7. Ability of Supply to Meet Demand

To provide a basis for determining what alternatives will be needed to address the future demands of the region, this section summarizes and integrates the water supply and demand information presented in Sections 5 and 6. A water budget that provides an overall reconciliation of supply and demand is provided in Section 7.1. Conclusions regarding the supply and demand, based on information presented in Section 5 and 6 as well as the legal constraints discussed in Section 4, are presented in Section 7.2.

7.1 Water Budget for the Socorro–Sierra Planning Region

Development of a water budget that integrates water supply and demand information is a key aspect of an overall regional water plan as prescribed by the New Mexico ISC (1994). A water budget for planning is designed to answer the question, “Are the available water supplies in the planning region sufficient to meet current and projected future water needs by the region’s residents?” To do this, information on groundwater and surface water supplies (Section 5) was synthesized with the analysis of historic and future water demands (Section 6).

One simple way to view a water budget is as a bank account in which income and savings (water supply) is compared to expenses (water depletions) over some given time interval (typically annually). In a purely surface-water supply system, water depletions on an annual basis could not exceed supplies without storage (i.e., reservoirs) of water in wet years (akin to a savings account). In a groundwater supply system, it is possible for a community to withdraw more groundwater than is replenished through return flow and/or natural recharge. These excess withdrawals lead to declining water levels and continuously increasing pumping costs, and eventually, land subsidence may occur. If such a situation continues unabated, extinction of the groundwater reservoir can ultimately result. Within local areas where recharge reaches the pumping centers relatively quickly, water use from a groundwater-supplied (not stream-connected) system can be sustained essentially indefinitely if the water use rate does not exceed the system’s groundwater recharge rate. Conversely, in large basins, water level declines, increasing pumping costs, and subsidence may occur close to pumping centers, even when the basin-scale recharge is similar to the withdrawals.

To be accurate, a water budget should be prepared based on an area that is hydrologically distinct. As discussed previously, the central water supply and most of the water use in the Socorro-Sierra region is in the Rio Grande Basin. A quantitative water budget for the Rio Grande, which considers both surface water and stream-connected groundwater, is presented in Section 7.1.1. Additionally, water budget components for the San Agustin Basin, Alamosa Creek Basin, Jornada del Muerto and Tularosa Basin, and alluvial basins west of the Rio Grande in Sierra County are discussed in Section 7.1.2.

