely as there is not a comprehensive program of metering and measurement.

In principle, transfers of water rights from lands within the MRGCD can be used to contribute flow supplementation in two ways: as a source of flow component from reduced diversions and as a way to reduce depletions to offset the increased depletions caused by other flow management practices. In practice, as discussed above, it is likely at this time that no reduction in diversions can be expected from a transfer off of the District, so water rights transfers cannot be used today as a source of the flow component. However, it is worth considering what acquisitions made today might contribute to the flow component under future operating policies.

In order to explore the potential for water rights acquisitions to contribute to the flow component, we can assume a condition where project efficiency results in a project delivery requirement consistent with the State Engineer's nominal value of 7.2 acre-feet/acre. We can also assume that the conveyance system is configured and operated such that a reduction in farm delivery is reflected directly in reduced diversions. This would only be the case if the system was completely "tight" (e.g. used a pressurized pipe distribution system) and should be viewed as an upper limit to the effectiveness of a transfer.

Under these assumptions, a transfer would yield 7.2 acre-feet of water for each acre of acquired land, which would, if bypassed, increase river flows by a like amount. This increased flow would be distributed over the irrigation season. To determine to what degree it would accrue at particular locations along the Rio Grande would require an analysis that is beyond the scope of this work.

If it were possible to yield 7.2 acre-feet of flow component from the acquisition and transfer of an agricultural water right, the allowable consumptive use associated with the right would more than compensate for the increased depletions arising from the contribution to the flow component[†] so some of the allowable consumptive use could be used to offset depletions from

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or increased wasteway and drain flows. Seepage will only increase if the heads in canals are increased as a result of a transfer. This seems unlikely, so the expected result is increased wasteway flows.

[†] The OSE has found that a diversion (project delivery) of 7.2 acre-feet per acre of irrigated land can be considered non-wasteful. The OSE has also declared that the allowable consumptive use for irrigated agriculture in the Middle Rio Grande valley is 2.1 acre-feet per acre (about 30% of the 7.2 acre-feet per acre of project delivery.) The depletions arising from flow supplementation average roughly 14% of the amount of flow supplementation (depletions range from 6% to 50% of supplemental flow depending on hydrologic conditions. See Appendix A.) The average depletion associated with a transfer of 7.2 acre-feet per acre (of acquired land) to flow supplementation would be approximately 1.4 acre-feet per acre. This indicates that an additional 0.7 acre-feet per acre (2.1–1.4) would be available to support other uses.

other flow supplementation activities. If the transfer contributes less to the flow component, more depletion will be available to offset depletions caused by other flow management activities.

7 POLICY CONSIDERATIONS

The use of water rights acquisition for maintenance of fish and wildlife habitat raises several important policy issues. The most important and immediate of these is the enforcement of dry-up on lands from which water rights are transferred, as no program can succeed unless dry-up is enforced. Another fundamental issue is how to formulate a program that addresses the uncertainty about the natural variability of in-stream depletions. Less immediate, but no less important is the nature of water rights administration on the Middle Rio Grande.

7.1 Enforcement of Dry-up

There have been numerous transfers of pre-1907 water rights off of lands within the MRGCD. Anecdotal evidence indicates that in some of these cases the lands were brought back under irrigation using the MRGCD "District" rights. In such cases overall depletions from the basin will be increased by the amount of depletions caused by the new use.

A program of acquisition of water rights should not proceed without strict enforcement of dry-up. It is probably possible for the Program to enforce dry-up through the contract for acquisition, but this is a matter best left to counsel.

7.2 Operation in the Face of Uncertainty and Variability

Depletions from irrigation or natural systems cannot be directly measured. They can be estimated based on water balance calculations or remote sensing techniques, but the precision of these estimates are limited and costly. Given current technology we must assume that it will be impractical to obtain very precise estimates of depletions. This is true for depletions resulting from flow enhancement and for depletions resulting from irrigation, though the latter are better understood. In addition, depletions will vary from year to year, depending on hydrological and meteorological conditions.

Thus, a program of acquisition must be formulated in such a way as to address uncertainty and variability. If offsets consistently fall short of depletions induced by flow management, the consequence will be a shortfall against the delivery obligation of the Rio Grande Compact. This will have certain economic, political, social and legal consequences. Conversely, a consistent surplus of offsets will represent an economic impact, both in terms of direct costs to the Program but also in terms of impacts to the local economy from the reduction in agricultural activity.

While we have not done any economic analysis of these possibilities, it is very likely that the economic consequences of a shortfall of offsets will be considerably more severe than the consequences of a surplus. The legal and political consequences of shortfall are clearly much more severe.

This suggests that one approach to uncertainty is the conservative one of adopting a factor of safety—simply acquire more water rights than is thought to be necessary. If this results in a surplus of offsets the Program could mitigate this by depositing excess water rights in a water bank so that they could be used for irrigation. In this way the water acquisition program could be made to adapt to varying conditions.

Because the State has the responsibility for insuring compliance with the Rio Grande Compact, it would seem appropriate to place the authority for management of depletion offsets with the State.

7.3 Priority Administration

New lands are right now being brought into irrigation in the Middle Rio Grande basin despite the fact that it is almost universally agreed that the basin is over-appropriated with regard to depletions. This means that although water rights acquired by the Program will reduce depletions on the transferred lands (assuming dry-up is enforced) the net benefit in the basin may be reduced or eliminated if the water once applied under the acquired water rights is used to irrigate new lands. Until the Middle Rio Grande comes under some form of priority administration (such as AWRM, in the interim, or full priority administration at some point in the future) the State will not have efficient and effective control over depletions arising from any source.

8 SUMMARY AND CONCLUSIONS

This technical report describes the range of hydrologic considerations and impacts that must be considered in acquiring water rights from within the Middle Rio Grande Conservancy District (MRGCD) and transferring them to supplement Rio Grande channel flows in critical habitat reaches to benefit the silvery minnow. We also describe conceptually the types of calculations necessary to quantify the effect of a transfer as needed to support a transfer application with the New Mexico Office of the State Engineer (OSE). We attempt to identify those issues that are reasonably likely to be important to transfers from the MRGCD to in-stream uses.

As part of the report, we provide background information on the *Water Acquisition and Management Subcommittee* (WAMS) of the Middle Rio Grande Endangered Species Act Collaborative Program that helps define the context of this project, including WAMS estimates of the amount of water needed (as upstream storage) to meet the flow targets of the Biological Opinion, an overview of the hydrology of flow supplementation, an overview of acquisition considerations, a listing of OSE criteria for evaluating transfers, and how to quantify transfers. We also provide preliminary estimates of the depletions arising from flow supplementation. We characterize the hydrologic aspects of agricultural use and in-stream flow hydrology, as well as the overall hydrologic effects of water rights acquisitions for flow supplementation, by considering the effect of changes in the hydrologic factors particular to the source of the transfers (agriculture) and the recipient of the transfers (supplemental flows). Finally, we close this report by presenting policy considerations associated with transfers of rights within the MRGCD to instream uses, especially the enforcement of dry-up of the lands from which those water rights would be removed.

Based on our analysis, we can conclude:

- Given the current management practices by MRGCD, current metering and measurement systems, and current administrative practices in the Middle Rio Grande Basin, it is not likely that water rights transfers from lands within the District will provide any contribution to the flow component of the Flow Targets.
- Preliminary estimates of the depletions associated with a transfer from MRGCD to supplemental flows would be expected to average approximately 7,000 acre-feet/year, which would represent, on average, roughly 14 percent of the annual flow requirements identified by the WAMS.
- Numerous hydrological processes affect the magnitude and timing of depletions.
- The primary depletions associated with transferring water to supplemental flows are open water evaporation and riparian vegetation evapotranspiration in the vicinity of the river channel.
- A more rigorous calculation of expected depletions would necessarily involve application of hydrologic modeling tools that explicitly account for surface water – groundwater interactions.
- Conveyance losses from the upper basin reservoirs to the critical habitat locations south of Albuquerque are large, which is a disadvantage of delivery from upper basin storage.
- Delivering the transferred water via wells or pumping from MRGCD drains or the LFCC has the advantage of flexibility in timing and point of application.

- If the OSE does not enforce “dry up” of lands from which rights are transferred, and “District” water is used to re-irrigate the lands, net depletions will likely increase.

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APPENDIX A: ESTIMATES OF REQUIRED FLOWS AND RESULTING DEPLETIONS

Year	Annual Demand	10-year Moving Average Demand	Annual Depletion	10-year Moving Average Depletion	Percent Consumptive Use
1940	66.0		3.8		6%
1941	21.0		10.9		52%
1942	30.0		14.6		49%
1943	66.0		3.8		6%
1944	26.0	42.2	12.7	9.4	49%
1945	30.0	42.2	14.6	9.4	49%
1946	66.0	49.8	3.8	8.8	6%
1947	66.0	48.9	3.8	8.5	6%
1948	30.0	52.0	14.6	8.6	49%
1949	21.0	59.1	10.9	7.9	52%
1950	66.0	65.8	3.8	7.0	6%
1951	97.0	68.9	5.6	7.2	6%
1952	21.0	65.0	10.9	7.0	52%
1953	97.0	65.0	5.6	7.0	6%
1954	97.0	69.5	5.6	6.3	6%
1955	97.0	69.5	5.6	6.3	6%
1956	97.0	65.8	5.6	6.1	6%
1957	27.0	71.0	1.6	5.4	6%
1958	30.0	71.0	14.6	5.4	49%
1959	66.0	71.0	3.8	5.4	6%
1960	66.0	64.0	3.8	5.0	6%
1961	60.0	60.3	3.5	4.8	6%
1962	73.0	64.8	4.3	5.0	6%
1963	97.0	66.5	5.6	3.9	6%
1964	97.0	63.1	5.6	4.2	6%
1965	27.0	62.5	1.6	4.1	6%
1966	60.0	66.2	3.5	4.4	6%
1967	72.0	68.6	4.2	4.5	6%
1968	47.0	61.5	2.9	5.2	6%
1969	32.0	62.4	6.9	5.0	22%
1970	60.0	62.4	3.5	5.0	6%
1971	97.0	63.0	5.6	5.1	6%
1972	97.0	62.4	5.6	5.0	6%
1973	26.0	67.4	12.7	5.3	49%
1974	66.0	66.3	3.8	5.7	6%
1975	27.0	62.9	1.6	6.6	6%
1976	66.0	59.8	3.8	6.5	6%
1977	66.0	53.3	3.8	6.6	6%
1978	97.0	52.8	5.6	6.4	6%
1979	21.0	44.8	10.9	7.3	52%
1980	26.0	44.2	12.7	8.2	49%
1981	66.0	39.7	3.8	8.9	6%
1982	32.0	35.7	6.9	9.8	22%
1983	21.0	32.0	10.9	9.6	52%
1984	26.0	36.5	12.7	8.9	49%
1985	21.0	39.9	10.9	8.0	52%
1986	21.0	36.5	10.9	8.3	52%
1987	26.0	37.5	12.7	8.5	49%
1988	60.0	37.5	3.5	8.5	6%
1989	66.0	37.9	3.8	8.7	6%
1990	60.0	37.9	3.5	8.7	6%
1991	32.0	42.4	6.9	8.0	22%
1992	42.0	41.9	9.0	7.8	21%
1993	21.0	41.9	10.9	7.8	52%
1994	30.0	38.5	14.6	8.1	49%
1995	21.0		10.9		52%
1996	66.0		3.8		6%
1997	21.0		10.9		52%
1998	60.0		3.5		6%
1999	32.0		6.9		22%
Average	52.7	54.7	7.0	6.8	
Maximum	106.0		14.6		
Minimum	21.0		1.6		

APPENDIX B: URGWOM WATER SURFACE EVAPORATION EQUATIONS

Cochiti to San Felipe:

Bank-full discharge = 5650 cfs and corresponding surface area = 625 acres.

For $Q < 5650$ cfs; $L = Pane\,(111\,Q^{.20}) + 0.25\,Pane\,(625-111\,Q^{.20})$

For $Q \geq 5650$ cfs; $L = Pane\,(111\,Q^{.20})$

San Felipe to Albuquerque:

Bank-full discharge = 4820 cfs and corresponding surface area = 2718 acres.

For $Q < 4820$ cfs; $L = Pane\,(84\,Q^{.41}) + 0.25\,Pane\,(2718-84\,Q^{.41})$

For $Q \geq 4820$ cfs; $L = Pane\,(84\,Q^{.41})$

Albuquerque to Bernardo:

Bank-full discharge = 4820 cfs and corresponding surface area = 5175 acre.

For $Q < 4820$ cfs; $L = Pane\,(124\,Q^{.44}) + 0.25\,Pane\,(5175 - 124\,Q^{.44})$

For $Q \geq 4820$ cfs; $L = Pane\,(124\,Q^{.44})$

Bernardo to San Acacia:

Bank-full discharge = 4000 cfs and corresponding surface area = 1054 acres.

For $Q < 4000$ cfs; $L = Pane\,(13\,Q^{.53}) + 0.25\,Pane\,(1054 - 13\,Q^{.53})$

For $Q \geq 4000$ cfs; $L = Pane\,(13\,Q^{.53})$

San Acacia to San Marcial:

Bank-full discharge = 9100 cfs and corresponding surface area = 2913 acres.

For $Q < 9100$ cfs; $L = Pane\,(158\,Q^{.32}) + 0.25\,Pane\,(2913 - 158\,Q^{.32})$

For $Q \geq 9100$ cfs; $L = Pane\,(158\,Q^{.32})$

San Marcial to Elephant Butte Reservoir:

Bank-full discharge = 2400 cfs and corresponding surface area = 166 acres.

For $Q < 2400$ cfs; $L = Pane\,(60\,Q^{.13}) + 0.25\,Pane\,(166 - 60\,Q^{.13})$

For $Q \geq 2400$ cfs; $L = Pane\,(60\,Q^{.13})$

where:

Q = Mean daily discharge at the upstream end of the reach, in cfs;
L = Loss from water surface evaporation and wetted sands in the reach, in acre-ft/day; and
Pane = Pan evaporation data for the site nearest to the reach under consideration, in ft/day.

APPENDIX C: PAN EVAPORATION RATES

The following pan evaporation rates were used to calculate water surface evaporation losses.

Site	Total Annual Evaporation, inches	Summer-Fall Evaporation, inches	Winter-Spring Evaporation, inches
Cochiti Dam	111.1	51.4	59.7
Jemez Dam	91.0	34.8	56.3
los Lunas 3 SW	69.3	29.4	40.0
Socorro	60.5	26.3	34.1
Bosque del Apache	89.6	40.9	48.8
Elephant Butte Dam	111.1	51.4	59.7
Caballo Dam	104.5	49.5	55.0

APPENDIX D: PERCENTAGE OF CONSUMPTIVE USE, SAN ACACIA TO SAN MARCIAL

This table shows estimated percentage of consumptive use relative to a zero-flow condition at San Acacia. The flow in the Low Flow Conveyance Channel was set to zero in all cases. After Shafike (2005a.)

	Floodway Flow at San Acacia (cfs)				
Season	100	110	160	280	350
Winter-spring	15%	15%	14%	13%	11%
Summer-fall	44%	43%	41%	35%	30%

APPENDIX E: CALCULATIONS OF CONSUMPTIVE COMPONENT

Table 1 Water Requirements for Article VII years

				Winter/Spring						Summer/Fall						
Compact	Runoff	MRGCD	Monsoon	# days	% loss El Vado to Cochiti	Absolute losses Cochiti to Isleta	Absolute losses Isleta to San Acacia	Required Flow at San Acacia	Af at El Vado	Runoff effect	% days requiring release	Monsoon effect	Days requiring release	% loss, El Vado - Cochiti	Required flow at Cochiti	Af at El Vado
Art VII	Poor	0%	Dry	30	21%	110	120	110	25610	30	85%	92	122	26%	340	68672
Art VII	Poor	0%	Average	30	21%	110	120	110	25610	30	65%	70	100	25%	340	55538
Art VII	Poor	0%	Wet	30	21%	110	120	110	25610	30	45%	49	79	24%	340	43298
Art VII	Average	0%	Dry	15	19%	110	120	110	12489	15	85%	92	107	26%	340	60229
Art VII	Average	0%	Average	15	19%	110	120	110	12489	15	65%	70	85	25%	340	47207
Art VII	Average	0%	Wet	15	19%	110	120	110	12489	15	45%	49	64	24%	340	35077
Art VII	Good	0%	Dry	0	17%	110	120	110	0	0	85%	92	92	26%	210	51785
Art VII	Good	0%	Average	0	17%	110	120	110	0	0	65%	70	70	25%	210	38877
Art VII	Good	0%	Wet	0	17%	110	120	110	0	0	45%	49	49	24%	210	26856

Table 2 Water requirements for Dry Years

Compact	Runoff	MRGCD	Monsoon	# days	% loss El Vado to Cochiti	Absolute losses Cochiti to Isleta	Absolute losses Isleta to San Acacia	Required Flow at San Acacia	Af at El Vado	Runoff effect	% days requiring release	Monsoon effect	Days requiring release	% loss, El Vado - Cochiti	required Cochiti release	Af
Normal	Poor	45%	Dry	30	21%	110	120	110	25610	30	85%	92	67	26%	210	37770
Normal	Poor	45%	Average	30	21%	110	120	110	25610	30	65%	70	55	26%	210	30959
Normal	Poor	45%	Wet	30	21%	110	120	110	25610	30	45%	49	43	26%	210	24457

Table 3 Water requirements for Average Years

Compact	Runoff	MRGCD	Monsoon	# days	% loss El Vado to Cochiti	Absolute losses Cochiti to Isleta	Absolute losses Isleta to San Acacia	Required Flow at San Acacia	Af at El Vado	Runoff effect	% days requiring release	Monsoon effect	Days requiring release	% loss, El Vado - Cochiti	Absolute Loss Cochiti - Isleta	Absolute Loss Isleta - San Acacia	Af	partial # days	partial af
Normal	Average	75%	Dry	15	19%	110	120	110	12489	15	85%	92	27	25%	110	120	19809	95	17587
Normal	Average	75%	Average	15	19%	110	120	110	12489	15	65%	70	21	25%	110	120	15736	86	15921
Normal	Average	75%	Wet	15	19%	110	120	110	12489	15	45%	49	16	25%	110	120	11848	76	14070

Table 4 Water Requirements for Wet Years

Compact	Runoff	MRGCD	Monsoon	# days	% loss El Vado to Cochiti	Absolute losses Cochiti to Isleta	Absolute losses Isleta to San Acacia	Required Flow at San Acacia	Af at El Vado	Runoff effect	% days requiring release	Monsoon effect	Days requiring release	% loss, El Vado - Cochiti	Absolute Loss Cochiti - Isleta	Absolute Loss Isleta - San Acacia	Af	partial # days	partial af
Normal	Good	90%	Dry	0	17%	110	120	160	0	0	85%	92	9	24%	110	120	7924	113	9732
Normal	Good	90%	Average	0	17%	110	120	160	0	0	65%	70	7	24%	110	120	6029	100	8613
Normal	Good	90%	Wet	0	17%	110	120	160	0	0	45%	49	5	24%	110	120	4220	87	7493

Table 5 Pan Evaporation and Resulting Zero-flow Depletions

	Pan Evaporation Rates, inches/day		Zero-flow Depletions, acre-feet/day	
	Winter/ Spring	Summer/Fall	Winter/ Spring	Summer/Fall
Cochiti - San Felipe	0.017	0.032	2.6	4.9
San Felipe - Albuquerque	0.013	0.026	8.6	17.8
Albuquerque - Bernardo	0.011	0.020	14.2	26.1
Bernardo - San Acacia	0.010	0.019	2.7	4.9
San Acacia - San Marcial	0.013	0.023	9.6	16.4

Table 6 Depletions for Article VII Years, Winter / Spring

Compact	Runoff	MRGCD	Monsoon	# days	Flow at El Vado	Required flow at Cochiti	Required flow at Isleta	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Daily Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total depletions
Art VII	Poor	0%	Dry	30	430	340	230	110	0	285	170	55	12.4	11.3	32.4	30	1683
Art VII	Poor	0%	Average	30	430	340	230	110	0	285	170	55	12.4	11.3	32.4	30	1683
Art VII	Poor	0%	Wet	30	430	340	230	110	0	285	170	55	12.4	11.3	32.4	30	1683
Art VII	Average	0%	Dry	15	420	340	230	110	0	285	170	55	12.4	11.3	32.4	15	841
Art VII	Average	0%	Average	15	420	340	230	110	0	285	170	55	12.4	11.3	32.4	15	841
Art VII	Average	0%	Wet	15	420	340	230	110	0	285	170	55	12.4	11.3	32.4	15	841
Art VII	Good	0%	Dry	0	410	340	230	110	0	285	170	55	12.4	11.3	32.4	0	0
Art VII	Good	0%	Average	0	410	340	230	110	0	285	170	55	12.4	11.3	32.4	0	0
Art VII	Good	0%	Wet	0	410	340	230	110	0	285	170	55	12.4	11.3	32.4	0	0