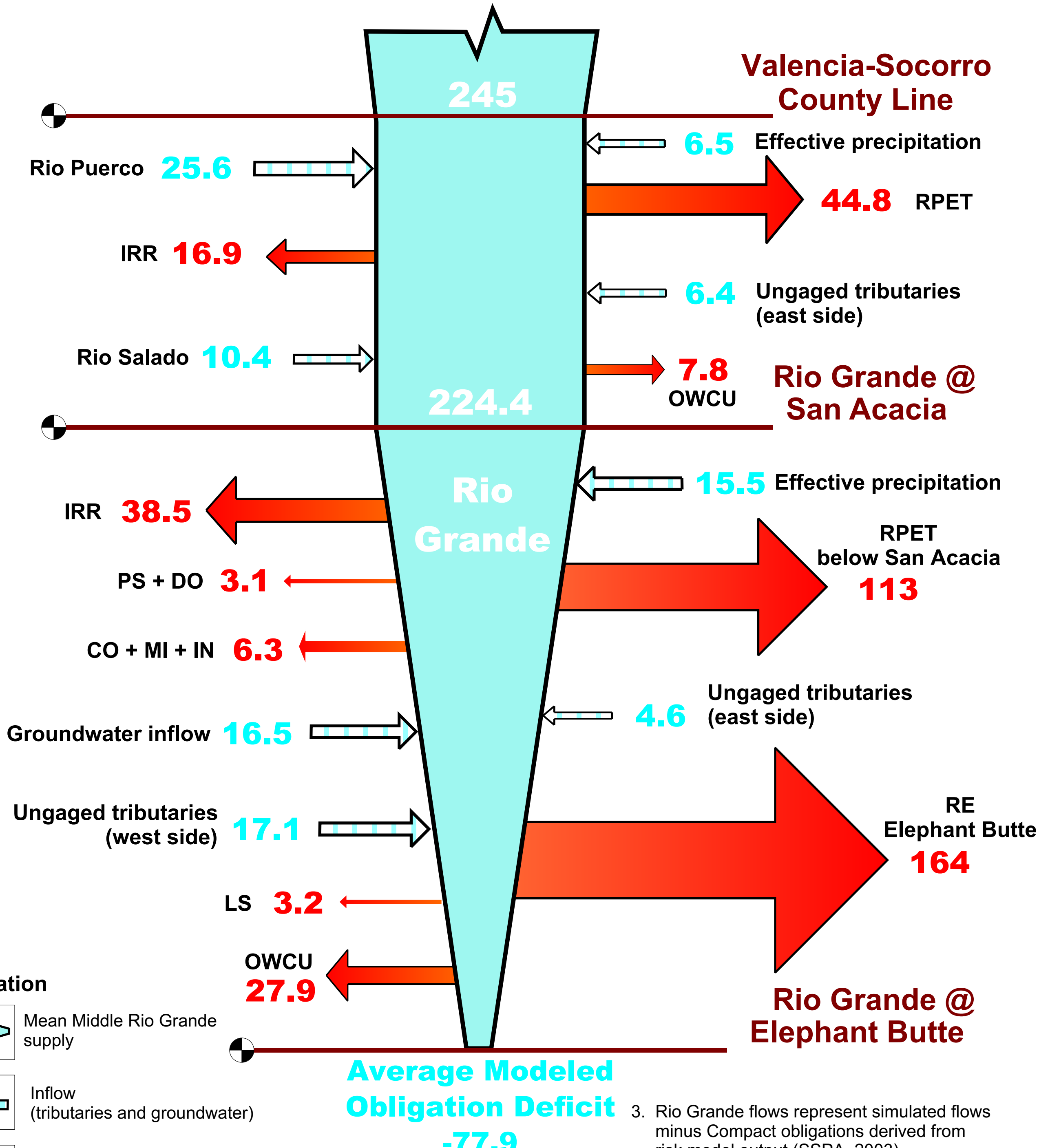
7.1.1 Rio Grande Basin

The vast majority of population, economic activity, and appurtenant water use in the planning region is concentrated within the Rio Grande Basin. Figure 7-1 summarizes the average annual water budget for the Rio Grande Basin within the planning region, including all major supplies into and demands out of the system. The inflows and depletions shown on the figure are based on results of modeling conducted by SSPA (Appendix E1) and the demand estimates presented in Section 6. The inflows shown in Figure 7-1 have been corrected to account for depletions upstream of the region and for Compact delivery requirements.

The water supply to the Rio Grande Basin is comprised of flows in the Rio Grande itself together with connected groundwater and tributary inflows. Demands from both human and natural (i.e., riparian evapotranspiration) processes deplete those supplies, resulting in a net modeled deficit of approximately 77,900 acre-feet per year.

The water budget modeling is based on full satisfaction of all demands and current water supply conditions. The modeled deficit indicates that in order to meet Compact requirements in the long term, changes in water supply management will need to occur and/or demands will need to be reduced.

The water budget presented in Figure 7-1 represents average flows; supply conditions will be worse in drought years. In water-short years, storage in reservoirs in the upper Rio Grande watershed (e.g., El Vado Reservoir) from preceding wet periods provides more annual reliability to the water supply than would otherwise be available without the reservoirs. Drought periods



Explanation

Mean Middle Rio Grande supply

Inflow (tributaries and groundwater)

Depletions (crops, riparian evapotranspiration, reservoir evaporation, and urban)

CO	Commercial
MI	Mining
PS	Public water supply
DO	Self-supplied domestic
RE	Reservoir evaporation
RPET	Riparian evapotranspiration
IRR	Irrigated agriculture
LS	Livestock
OWCU	Open water consumptive use
IN	Industrial

Notes:

1. Values represent average annual flow in thousands of acre-feet per year.
2. Riparian evapotranspiration depletions based on USBR ET toolbox data, as reported by SSPA (2003); agricultural and evaporation depletions from SSPA (2003); other depletions based on year 2000 data.
3. Rio Grande flows represent simulated flows minus Compact obligations derived from risk model output (SSPA, 2003).
4. Model addresses the regional supply from the Socorro County line to Elephant Butte Reservoir. Irrigation from Elephant Butte Irrigation District is not included.
5. The modeled obligation deficit is based on full satisfaction of demands under current supply conditions. Negative number indicates that Compact requirements will not be met without changes to the supply/demand regime.