Table 7 Depletions for Article VII Years, Summer / Fall

Compact	Runoff	MRGCD	Monsoon	# days	Flow at El Vado	Required flow at Cochiti	Required flow at Isleta (Central Ave)	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Daily Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions
Art VII	Poor	0	Dry	30	284	210	100	0	0	155	50	0	20.3	11.9	0.0	122	3928
Art VII	Poor	0	Average	30	280	210	100	0	0	155	50	0	20.3	11.9	0.0	100	3220
Art VII	Poor	0	Wet	30	276	210	100	0	0	155	50	0	20.3	11.9	0.0	79	2543
Art VII	Average	0	Dry	15	284	210	100	0	0	155	50	0	20.3	11.9	0.0	107	3445
Art VII	Average	0	Average	15	280	210	100	0	0	155	50	0	20.3	11.9	0.0	85	2737
Art VII	Average	0	Wet	15	276	210	100	0	0	155	50	0	20.3	11.9	0.0	64	2061
Art VII	Good	0	Dry	0	284	210	100	0	0	155	50	0	20.3	11.9	0.0	92	2962
Art VII	Good	0	Average	0	280	210	100	0	0	155	50	0	20.3	11.9	0.0	70	2254
Art VII	Good	0	Wet	0	276	210	100	0	0	155	50	0	20.3	11.9	0.0	49	1578

Table 8 Depletions for Dry Years, Winter / Spring

Compact	Runoff	MRGCD	Monsoon	# days	Required flow at El Vado	Flow at Cochiti	Flow at Isleta / Central	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions
Normal	Poor	0.45	Dry	30	430	340	230	110	0	285	170	55	12.4	11.3	32.4	30	1683
Normal	Poor	0.45	Average	30	430	340	230	110	0	285	170	55	12.4	11.3	32.4	30	1683
Normal	Poor	0.45	Wet	30	430	340	230	110	0	285	170	55	12.4	11.3	32.4	30	1683

Table 9 Depletions for Dry Years, Summer / Fall

Compact	Runoff	MRGCD	Monsoon	# days	Required flow at El Vado	Flow at Cochiti	Flow at Isleta / Central	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions
Normal	Poor	0.45	Dry	30	284	210	100	0	0	155	50	0	20.3	11.9	0.0	67	2160
Normal	Poor	0.45	Average	30	284	210	100	0	0	155	50	0	20.3	11.9	0.0	55	1771
Normal	Poor	0.45	Wet	30	284	210	100	0	0	155	50	0	20.3	11.9	0.0	43	1399

Table 10 Depletions for Average Years, Winter / Spring

Compact	Runoff	MRGCD	Monsoon	# days	Required flow at El Vado	Flow at Cochiti	Flow at Isleta / Central	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions
Normal	Average	0.75	Dry	15	420	340	230	110	0	285	170	55	12.4	11.3	32.4	15	841
Normal	Average	0.75	Average	15	420	340	230	110	0	285	170	55	12.4	11.3	32.4	15	841
Normal	Average	0.75	Wet	15	420	340	230	110	0	285	170	55	12.4	11.3	32.4	15	841

Table 11 Depletions for Average Years, Summer / Fall

Compact	Runoff	MRGCD	Monsoon	# days	Required flow at El Vado	Flow at Cochiti	Flow at Isleta / Central	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions	Partial days	MRGCD %	Partial Depletions
Normal	Average	0.75	Dry	15	373	280	170	50	0	225	110	25	23.0	17.0	43.2	27	2227	95	75%	5931
Normal	Average	0.75	Average	15	373	280	170	50	0	225	110	25	23.0	17.0	43.2	21	1769	86	75%	5369
Normal	Average	0.75	Wet	15	373	280	170	50	0	225	110	25	23.0	17.0	43.2	16	1332	76	75%	4745

Table 12 Depletions for Wet Years, Winter / Spring

Compact	Runoff	MRGCD	Monsoon	# days	Required flow at El Vado	Flow at Cochiti	Flow at Isleta / Central	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions
Normal	Good	0.9	Dry	0	284	210	100	0	0	155	50	0	10.1	6.5	0.0	0	0
Normal	Good	0.9	Average	0	280	210	100	0	0	155	50	0	10.1	6.5	0.0	0	0
Normal	Good	0.9	Wet	0	276	210	100	0	0	155	50	0	10.1	6.5	0.0	0	0

Table 13 Depletions for Wet Years, Summer / Fall

Compact	Runoff	MRGCD	Monsoon	# days	Required flow at El Vado	Flow at Cochiti	Flow at Isleta / Central	Flow at San Acacia	Flow at EB Reservoir	Average flow, Cochiti - Isleta	Average Flow Isleta - San Acacia	Average Flow San Acacia - EBR	Daily Depletions Cochiti - Isleta	Depletions Isleta - San Acacia	Daily Depletions San Acacia - EBR	# days	Total Depletions	Partial days	MRGCD %	Partial Depletions
Normal	Good	0.9	Dry		434	330	220	100	0	275	160	50	24.6	20.2	86.5	9	1207	113	90%	13347
Normal	Good	0.9	Average		434	330	220	100	0	275	160	50	24.6	20.2	86.5	7	919	100	90%	11812
Normal	Good	0.9	Wet		434	330	220	100	0	275	160	50	24.6	20.2	86.5	5	643	87	90%	10276

APPENDIX F: LETTER FROM TOM TURNEY TO SUBHAS SHAH

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER
SANTA FE

THOMAS C. TURNEY
State Engineer

BATAAN MEMORIAL BUILDING, ROOM 101
POST OFFICE BOX 25102
SANTA FE, NEW MEXICO 87504-5102
(505) 827-6175
FAX: (505) 827-6188

March 23, 2001

Mr. Subhas Shah, District Engineer
Middle Rio Grande Conservancy District
P.O. Box 581
1931 2d St. SW
Albuquerque, NM 87102

Mr. Steve Hansen, Deputy Area Manager
United States Bureau of Reclamation
505 Marquette NW, Suite 1313
Albuquerque, NM 87102

BY FAX AND MAIL

Dear Mr. Shah and Mr. Hansen:

The future of the Middle Rio Grande Valley depends on the ability of federal agencies and Middle Valley water users to comply with the requirements of the federal Endangered Species Act in a manner that does not sacrifice our farms and cities and respects our priceless cultural heritage. In this regard, the State of New Mexico is committed to defend the rights of its citizens to use the public waters of the State (many of which rights have been established centuries ago) and to ensure that federal needs for water for endangered species purposes respect these rights.

The Plaintiffs in *Minnow v. Martinez* have asserted that the United States Bureau of Reclamation must regulate wasteful diversions by the Middle Rio Grande Conservancy District (MRGCD). As you know, the State of New Mexico has asserted that the Bureau does not have this authority, and that state law defines what is a beneficial use of water. It is likely that the State will be forced in this litigation to take a position on this issue, in order to protect the farmers of the District.

New Mexico State Engineer Permits Nos. 0620 and 1690 provide for a farm delivery requirement of 3.0 acre-feet per acre annually. In the absence of a response to the June 16, 1997 requirement by the Office of the State Engineer that MRGCD file a Proof of Beneficial Use, the State has made a preliminary assessment regarding the use of water by MRGCD for other than Pueblo lands which the State will use as this case proceeds. Based on the best available data and other information available to the Office of the State Engineer and the Interstate Stream Commission, and making very conservative assumptions in favor of MRGCD, the State will take the position in this litigation that the diversion from the Rio Grande by MRGCD (i.e., a project delivery requirement) of 7.2 acre-feet of water per acre of irrigated non-Pueblo lands on an annual basis is a sufficient and non-wasteful diversion of water.[1] This quantity is based upon a consumptive irrigation requirement of 2.1 acre-feet per acre and a reasonable allowance for losses. In addition, the rate of diversion at any point in time and at any particular location must be limited to the quantity reasonably required to deliver and place water to beneficial use. This is a preliminary assessment, and is subject to revision at any time if better information or analyses become available. However, it is our determination at the present time that this quantity of water is sufficient to ensure that no farmer in the District will incur any shortage and that all will be able to make beneficial use of the full amounts of water to which they are entitled under New Mexico law, provided, of course, that sufficient river flows exist.

We also recognize that your diversions under Permits Nos. 0620 and 1690 include amounts for Pueblo lands. In light of the complex issues regarding the use of water on Pueblo lands and in recognition of the need to respect the interests of the Pueblos and the trust responsibility of the United States to the Pueblos, we are by this letter requesting that the Department of the Interior advise us as to its position regarding the project delivery requirement for irrigated Pueblo lands, a request which we emphasize is limited to the specific river administration context described above and, in particular, is not intended to prejudice in any way any future water rights adjudication proceeding.

We wish to note that the State of New Mexico has funds available for metering projects and for conveyance system improvements and stands ready to assist the District to meet those needs. Further, we look forward to a cooperative technical effort with the District to further the goal of preparing an accurate Proof of Beneficial Use for filing at the earliest possible date.

We consider this matter to be of the utmost importance for District farmers and indeed for all New Mexicans, an appreciation we trust you share as well, and we respectfully request a prompt acknowledgment.

Sincerely,

Thomas C. Turney
State Engineer
P.O. Box 25102
Santa Fe, NM 87504-5102
505-827-6166

1 For purposes of comparison, I note that, based on data submitted by MRGCD to the US Bureau of Reclamation (USBR Form 7-2045, Crop Production and Water Utilization) for the years 1989 through 1999, the District diverted an annual average of 609,700 acre-feet, for application to 53, 685 acres of irrigated land, a diversion of over 11 acre-feet per acre.

APPENDIX G: TRANSFER HANDBOOK

Implementing Water Acquisitions on the Middle Rio Grande

Prepared by:
Benjamin L. Harding, P.E. and James T. McCord, Ph.D., P.E.
Hydrosphere Resource Consultants

Prepared for:
New Mexico Interstate Stream Commission, Rio Grande Bureau

FY2004 Middle Rio Grande Endangered Species Act Collaborative Program
Water Acquisition and Management Subcommittee

June 10, 2005

TABLE OF CONTENTS

1 INTRODUCTION

This report provides guidance regarding the steps that should be taken to transfer a water right from agricultural use in the middle Rio Grande valley to use for flow supplementation in the Rio Grande floodway. It is intended to set out the overall structure for a process for evaluating, acquiring and transferring water rights as effectively and efficiently as possible.

Just exactly how the transfer process will work cannot be defined precisely at this time. Discussions with the staff of the Office of the State Engineer (OSE) reveal that no previous transfers from irrigated lands within the MRGCD to a use of flow supplementation have been made. The requirements for the hydrologic analysis on which such transfers would be based will be defined by the OSE, and possibly by protests and court decisions. Until some transfers have been completed it will be difficult to define those requirements with much precision.

This document does not offer legal advice and is *not* a substitute for legal advice or services from a competent lawyer. Throughout this document we may note areas where we feel that the assistance and advice of a lawyer is necessary. We do not mean to imply that legal assistance should not be obtained in other areas. Legal assistance should be obtained for any water rights transfer.

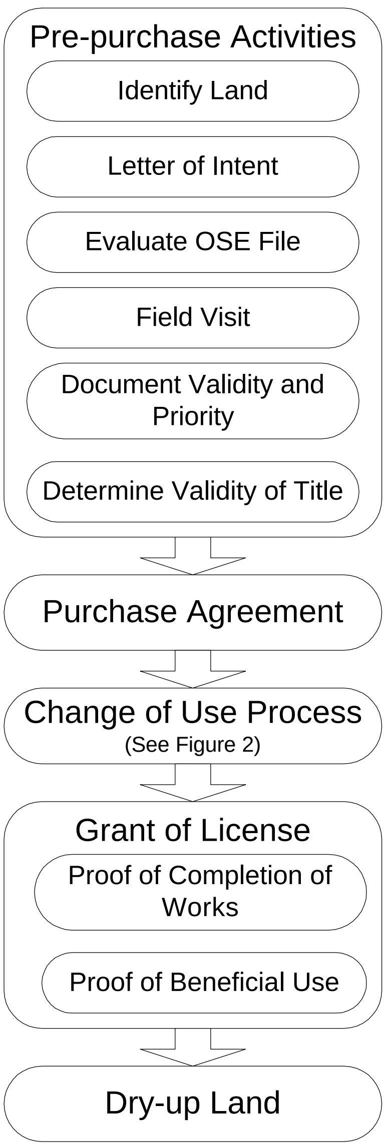
In the following section we provide an overview of the process of transferring a water right. In Section 3 we provide a more detailed, step-by-step description of the process. In Section 4 we discuss some of the special considerations pertinent to the State of New Mexico that arise when transferring water off of the MRGCD to a purpose of flow supplementation. In the appendices we provide documents that may be required in support of a transfer of a water right.

2 OVERVIEW OF TRANSFER PROCESS

This section provides an overview of the process involved in a water rights transfer. Figure 1 provides a graphical depiction of the transfer process.

Identification of candidate land and water rights. Because the evaluation of water rights will incur some costs and delay, careful identification of candidate lands will improve the efficiency of an acquisition program. The principle attribute of the candidate land is an appurtenant water right. The primary consideration is that the water right is valid. Given that, seniority of the water right, its yield (based on historic use), and cost will be the primary considerations in evaluating candidate lands and water rights.

Figure 1: Flow chart of the acquisition and transfer process



Evaluation of water rights. Careful and accurate evaluation of candidate water rights will be critical to the success of an acquisition process. The evaluation should generally proceed stepwise, with opportunities to disqualify candidate lands at intermediate points.

Land and/or water purchase. The land purchase is a three-stage process. The first stage is the negotiation and execution of formal letter of intent that allows the Buyer to evaluate the validity of the water rights and negotiate a final purchase contract. The purchase contract is the second stage. The contract terms should be contingent on successful transfer of the water rights to the new use. The final stage of the purchase is closing.

Change of use of water rights through OSE. The change of use process is essentially the same process used many times each year to transfer water rights throughout the state. The principle difference involved in transfers for flow supplementation is the method by which the depletions associated with the new use are quantified and how the allowable diversion rate at the new place of use will be quantified.

Dry-up of old use. The dry up of the lands from which water rights have been transferred is one of the most important parts of the transfer process. If water use is not halted on the land, or if it is allowed to resume under junior water rights, then overall basin depletions will increase as a result of the transfer, which will compromise the State's ability to meet its compact obligations on the Rio Grande. The Buyer may elect to insure dry up of lands by acquiring title to the lands to which the water rights are appurtenant. If the Buyer chooses not to acquire lands, we emphasize the importance of including in the purchase contract and other documents enforceable terms requiring dry up, possibly including covenants attached to the property and recorded.

Initiation of new use. After the transfer is complete and dry-up has begun, the new use may be initiated. In the case of transfers for flow supplementation, actual application of water to the new use will be driven by the requirements of the Biological Opinion (BO) and other operational documents.

Proof of Beneficial Use. The final step in a transfer is the filing of the Proof of Beneficial use, which is required to perfect the water right.

Administration of transfer. Day-to-day administration of the transfer will require reporting to the OSE.

3 DETAILED PROCESS DESCRIPTION

3.1 Pre-purchase Activities and Preliminary Evaluation

It should be noted that all of the procedures discussed in this section (3.1) must be completed. There is no exact order to which they must be done. However, we have chosen to present them in an order which we believe is likely to be the most efficient and convenient.

3.1.1 Identification of Land

Because flow supplementation will be required during periods of low water supply, the water rights that are acquired must be senior. In practical terms this means that acquired water rights must have a pre-1907 priority. Accordingly, the discussions that follow are focused on pre-1907 water rights. Because the scope of this study is limited to lands within the MRGCD, candidate lands will be from within the District and will have an appurtenant water right with a pre-1907 priority.

Because of the nature of the MRGCD system, and because of the hydrology of the Middle Rio Grande valley, almost any valid pre-1907 water right within the District would be a reasonable candidate for transfer. Thus, the initial identification of candidate lands will be based largely on the validity of the water right, its yield to a new use, and the cost of the acquisition.

However, very few water rights within the MRGCD have been adjudicated or otherwise quantified, so it will often be the case that the validity of a candidate water right will not be known with certainty. In such cases the validity, priority and quantity of a water right will be established as part of the transfer, and the process of assembling the information to support a finding of validity involves substantial cost and time. This suggests that consideration be given to the expected validity of a particular water right before it is identified as a candidate for further evaluation. As a practical matter, the assessment of expected validity will probably be based on the experience and judgment of the personnel with the responsibility for initial acquisition activities.

The evaluation of lands and water rights, and the subsequent transfer process requires attention to detail and can be time consuming with the result that a program of acquisition will require substantial skilled staff and/or contractual resources.

3.1.2 Enter into Letter of Intent to Purchase Agreement

Because the evaluation of the validity and yield of a candidate acquisition will require a significant effort and some time, it is important that the right to purchase a property be preserved during evaluation. At the same time, the detailed evaluation may disclose facts that render the acquisition unattractive, so the Buyer must also preserve its right to step back from the acquisition without penalty.

The letter of intent to purchase serves these purposes. The document should make clear for the record the intentions of the Buyer and Seller and should set out the terms of any acquisition. Among other things it should specify whether or not the water rights are appurtenant to the land. Additionally, it should allow for preservation of the right to purchase at the specified terms for a period that allows due diligence in an investigation of the water rights and property. Most significantly, this agreement should provide contingencies that allow the Buyer to cancel the purchase should the detailed evaluation reveal unsatisfactory aspects of the property or water right. A lawyer should be involved in drafting this document.

3.1.3 Obtain and Evaluate OSE File

Evaluation of a candidate water right should be a two-stage process. Once a candidate water right has been identified, an initial evaluation should be done to detect any major problems with the validity of the water rights. This initial evaluation will involve a review of the records that support the validity and priority of the water right, and a field visit.

Only a small percentage of the water rights in the Middle Rio Grande have been adjudicated or have been the subject of a previous transfer. For these rights a file will exist at the OSE and these records and files should be reviewed to confirm that the transfer-from rights are in good standing with the OSE; any shortcomings in the filings should be noted. This evaluation should include a finding as to the feasibility, cost and risks of curing any shortcomings. A lawyer must oversee this process to make sure that the necessary filings are in order.

If the result of this evaluation shows that it would be inordinately risky or costly to cure shortcomings in the water rights filings, then this right should be dropped from evaluation.

For the majority of water rights in the Basin it is likely that no file will exist. In the absence of filings at the OSE, the initial assessment of the validity of the water right will rest on the results of the field visit, an initial review of readily available records and documents that are relevant to establishing priority and amount, and the judgment of the staff person making the evaluation.

The second stage of the evaluation (described in Section 3.1.5) will involve a detailed analysis using the criteria established by the OSE (OSE, 2001, Appendix A). This will involve evaluation of aerial photographs and irrigation surveys, and evaluation of the property during the field visit.

3.1.4 Field Visit

No purchase agreement should be executed until the candidate property has been visited and the observations from that visit carefully evaluated. A field visit should be made to the site before substantial effort or expense is expended in evaluating the water right. The field visit can be brief, but should be done as early in the process as possible to ensure that there is, in fact, an actual water right to be transferred. When the visit is made, check to make sure that the diversion facilities, wells, and/or pumps are as described in the water rights filings or the seller’s representations and are all in good working order. Confirm that ditches are in running order and show evidence of recent irrigation use. Include a quick GPS survey of relevant facilities and note the extent of irrigated land. The assistance of an engineer during this process will be beneficial.

3.1.5 Document Validity and Priority of Water Right

If a water right has been previously transferred or adjudicated its validity, priority and quantity will have been established. This is unlikely to be the case with any pre-1907 water right offered for acquisition within the MRGCD. Permitted water rights, those created after March 19, 1907, will be defined by the terms of their permit or license, but because these are a lower priority, and thus less useful for flow supplementation, they should not be acquired for that purpose.

It is more likely that a pre-1907 water right will be undocumented—a small percentage may have a declaration regarding historical use. When the OSE evaluates the priority and amount of a water right it will use several “standard” sources of information, supplemented by information provided by the applicant (OSE, 2001, Appendix A.) The standard sources of information used by the OSE are:

- Rio Grande Drainage Survey Sheets, prepared 1917-1918.
- MRGCD Appraisal Sheets, compiled 1926-1927.
- MRGCD Planetable Surveys, prepared 1926-1927.
- Rio Grande Joint Investigation, compiled 1936.
- Aerial Photography, flown in 1935, 1947, 1955 and 1963 and later.
- Site inspection.

The Buyer should recognize that these sources of information may not be definitive regarding priority and validity of a water right. The OSE will accept evidence of continuous irrigation provided by the applicant, or evidence that explains periods of apparent or actual non-irrigation.