SOCORRO-SIERRA REGIONAL WATER PLAN

Rio Grande Basin Average Annual Water Budget in Socorro-Sierra Planning Region

VDR10-VDR-PROJECTS\9469\946903W.CDR

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12-15-03 JN 9469

Figure 7-1

with several consecutive water-short years, however, can lead to supply shortfalls, particularly for agricultural water users. This is the case currently, where several years of below-normal conditions have depleted storage levels; if precipitation continues to be low in future years, there will not be enough water to supply all of the demands and the State will be unable to meet downstream delivery obligations without curtailing uses.

Depletions associated with instream flow demands that have arisen in recent years to benefit listed endangered species (e.g., the silvery minnow) occur due to operations such as flow bypasses at the San Acacia diversion and pumping from the LFCC to the river below Escondida. However, these depletions have not been quantified and are therefore not included on Figure 7-1. These instream flow needs exacerbate the deficit between supply and demand in the region and will mostly affect surface water users, in particular, agricultural users.

As part of the probabilistic modeling effort conducted by SSPA, a water budget for both high- and low-flow years was developed and is presented as Table 7-1. SSPA used a stochastic (i.e., probabilistic) approach to describe the variability of the surface water supply. A water budget model was constructed, consisting of all identified inflow components (representing the water supply) and outflow components (representing the depletions):

- Inflows:
  - Gaged flow on the Rio Grande at the Otowi Gage, which is used as an index for required deliveries on the Rio Grande Compact (i.e., delivery requirements at Elephant Butte Reservoir are based on the flow past the Otowi Gage)
  - Tributary inflow between Otowi Gage and Elephant Butte Reservoir (Santa Fe River, Galisteo Creek, Jemez River, Rio Puerco, Rio Salado), based on historical or reconstructed flow records for the period from 1950 through 2002
  - Flow from flood control channels in the Albuquerque area
  - Wastewater return flows
  - San Juan-Chama project water (water imported from the Colorado River Basin to the Rio Grande through the Azotea Tunnel and Heron Reservoir)
  - Groundwater inflow, as estimated from USGS and OSE modeling efforts
  - Flow from ungaged tributaries.

Table 7-1. Modeled Inflow and Outflow of the Rio Grande in the Socorro-Sierra Water Planning Region

Flow Term	Surface Water Flow [a] (ac-ft/yr) 10th Percentile	Average	90th Percentile
Inflow at Otowi gage	335,512	930,084	1,679,158
Rio Grande Compact obligation	–191,242	–624,104	–1,274,158
Total inflow (Cochiti to Elephant Butte) less Rio Grande Compact obligation	510,440	687,070	835,774
Elephant Butte losses	–94,012	–163,577	–253,611
Adjusted modeled inflow upstream of SSPR [b]	312,133	419,867	502,914
Modeled depletions upstream of SSPR	327,841	336,089	344,401
SSPR mainstem inflow [b]	–24,858	83,779	167,212
Inflows within SSPR			
Rio Puerco inflow	7,466	25,645	51,197
Rio Salado inflow	1,508	10,393	23,032
Ungaged tributaries, west side	2,511	17,090	38,534
Ungaged tributaries, east side section 2	935	6,381	14,322
Ungaged tributaries, east side section 3	675	4,602	10,331
Wastewater inflow	966	966	966
Effective precipitation	22,050	22,050	22,050
Groundwater inflow	16,500	16,500	16,500
Adjusted SSPR total inflow [b]	57,597	187,405	293,032
Outflows within SSPR			
Agricultural consumptive use	–52,254	–55,735	–59,260
Riparian consumptive use	–157,621	–157,621	–157,621
Open water consumptive use	–35,650	–35,650	–35,650
Surface water depletions from groundwater pumping	–3,300	–3,300	–3,3300
Total SSPR depletions	–248,825	–252,306	–255,831
SSPR outflow = New Mexico delivery credit/debit	–194,420	–64,901	40,230

Note: Because of the variability in input and depletion terms, the mean modeled flows do not necessarily equal the mean inflows minus the mean depletion terms for a given modeled section.