New Mexico law provides for forfeiture of a water right after four years of non-use. Evaluation of a claim for a pre-1907 right first tests if the right was plausibly in use in 1907, then the evaluation considers if irrigation has been continuous since that time, with no periods of four years or more of inactivity. If evidence indicates that there have been periods of non-use it is necessary for the applicant to provide evidence to establish that such non-use was due to factors recognized by the OSE as excusing non-use. An example of such a factor is evidence that there were periods after 1927 when the property was not served by drains with the result that the land was waterlogged. The advice of an engineer regarding this type of explanatory evidence may be necessary.

The means by which evidence is provided by the applicant is through declarations. Once an application has been filed it is too late to provide additional evidence, so it is important to insure that the file is completely documented. A declaration is filed using Form WR-21, *New Mexico Office of the State Engineer Declaration of Ownership of Water Right of Surface Waters Perfected Prior to March 19, 1907.*

3.1.6 Determine Validity of Title

Whether or not the water is appurtenant to the land is of critical importance. Generally speaking, water rights used for irrigation, livestock, and/or domestic purposes are appurtenant to the land and are passed on to the Buyer by operation of law, whether or not they are explicitly noted in the conveyance instrument. Rights used for commercial or industrial uses are not necessarily appurtenant, and may not be conveyed with the land unless explicitly noted in the conveyance instrument. Water rights used for recreation or wildlife may or may not be appurtenant.

It should be verified that a clear title exists to both the land and the water rights Both land and water rights are subject to mandatory recording procedures when they are transferred. The land title should be relatively straightforward to research with the assistance of a title company; however, establishing title of the water right may not be as straightforward. If the water rights are appurtenant then you must also check that there are no mortgages or liens against the land. This evaluation should be done by or under the close supervision of a lawyer with experience with water rights transfers.

3.2 Purchase Agreement

The Buyer should negotiate terms in the purchase agreement that reduce the risk of the acquisition. The risk to the Buyer is that the transfer of water rights may be denied by the State Engineer, or the quantity or priority of the water right may be reduced and only a partial transfer approved. To protect itself from these eventualities, the Buyer should try to negotiate a purchase price that is based on the volume of water actually allowed in the transfer, or a contingency that allows the Buyer to void the agreement if the transfer is disallowed or the quantity or priority is reduced below a set amount. Terms such as these will set an upper limit on the price per acre-foot that the Buyer will pay for water.

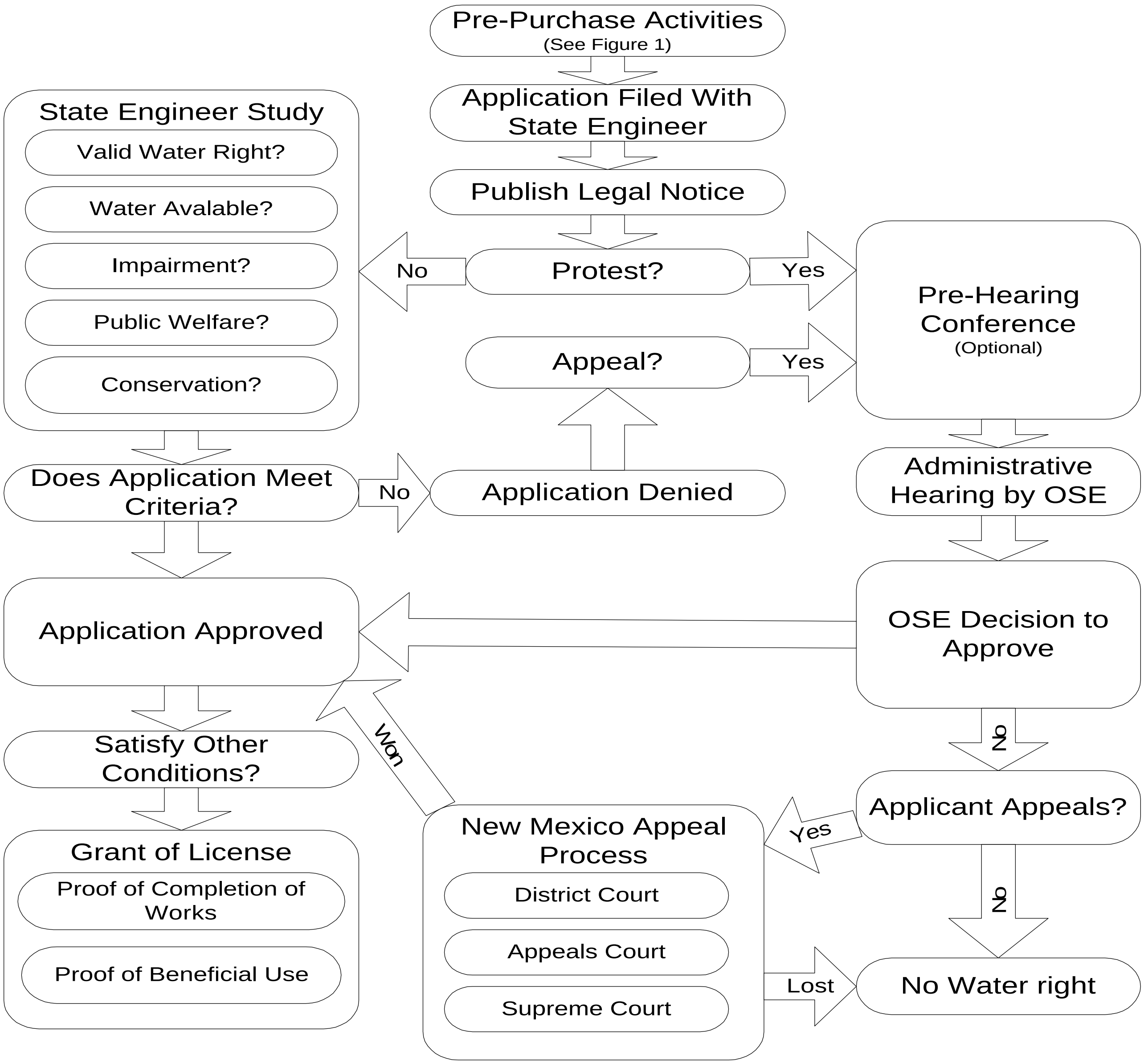
These price-limiting terms of the purchase agreement should be contingent only on the action of the OSE in the transfer process. The transferred depletions will be available to support flow supplementation immediately, but it should be recognized that transferred farm or project diversion will probably not be useable for flow supplementation until an operating agreement is made with the MRGCD.

The Buyer should use the services of a competent lawyer in drafting the purchase agreement.

3.3 Change of Use Process

Transfers of surface water rights proceed according to rules and regulations set by the OSE. The most recent rules and regulations (for the administration of surface water) were adopted on January 31, 2005 (OSE, 2005.) The process of changing a water right generally follows the procedure for any water right application and is shown schematically in Figure 2 (adopted from OSE, 1995.).

Figure 2. Flow Chart of Water Right Applications.



The MRGCD is largely contained within the Middle Rio Grande Administrative Area (MRGAA.) The New Mexico OSE Water Rights Division has set out its current practices for evaluating applications for permits for groundwater use within the MRGAA in *Middle Rio Grande Administrative Area Guidelines for Review of Water Right Applications* (OSE, 2000.) Any transfers that rely on groundwater pumping for application of water for flow supplementation will be required to conform to the Guidelines. In addition, the Water Rights Division has adopted formal and informal administrative procedures for water rights transfers. Finally, there are a number of good practices that will increase the effectiveness of the transfer process.

One objective during the transfer process is to avoid a hearing, with its considerable uncertainty and expense. A hearing will occur whenever there is an unsettled protest, or at the applicant's option when the OSE denies an application. The Buyer will have little control over whether or not there is a protest. At least initially protests should be expected, given the novelty of transfers for flow supplementation. However, the Buyer, as applicant, has complete control over the completeness and quality of the application for transfer, and a complete and thorough application stands a lower chance of denial by the OSE. The Buyer may find it advisable to do additional analysis and provide additional evidence prior to or in the application in order to reduce the chances of a denial, as the costs, in time and money, of a hearing are substantial.

3.3.1 Application for Permit to Change Place and/or Purpose of Use

A water rights transfer formally begins with the receipt by the OSE of an application for a permit to change the place and/or purpose of use. However, there is much work that should be done before the application is submitted that will help insure a successful and efficient transfer.

The application for a transfer from surface water to groundwater uses Form WR-09, *New Mexico Office of the State Engineer Application to Change Point of Diversion and Place and/or Purpose of Use From Surface to Ground Water.* The application for a transfer of surface uses Form WR-18, *New Mexico Office of the State Engineer Application for Permit to Change Point of Diversion and Place and/or Purpose of Use of Surface Waters.*

Evidence should be presented in or attached to the application to support all arguments, including the validity and priority of the transfer-from water right, non-impairment of other rights, the conservation of the resource test and the public welfare test. There is some possibility that these efforts will not be necessary (in the event that there is no protest and the OSE independently finds favorably on all tests) but it is best not to leave this to chance.

The application should be drafted by a competent attorney and technical representatives of the Buyer must be involved with counsel at all times in drafting the initial application to insure that details of the application reflects the Buyer's goals and the factual basis of the transfer. After these applications become more routine the time required of outside counsel and the Buyer's representatives can be reduced.

Prior to submitting an application the Buyer's technical staff and counsel should meet with OSE staff to go over all of the issues that can be foreseen to arise as a part of the transfer. This is particularly true for the first application of this sort, which will set precedents, or at least expectations.

3.3.2 Publication

After acceptance of an application, the OSE will issue a notice for publication to the applicant. This publication contains a legal description including the coordinates of the land and water and must be published in a paper "of general circulation – as prescribed by the State Engineer" in every county affected by the application once a week for three consecutive weeks.

It is the responsibility of the applicant to provide all essential facts pertaining to the application and to ensure the accuracy of the publication. <u>It is very important to critically proof read the OSE's proposed notice and, because newspapers sometimes make mistakes, the first published version of the notice</u>.

An affidavit of publication must be filed with the OSE within sixty days after the notice has been issued to the applicant by the OSE.

3.4 Protests

Protests may be filed by persons or entities with standing within ten days of the last date of publication of a water rights application. Only owners of water rights that will be impaired by the granting of an application have standing to file a protest based on impairment. Any person or entity can file an objection that granting the application will be detrimental to conservation of water within the state or detrimental to the public welfare, if they can show that they will be “substantially and specifically” affected by the granting of the application.

3.5 Resolution of Application

3.5.1 Denial

The State Engineer may deny an application for change of use with or without a protest if the OSE determines that one or more of the following are true:

- No water right exists
- Granting the application would be detrimental to or impair existing water rights
- Granting the application would be contrary to the conservation of water within the state.
- Granting the application would be detrimental to the public welfare of the state.

In the case of an application for change of point of diversion and type of use, the OSE will first determine if the right being transferred is a valid water right. If the priority and validity of the right has been established previously (through a prior transfer) and the Proof of Beneficial Use has been completed and filed in a timely manner, and the water right is not subject to forfeiture, then the water right will be found valid with the established priority. Otherwise the OSE will apply its established procedures to determine the validity and priority of the water right.

3.5.2 Reconsideration

In the event the OSE denies an application, the applicant may, within 30 days of receipt of notice of denial, request that the decision be set aside for reconsideration.

3.5.3 Settlement

The OSE encourages parties to a water rights protest to resolve the objection or protest by negotiations. If such negotiation is successful, the protest will be withdrawn and new stipulated terms for the application offered to the OSE.

3.5.4 Hearing

Hearings may result from two courses of action. In the event that a protest cannot be resolved by negotiation the matter will proceed to a hearing. If the OSE denies an application the applicant may, within 30 days of receipt of notice of denial, request that the decision be set aside for a hearing.

3.5.5 Approval

An application can be approved by the administrative action of the OSE, as the result of a hearing or by action of a higher court of appeals. In any event, upon approval an application becomes a permit, subject to any conditions of approval set by the OSE.

3.6 Grant of License

A permit allows the permittee to place water to beneficial use in accordance with any conditions of approval. Perfection of a water right requires proof of construction of necessary works, and proof of beneficial use. Upon inspection by the OSE a license to appropriate water will be issued. This license will define conditions and extent of use for the water right.

3.6.1 Proof of Completion of Works

Prior to the time limit set in the permit the permittee must submit proof of completion of any works required to put water to beneficial use. Proof of completion of works uses either Form WR-11, *New Mexico Office of the State Engineer Proof of Completion of Well,* or Form WR-22, *New Mexico Office of the State Engineer Proof of Completion of Works (Surface Waters.)*

3.6.2 Proof of Beneficial Use

The permittee must file with the OSE proof of application of water to beneficial use, consistent with the conditions of approval. This process establishes the quantification of the right. Proof of beneficial use is submitted on Form WR-23 for surface water and on Form WR-12 for groundwater. The Proof of Beneficial Use must be filed within the time limits set by the State Engineer in the permit (typically four years.) Extensions are available under certain circumstances, but regulations now limit extensions to no more than ten years.

3.7 Dry-up

The final step in transfer is to cease all consumptive use of water on the transfer-from parcel. Absent this dry-up depletions in the basin will be increased. If the land is not conveyed with the water rights, contractual terms and covenants should be used to enforce dry up. These terms should be drafted by a lawyer.

The physical process of drying up agricultural lands may be regulated by local or State land use agencies for purposes of weed control. We do not discuss the physical process of dry up.

4 SPECIAL CONSIDERATIONS FOR THE STATE OF NEW MEXICO

The State of New Mexico, through the Interstate Stream Commission or other agencies, may be responsible for the acquisition and transfer of water rights from irrigated land to a use of flow supplementation. This role raises two related policy issues.

The first of these is the State's special responsibility to insure dry-up and prevent out-of-priority irrigation of acquired lands. Because the purpose of acquisition of water rights is to supplement flows and offset resulting depletions, irrigation of the lands from which water rights are acquired (without a valid senior water right) would obviate the benefits of the acquisition. This would result in a waste of the State or Federal funds used for the acquisition and compromise the State's ability to meet its compact obligations on the Rio Grande.

One way to prevent this outcome is for the State to purchase the lands and maintain control over their use. This raises the second issue, whether the State may wishes to own lands that do not have direct public value, e.g. for rights of way, recreation or public facilities.

Given these two policy concerns it is strongly recommended that if the State buys water rights and chooses not to take title to the lands to which the water rights are appurtenant, it should impose restrictive and enforceable contractual terms and, if possible, recorded covenants, that will provide recourse should a subsequent owner irrigate these lands without acquiring a senior water right.

5 REFERENCES

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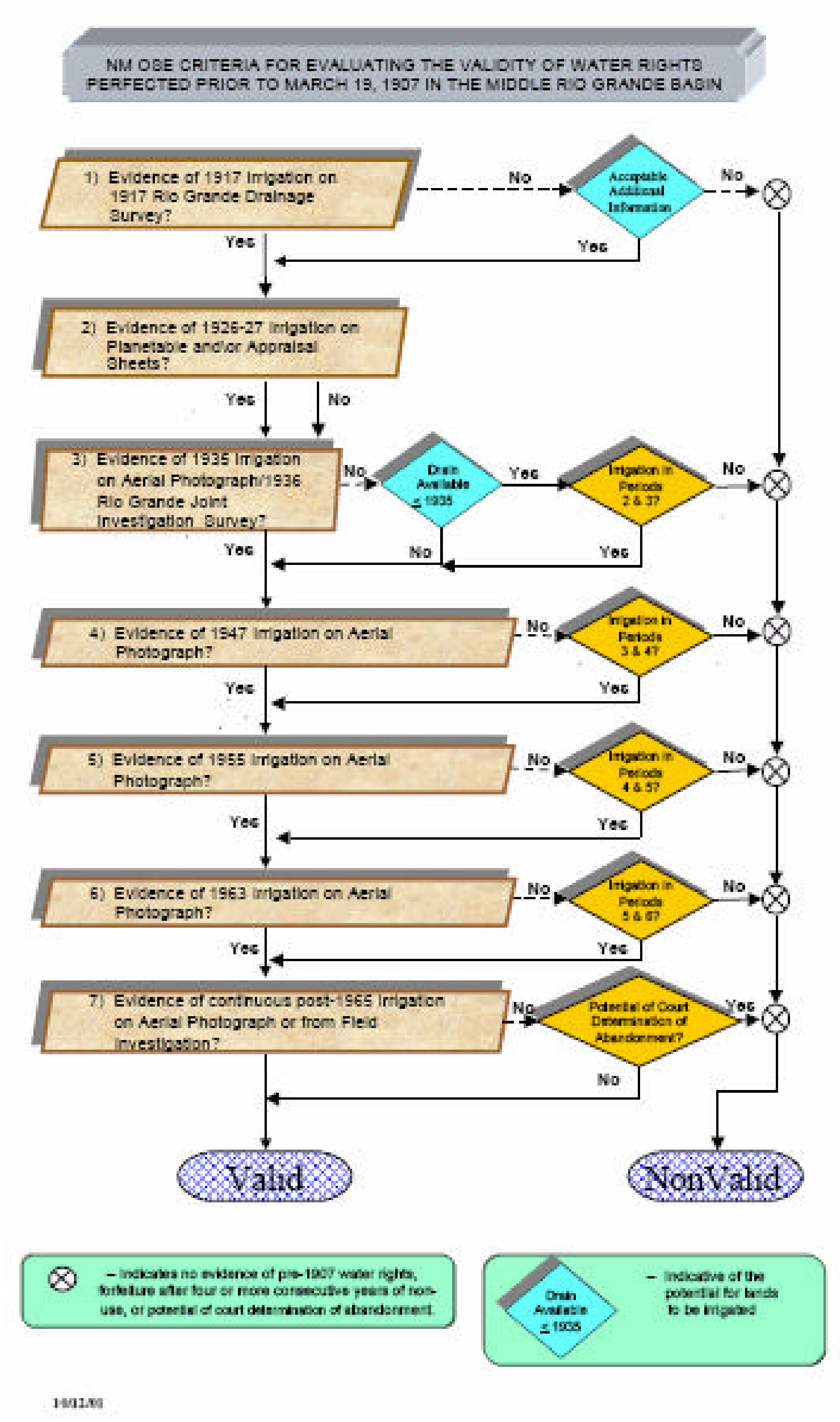
APPENDIX A: OSE WATER RIGHT VALIDITY FLOW CHART

Figure 1. OSE flow chart for determining priority and validity of MRG water rights.



APPENDIX H: GUIDANCE MEMORANDUM

MEMORANDUM

TO: Kevin Flanigan, New Mexico Interstate Stream Commission
FROM: Ben Harding, Hydrosphere Resource Consultants, Inc.
SUBJECT: Guidance Memorandum
DATE: June 10, 2005
CC:

This technical memorandum is intended to provide guidance with regard to priorities for acquisition of land and appurtenant water rights for use to provide supplemental flows in the Rio Grande floodway. This memorandum accompanies a report entitled *Evaluating Hydrologic Effects of Water Acquisitions on the Middle Rio Grande* that discusses in greater detail why acquisitions would be useful, how effective they might be, and how they might be accomplished.

Habitat requirements for the silvery minnow are set out in the Reasonable and Prudent Alternative of the March 17, 2003 Biological Opinion. Some of the habitat requirements involve meeting specified flow levels at various locations along the Middle Rio Grande. The Water Acquisition and Management Subcommittee (WAMS) of the Middle Rio Grande Endangered Species Act Collaborative Program has made estimates of the volume of water required to meet the flow targets of the Biological Opinion. The WAMS identified two components of water supply for any flow supplementation element – a flow component and a consumptive component. The WAMS also identified a number of measures by which water could be provided to meet the flow targets. One of these measures was acquisition of water rights from willing sellers. A useful compilation of the water elements of the RPA is given in Table 1 of the Water Acquisition and Management Subcommittee (WAMS) Report (2004.)

The flow component is the water used to supplement flows in the Rio Grande River in order to enhance or preserve habitat for the fishes. Providing the flow component is the ultimate objective of a program to acquire water. In principle, or at least on paper, the flow component requirements could be met by using the project diversion requirement attributable to an acquired water right. In order for this to be done, several requirements must be in place. First, the MRGCD system must be operated so that a reduction in farm delivery requirement (such as would occur when land served by District canals is taken out of irrigation) would result in a reduction in MRGCD project delivery requirements and hence project diversions. There is no commitment on the part of MRGCD to operate the system in this way and there may be physical constraints imposed by the configuration of the existing system that limit the effectiveness of acquisitions in reducing project delivery requirements.

If the policies and facilities were in place in the MRGCD to allow for a reduction in project delivery requirement as a result of an acquisition, a second requirement would be a regulatory structure within the OSE that would allow foregone project delivery requirement to be applied at a different place for the purpose of flow supplementation. In a transfer to a new purpose, the OSE currently limits the diversion to the amount of historical consumptive use. OSE has allowed a diversion rate from municipal wells equal to twice the transferred consumptive use based on the principle that municipal use is fifty-percent consumptive. Other than this there appears to be no precedent for transferring a foregone farm or project delivery to a new purpose.