Source: S.S. Papadopulos & Associates (Appendix E)

[a] 10,000 model realizations

[b] Rio Grande Compact obligation and Elephant Butte losses removed.

ac-ft/yr = Acre-feet per year
SSPR = Socorro-Sierra planning region

- Depletions (outflows):
  - Reservoir evaporation
  - Surface water depletions due to groundwater pumping
  - Agricultural consumptive use
  - Riparian and open water consumptive use

Additionally, delivery obligations under the Rio Grande Compact were subtracted from the Otowi gage inflow.

Because water budgets are highly variable, with inflow terms such as evaporation and tributary inflow being extremely variable depending on climatic conditions, the water budget model was operated using Monte Carlo procedures. The Monte Carlo method consists of developing many potential water budgets, in this case 10,000, and for each one picking a different combination of input parameters (inflows and depletions) that are representative of the variability of inflows and depletions based on historical data. The intention of this type of modeling approach is to represent all of the potential scenarios in a water budget by considering the 10,000 different possibilities. The 10,000 possible water budgets are then presented statistically; that is, the median of all possibilities as well as the high and low extremes can be examined to understand the range of potential conditions that can exist in the region.

The mean inflow and outflow components, as well as the 10th and 90th percentile values (e.g., the 10 percentile represents the value below which 10 percent of the values fall, or the lowest 10 percent of the range of flows modeled), of the Socorro-Sierra supply are shown on Table 7-1. The mean deficit shown on Table 7-1 varies slightly from the deficit shown on Figure 7-1 due to differences between SSPA and Hydrosphere depletion estimates. The full distribution of inflows and outflows is presented in Appendix E1. Because of the variability in input and depletion terms, the mean modeled flows do not necessarily equal the mean inflows minus the mean depletion terms for a given modeled section.

7.1.2 Outlying Groundwater Basins

Given the sparse population and the absence of modeling efforts typically used for quantitative groundwater analyses, the water budgets for groundwater basins more removed from the Rio Grande Basin are only generally discussed. While this report quantifies the water demands only by county, not within in each basin, most of the population in these other basins is served by individual domestic wells. The total estimated diversions from self-supplied users in the entire region is about 500 ac-ft/yr, the majority of which is in the Rio Grande Basin; therefore, the total demands from domestic wells in these groundwater basins is probably much less than the 500 ac-ft/yr.

Irrigation of agricultural lands with groundwater does occur in the San Agustin and the Jornada del Muerto Basins, however. In these outlying areas recharge exceeds current demands and, therefore, the systems are in a relative state of equilibrium. Water level hydrographs (Appendix F1) confirm that the water levels in the basin aquifers are relatively stable. Water budget information for each of these outlying basins is summarized below:

- *San Agustin Basin.* The San Agustin Basin includes no perennial surface water supplies, and the groundwater basin stores on the order of 10 million acre-feet of potable groundwater. The basin receives approximately 7,500 acre-feet of groundwater recharge annually (Section 5). The village of Magdalena pumps their potable water supply of less than 200 ac-ft/yr from the eastern fringe of the basin, 20 miles east of town, and a small number of rural private wells also pump from the basin, less than 3 ac-ft/yr each. Irrigation in the northern portion of the basin is served by groundwater, but the amount of water pumped for irrigation has not been quantified.

- *Alamosa Creek Basin*. The Alamosa Creek Basin is largely undeveloped except for a few ranches that obtain their domestic and livestock supplies from the basin. The groundwater basin holds on the order of half a million acre-feet of potable water and receives approximately 2,000 acre-feet of groundwater recharge annually (Section 5). The aquifer discharges from springs near the Monticello Box in the southeast corner of the basin. Surface flows from Monticello Box are diverted and fully depleted by irrigators in the vicinity of the Village of Monticello.