If both operational and regulatory systems are in place, some storage would be necessary to put foregone deliveries to effective use for flow supplementation. The temporal pattern of supplemental flows necessary to meet the flow targets does not correspond with the delivery patterns of the MRGCD. Storage would allow foregone deliveries to be stored for release at later times.

Finally, a system of measurement will be required to allow for day-to-day administration of any transfer.

At this time none of these requirements are fully met. Thus, project deliveries cannot be directly put to use for flow supplementation at this time.

What can be done within the existing physical and regulatory framework is to transfer consumptive use to a new purpose of flow supplementation and use that consumptive use to offset increased depletions that will result from flow supplementation. Any of the measures identified by the WAMS to supplement flows will increase depletions, and as the basin is fully appropriated these depletions must be offset by a reduction of existing consumptive use.

In previous transfers of consumptive use from lands within the MRGCD (many of which have been to municipal well fields) the OSE has provided considerable flexibility in the place of use. There will be special issues related to the transfer of consumptive use to offset depletions from flow supplementation. These will have to be identified and addressed in the first transfers of this type, but at this time there is no reason to believe that there will be a relative advantage to be gained by acquiring lands in any particular part of the MRGCD. Absent a spatial criterion for selection, land will be chosen based on cost-effectiveness as measured by the cost of acquisition, reliability of supply, and the amount of consumptive use. This determination will be specific to each tender of sale and subject to negotiation. Because there are no categorical differences between lands and water rights (except for the threshold issues of validity and priority, discussed below) and because actual cost effectiveness will depend on market conditions at the time of acquisition, it was not useful to undertake any pro-forma analyses of acquisition.

It goes without saying that a threshold requirement is the validity and priority of the appurtenant water right. Because flow supplementation will be required during dry years, it is important that the water right from which consumptive use (or eventually delivery) is transferred be in priority in such dry conditions. This in turn requires that water rights to be acquired be pre-1907 rights. As to priorities among pre-1907 rights it will be better to acquire rights with the earliest documented history of continuous application to beneficial use.

REFERENCES

WAMS, 2004 — Water Acquisitions and Management Plan. Middle Rio Grande Endangered Species Act Collaborative Program Water Acquisitions and Management Subcommittee, February 9, 2004.

APPENDIX I: TRANSFER ANALYSIS MEMORANDUM

MEMORANDUM

TO: Kevin Flanigan, New Mexico Interstate Stream Commission
FROM: Ben Harding, Hydrosphere Resource Consultants, Inc.
SUBJECT: Transfer Analysis Memorandum
DATE: June 10, 2005
CC:

This technical memorandum addresses the types of analyses that will be required by the New Mexico State Engineer to support a permit for transfer of an existing water right to a purpose of flow supplementation.

SCOPE

This work addresses acquisition of water only from lands within the Middle Rio Grande Water Conservancy District. Acquisition includes purchase of land, and appurtenant water rights, as well as temporary leases of water.

STREAMFLOW OBJECTIVES

In March, 2003 the U.S. Fish and Wildlife Service issued a Biological Opinion regarding the silvery minnow, the flycatcher, and other species (*Biological Opinion*). The *Biological Opinion* set out a Reasonable and Prudent Alternative (RPA) for recovery and preservation of the listed species. Among the elements of the RPA are several Water Operation Elements, which set out flow targets ("the flow targets") intended to benefit the species. In order to meet these flow targets it will be necessary in many years to supplement the flows of the Rio Grande during summer months.

Habitat requirements for the fishes are set out in the Reasonable and Prudent Alternative of the March 17, 2003 Biological Opinion. Some of the habitat requirements involve meeting specified flow levels at various locations along the Middle Rio Grande. A useful compilation of the RPA is given in Table 1 of the Water Acquisition and Management Subcommittee (WAM) Report (2004.)

Water requirements for the endangered silvery minnow may be broken down into a flow component and a consumptive use component. The WAM has quantified the flow component portion of the water requirements for the minnow. The flow component is the water used to supplement flows in the Rio Grande River in order to enhance or preserve habitat for the fishes. It will have a certain temporal and spatial pattern. Supplemental flows can be provided by a variety of means, including, among others, acquisition, forbearance or operational changes. The WAM report and Hernandez (1997) identify candidate means of flow supplementation.

Supplementation of stream flows will increase the absolute levels of depletions in the river system. These increased depletions make up the consumptive component. They don't directly benefit the fish, but are a side effect of flow supplementation.

Because the Rio Grande stream system is fully appropriated, any additional depletions arising as a result of flow supplementation must be offset by a reduction in depletions elsewhere in the basin. Every means of supplementing late-season flows will increase depletions and therefore require an offsetting reduction of depletion elsewhere in the basin. These offsetting depletions can be obtained either by temporary forbearance of water consumption on irrigated acreage or by permanent acquisition and transfer of water rights to a new purpose and place of use (i.e., supplemental river flows).

The WAMS has made estimates of the amount of flow supplementation that would have been required to meet the flow targets set out in the Biological Opinion for each year from 1940 through 1999. The annual requirements range from 21,000 acre-feet to 97,000 acre-feet and average 50,000 acre-feet. We estimate that depletions arising from the levels of flow supplementation estimated by the WAMS would range from 2,000 acre-feet to 15,000 acre-feet per year, with a long-term average of approximately 7,000 acre-feet per year.

ACQUISITION OF WATER

The general objective of a water acquisition program is to acquire water rights or annual leases of water from existing uses and transfer that water right or water to supplement flows in critical habitat reaches to meet the flow targets set out in the RPA.

Providing the flow component is the ultimate objective of a water acquisition program. In principle, or at least on paper, the flow component requirements could be met by using the project diversion requirement attributable to an acquired water right. By ceasing acquisition on acquired lands, the farm delivery requirement for the acquired lands would no longer need to be delivered by the MRGCD at the farm headgate. Under the proper circumstances, a reduction in farm delivery to land served by District canals would result in a reduction in MRGCD project delivery requirements and hence project diversions. This reduction in project diversions would accrue to the river.

There is no commitment on the part of MRGCD to operate the system in this way and there may be physical constraints imposed by the configuration of the existing system that limit the effectiveness of acquisitions in reducing project delivery requirements. Transfer of flow component would also require changes in the practices of the OSE, better measurement and administration and, probably, storage. Accordingly, in practice, at least over the short term, it will only be possible to put the consumptive component to use for flow supplementation.

The ability to transfer a flow component will require a cooperative agreement with MRGCD, or implementation and enforcement of strict administrative practices by the OSE along with better water measurement and accounting practices.

WATER RIGHTS AND ADMINISTRATIVE ISSUES

Kery, et. al. (2003) made an effort to describe the water rights in the Middle Rio Grande Conservancy District. The following discussion is excerpted from that description.

The MRGCD encompasses parts of six Pueblos and 70 pre-existing acequias. In addition to serving water to farmers in those entities, the MRGCD brought new lands under irrigation. It also developed a storage facility. As a result, Kery suggests there exist seven categories of legally recognized water rights within the District. These are:

8. Individual pre-1907 water rights. These are water rights perfected prior to when the State Engineer was given jurisdiction over water rights. These water rights are vested in the individual water rights holders. These water rights may be transferred to a new point of diversion, place of use, or type of use. Kery estimates these water rights are appurtenant to an estimated 80,785 acres of land within the District.

9. Water rights permits between 1907 and 1927. These water rights were granted through permits from the State Engineer and were perfected prior to the formation of the District in 1928.

10. MRGCD permitted surface water right. MRGCD has obtained two permits from the State Engineer for approximately 42,000 acres of land, including more than 11,000 acres within the six Pueblos. No Proof of Beneficial Use has yet been filed for these permits, so these water rights have not been formally quantified.

> (It must be noted that the OSE does not allow transfers of District Rights outside of the District. The Rio Grande floodway is clearly outside the District boundaries below the northern boundary of the Bosque del Apache National Wildlife Refuge (BDA). It is not clear whether the floodway is within District boundaries above that point. Since the District Rights are junior and un-adjudicated, they are more likely to be out of priority in the event of any action to maintain compact compliance (assuming such action will be applied to rights in priority order.) Because the MRGCD water bank is based on the District rights, transfers from the Water Bank might not be applicable to some reaches of the river and might, in some future conditions, be out of priority.)

11. Pueblo water rights. These are the “prior and paramount” water rights of the Pueblos which are based on their aboriginal sovereignty and cover 8,847 acres and are prior and paramount to any other water rights in the District.

12. Pre-1956 and permitted groundwater rights. Wells drilled prior to 1956, when the State Engineer asserted jurisdiction over groundwater in the Rio Grande Basin, were granted water rights at that time. Since 1956, groundwater rights are based on permits from the State Engineer. Wells with both types of groundwater rights are owned by individuals and the MRGCD within the District.

13. San Juan-Chama water. The District has a contract with the USBR for delivery of 20,900 acre-feet of water annually from the San Juan-Chama Project.

14. Storage rights. MRGCD has a right to store water in 198,110 acre-feet of El Vado Reservoir. This right is for the use of reservoir space and is not a water right.

Because of their seniority, pre-1907 water rights should be of primary interest for acquisition. Storage of acquired water is necessary to allow water to be stored for release during periods of low flows, so rights to the use of storage space would also be valuable for flow supplementation.

Criteria for Transferability

A transfer is initiated by the applicant through an application to the OSE. The application provides basic information about the water right to be transferred and the new type of use and point of use. The OSE will evaluate a water right and the proposed transfer against the following criteria.

Valid water right. This is the first step. OSE requires a valid water right. If the right has been adjudicated then this establishes validity. Otherwise, the State Engineer evaluates the water right according to a set procedure. This process will be described more thoroughly in the transfer handbook.

Allowable quantity. Only the historical consumptive use can be transferred. Depletions associated with the new use may not exceed the historical depletions. In the Middle Rio Grande, the OSE has adopted a standard quantification of consumptive use for irrigated lands.

Impairment of water rights. Use of a transferred right will be limited to avoid injury to other water rights. This injury, called impairment, could take the form of reduced flows in a stream or excessive reduction of groundwater levels.

Public welfare. Despite the fact that the New Mexico legislature added a public welfare criterion to the water code in 1985, the OSE has not addressed the application of the criterion by regulation and has only addressed public welfare briefly in a few decisions. There is almost no case law in New Mexico addressing this issue.

Water conservation. Water right permits that are issued include a water conservation condition stating that the permittee "shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical." OSE policy on specific water conservation requirements for water right applicants is still evolving.

Transfer Policies and Precedents

Discussions with the staff of the OSE reveal that no previous transfers from irrigated lands within the MRGCD to a use of flow supplementation have been made. There has been considerable experience with transfers from lands within the MRGCD to municipal wells. The transfer-from analysis required for a transfer to a use of flow supplementation will be identical to these. However, the analysis to support conditions of use for the new use has never been done. As a result, no policies or standard procedures have been adopted by the OSE. The OSE will consider each transfer on a case-by-case basis, with the facts of a specific transfer determining the type of analysis that the OSE will accept. As a result we cannot say with certainty what will be required for an actual transfer.

The amount and priority of a water right resulting from a transfer depends largely on the transfer-from water right. (Other factors that may limit the amount of a transfer are impairment and public welfare impacts.) Three principle variables define a water right transferred from irrigated lands: validity/priority, consumptive use rate and irrigated acreage. The OSE has established standardized methods for establishing the validity and priority of a water right, and has established a standardized consumptive use for transfers off of lands within the Middle Rio Grande valley.

Transfer of Consumptive Component

The OSE has a well-defined process for evaluation of an application for transfer of consumptive use from irrigation to other places and other purposes. Numerous transfers of consumptive use have been made from lands within the MRGCD. Many, probably a large majority, have been to the City of Albuquerque wellfield for municipal use.

Transfers of consumptive use in the Middle Rio Grande are quantified at 2.1 acre-feet/acre.

There is no precedent or procedures for transferring consumptive use to a use of flow supplementation. However, an opinion by the New Mexico Attorney General concludes that transfers to instream purposes are probably not prohibited by New Mexico law. Because no such transfer has yet been requested, no standard procedures are in place for evaluation of the hydrologic effects resulting from a transfer of this type and the first of these transfers will be precedent-setting.

While the quantification of the transfer-from consumptive use is formalized, quantification of the transfer-to consumptive use will involve the development and acceptance of new procedures. In principle, the new use may not cause consumptive use greater than the amount available from the transfer-from lands. The OSE has limited diversions for past transfers to the amount of consumptive use, implying full consumption of all applied water by the transfer-to use. However, for transfers to municipal wells, the OSE has allowed a pumping rate of two times the transfer-from consumptive use, recognizing that municipal water use is roughly 50 percent consumptive and that the other 50 percent is returned to the hydrologic system from which it originated. The OSE regulations also allow for credit for return flows in other situations.

New Mexico regulations recognize return flows as:

> Surface water return flow is that percentage of the total diversion of surface water that has been applied to beneficial use pursuant to a water right or permit and returned to the same surface water stream from which it was appropriated.

The OSE may grant credit for return flows, thus allowing an increase in diversion, if the allowable consumptive use is not exceeded, if the increased diversion conforms to the impairment, public welfare and water conservation criteria discussed in Section 4.1, and if the return flows do not violate standards, regulations or permits under the New Mexico Water Quality Act or the federal Clean Water Act. The OSE also requires quantification of the return flows and a return flow plan that includes a method and program for measuring the return flows. In the case of flow supplementation, one hundred percent of the diversion would be returned to the stream so, according to a literal reading of the OSE policy, the return flows would equal the diversions. But, in fact, increasing flows in the river would cause depletions that would not have otherwise have occurred. The proper approach would be to set the allowable diversion at the amount where the depletions induced by the supplemental flows just equals the amount of consumptive use that has been acquired and transferred... To do so would require a reliable means of estimating the depletions arising from the increased stream flows.

Depletions arising from flow supplementation will arise from evaporation from water surface and wetted channel fringes and from induced evapotranspiration from riparian vegetation. Estimation of these depletions will require the use of modeling approaches. Because flow supplementation will be an incremental process, the depletive effect of a particular flow supplementation event will require that an estimate of "baseline" or "no-action" depletions be subtracted from the estimated depletions with the supplemented flows. Such an incremental analysis requires a realistic representation of the baseline conditions and a realistic representation of the hydrologic processes. Given the complexity of the hydrologic regime in the Middle Rio Grande valley a formal modeling approach will be required which will need to simulate the interaction between the surface water and groundwater systems. Because the surface water system is complex and dynamic, its representation will probably require a more sophisticated simulation than is typically available in the surface water modeling modules that are often used in linked surface water/groundwater models.

Transfer of Flow Component

The OSE recognizes a diversion right of 3.0 acre-feet/acre for private irrigation rights within the MRGCD. This represents the OSE's quantification of the farm delivery requirement. OSE has formally allowed transfer of the farm delivery requirement in past transfers. Since these have generally been transfers to groundwater, the flow quantification has not been used as the basis for a diversion from the river.

The OSE recognizes that MRGCD diverts water from the river at a higher rate than the 3.0 acre-feet/acre farm delivery requirement. In a letter to the District and the Bureau of March 23, 2001, the New Mexico State Engineer quantified the project delivery requirement for the purpose of establishing a sufficient and non-wasteful diversion in *Minnow v Keys* (formerly *Minnow v. Martinez)* at 7.2 acre-feet/acre of irrigated non-Pueblo land. Historical application rates have exceeded 10 acre-feet/acre but in recent years have not exceeded the limit established by the State Engineer. However, OSE has not recognized this diversion rate as a right.

As a practical matter, the amount of water diverted by MRGCD is currently solely under the control of the District. Absent a cooperative agreement with MRGCD, cessation of irrigation on acquired lands within the District will probably not lead to any reduction of the amount of water diverted from the Rio Grande unless strict administrative procedures are implemented and enforced by the OSE. In principle, absent any agreement with MRGCD, it might be possible to take delivery of water at a farm headgate on acquired lands and physically convey that water to the river. However, this would likely not allow much control over the timing of application of water.

Limitations on Transfers

A transfer to flow supplementation would be allowed only if the transfer does not impair existing water rights, is not contrary to the conservation of water within the state, and is not detrimental to the public welfare.

OPERATIONAL ISSUES

The success of a water acquisition program in generating "wet" water turns largely on operational and administrative issues. These issues include:

Means of application. Water can be physically applied to the river by several methods: direct bypass, release from storage, groundwater pumping or pumping from the Low Flow Conveyance Channel. For a more comprehensive evaluation of water sources refer to the WAM report or Hernandez (1997.)

Enforcement of the transfer. Enforcement of transfer of depletion is in one sense quite straightforward. It is necessary only to insure that the land from which water is transferred is not irrigated. There are anecdotal accounts of cases where water was transferred from lands within the MRGCD and those lands were subsequently irrigated with water from the District water bank. This can be prevented through prohibitions in the sale agreement.

After acquisition, when irrigation has been halted on a parcel, the water that was formerly used to irrigate the parcel will remain in the MRGCD system. Should MRGCD subsequently choose to allow that water to be applied to new lands, the depletions within the MRGCD system will be restored to the level that existed before the transfer. Because the transfer was intended to offset new depletions from flow supplementation, the overall level of depletions in the basin will therefore have increased. Prevention of this practice will require strict priority administration of water rights in the Rio Grande river system.

Because acquisition of water rights will only provide a consumptive component, other means of providing flow supplementation will be required.

Time and place of application of water. The time and place of depletions arising from flow supplementation will be determined by the patterns of flow supplementation. Based on previous transfers, there will probably be few constraints placed by the OSE on the location or timing of depletions. This is because the need to offset depletions is driven by the Rio Grande Compact since the basin is fully appropriated. The compact specifies deliveries at a point which is below all reaches where supplementation may be required. The compact also specifies deliveries on a calendar year basis. Accordingly, the place and time (within a calendar year) at which depletions occur will not affect the compact accounting.

The OSE policy is that unused consumptive use may not be carried over to a subsequent year.

Flexibility in timing of application of any flow component can be obtained through storage. Use of existing storage will require negotiations with the agencies who control the storage reservoirs and limits the flexibility with regard to where water can be applied to the river. Alternatively, new storage could be constructed, or groundwater storage could be exploited.

Flexibility and reliability. As noted above, restrictions on use of transferred depletions will probably not significantly limit a flow supplementation program. The biggest limitation is with getting water to where it is needed when it is needed. Use of existing storage reservoirs will provide good flexibility in timing, but no flexibility in terms of point of application. In addition, transport of water from the distant storage reservoirs at higher elevations causes additional losses, both in terms of seepage and depletions. Application of water through the use of groundwater pumping can provide flexibility in terms of both time and point of application.

The reliability of various approaches differ. Those involving storage are affected by hydrology, regulatory and statutory limitations, and compact restrictions. Groundwater pumping would only be restricted by extreme stress on the groundwater system, or by mechanical problems.

Cost effectiveness. Overall operational cost of groundwater pumping can be expected to be higher than storage alternatives (though the agreements necessary to use existing storage reservoirs may require some compensation.) Groundwater pumping has greater flexibility and with this flexibility comes better efficiency, which would favorably impact unit costs.

Adaptability. Legal, hydrological, economic and environmental conditions will change over time. A program of acquisition should consider long-term changes.

SUMMARY

Given the current lack of strict administration and enforcement by the OSE within the MRGCD, there is considerable uncertainty about how any transfer of diversion (flow component) could be administered and enforced absent the cooperation of MRGCD. Transfer of consumptive use from acquired lands should be done in a way to preserve any future ability to obtain a transfer of diversion.

Transfers of depletion (consumptive component) can likely be made and enforced, but issues of quantification of depletions from the new use must be addressed.

Given that there has been no adjudication of water rights in the Middle Rio Grande, and that there is uncertainty with regard to priority administration under compact delivery constraints, permanent transfers should be made from pre-1907 water rights.

Temporary water might be available from the MRGCD water bank, but if the “borrowed” water arises from District Rights, it cannot be used outside of the District. This probably restricts water from the water bank to use to above BDA. In addition, District rights are junior and may be out of priority in the event of administration arising from a compact call.

Water requirements, both the flow component and consumptive component, are probably best estimated using a modeling approach.

If the OSE is to allow transfers for flow supplementation, it will require reliable methods for estimating depletions arising from a given streamflow supplementation program. Modeling approaches can be used to develop relationships between flow supplementation and depletions for different reaches of the river.

Groundwater pumping can be used as both a short-term and long-term approach to flow supplementation. Transfers from surface water to groundwater have considerable flexibility, allowing transferred depletions to be applied where required. Pumping has considerable flexibility. Modeling studies will be required to establish the feasibility of groundwater use and to provide evidence to support an application for transfer.

Pumping from the LFCC is already underway, and the cost of this program promises to be less than for a well system, both in terms of capital investment and operating costs. The State Engineer will be requiring offsets to depletions caused by this pumping, and will determine those depletions to the Rio Grande “…using the best available data and commonly accepted engineering practices.” The consumptive use from acquired water rights can be used to provide offsets to pumping from the LFCC.

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