- *Jornada del Muerto and Tularosa Basins.* Both these groundwater basins contain large volumes of stored groundwater. Most of the stored groundwater, however, is of marginal quality. Recharge is on the order of 47,000 ac-ft/yr in the Jornada del Muerto Basin and 22,000 ac-ft/yr in the Tularosa Basin. Due to the sparse populations, the land status of the White Sands Missile Range, and the large distance from population centers in the planning region, the groundwater supplies in these basins are sufficient to meet current and likely future demands.

- *Sierra County alluvial basins.* West of the Rio Grande in Sierra County a number of small alluvial basins drain off the eastern slopes of the Black Range. Some of the basins have flowing streams (e.g., Las Animas Creek, Berenda Creek, Percha Creek), but little of this water generally reaches the Rio Grande Basin, as the supplies tend to be depleted by upstream uses. Those upstream uses include irrigation supplied by both surface flows and groundwater pumping and domestic uses supplied by wells that tap into the alluvial aquifers. Wilson et al. (2003) reports that more than 11,000 ac-ft/yr of groundwater is diverted for irrigation and another 600 ac-ft/yr of groundwater is diverted for livestock. The groundwater supplies are generally adequate to meet existing demands, but are not likely sufficient to accommodate large increases in use.

  Based on interviews with water users associated with the community ditches on the east slopes of the Black Range in Sierra County, these watersheds and associated alluvial basins exhibit a near balance between available surface water supplies and water use by diversion to beneficial use. NRCS personnel indicate that in drier than average years, most diverters for agricultural crop production grow crops under deficit irrigation. In other words, in drier years, there is barely enough, and in some cases not nearly enough, surface water available to meet crop consumptive use demands on all irrigated land within the region. For these systems, a water budget in which diversions and depletions match whatever supplies are available exists, and little water is available for additional development unless some existing demands are curtailed.

7.2 Conclusions Regarding Supply and Demand in the Socorro-Sierra Region

Based on the analysis of legal issues, water supply, and demand presented in Sections 4, 5, and 6, the following conclusions regarding the ability of the water supply in the region to meet water demands can be made:

- The Rio Grande, including the aquifers that are connected to this river, is a fully appropriated system. Endangered species and Rio Grande Compact obligations place significant constraints on the system. Although demands in the region have mostly been met with available supplies on the Rio Grande, this condition will change over multi-year drought periods, such the one currently ongoing, when upstream storage is insufficient to supply the needs of all the users on the Rio Grande.

- Natural depletions, including riparian evapotranspiration and reservoir evaporation from Elephant Butte Reservoir account for more than 80 percent of the total depletions in the Rio Grande Basin portion of the Socorro-Sierra water planning region. Much of these depletions are downstream of the major water users in the region, and reductions in the depletions would therefore not directly benefit the region. However, the region would benefit indirectly from reductions in the natural depletions, because to the extent that more water is available to meet Compact delivery and endangered species obligations, supplies for users within the region will be more secure.

- Probabilistic water budget modeling, consisting of estimating inflow components (representing the historical water supply) and outflow components (representing current depletions), for the Rio Grande and tributary groundwater indicated that (1) the mean modeled obligation deficit, or the mean difference between inflows and outflows, is approximately 64,000 to 78,000 acre-feet per year (depending on how depletions are accounted) and (2) the difference between supply and demand for the 10th and 90th percentile flows is approximately –194,000 acre-feet and 40,000 acre-feet, respectively. Based on these results, the supply is not adequate to supply all demands in dry to average years, and either reduced demands, storage from wetter years, improved water supply management, or development of new resources will be required to address the needs of the region.

- Groundwater resources that are connected to the Rio Grande have not been fully developed; that is, increased groundwater pumping from these resources is potentially physically possible. However, development of stream-connected groundwater is constrained by water rights, and to increase depletions of groundwater, water rights must be transferred from existing surface water or groundwater resources.

- There may be some opportunity for development of groundwater resources in areas that are farther away from the Rio Grande. For the San Agustin Basin, the Jornada del Muerto Basin, and the Tularosa Basin, groundwater recharge and storage estimates (Section 5) suggest that small quantities of water could potentially be developed without adverse impacts. However, site-specific evaluations of potential impairment and connection with the Rio Grande would be required. Additionally, the undeveloped nature of these basins and their large distance from major water users suggest that profitable development of these supplies would be challenging.