

The Reuse Strategy



Ten years ago, the Denver area was utilizing over 50,000 acre-feet of reusable return flow water each year. Today, utilities are pursuing even more reuse opportunities. Providers are using abandoned gravel pits for storage of reusable supply and are directly reusing effluent for non-potable irrigation. As water treatment technology advances and reuse opportunities are maximized, it is reasonable to project that by 2050 there will be close to 200,000 acre-feet of direct and indirect reuse occurring annually on the Front Range.

Categories of Reusable Water

Water reuse is any arrangement that utilizes legally reusable municipal return flows to increase municipal water supplies. Return flows are water that returns to a river after being treated at a wastewater treatment plant or to alluvial aquifers via percolation. Reuse can be accomplished in at least two ways: 1) return flows can be physically reused for non-potable and potable purposes; or 2) return flows can be reused under various substitution or exchange arrangements.*

To increase water supply through reuse, municipal return flows must be legally reusable. Under Colorado water law, reusable water available to Front Range water utilities can generally come from the following sources:

- Water imported to the South Platte or its tributaries from another river basin
- Nontributary groundwater from Denver Basin aquifers
- The historically consumed portion of water rights changed from one use to another, such as from irrigation to municipal use
- Water diverted under a water right that has been decreed to allow for reuse

* An exchange is generally an arrangement in which one junior water user makes available to a senior user water owned by the junior (e.g., reusable effluent), in exchange for permission to use or divert an equivalent amount of water to which the senior user would otherwise be entitled.

Existing Reuse Along the Front Range

The Metropolitan Water Supply Investigation (MWSI) included an extensive analysis of water reuse in Front Range cities of the Denver metro area as of the late 1990s, and the potential for future reuse by the year 2030 and beyond.⁴⁰ The authors of the report developed a computational model and collected a substantial database. Information ranged from stream flow and diversion records to plans for reusable return flows. The goal was to establish estimates of current and future reuse in the Denver area. They also looked at reuse in other Front Range urban areas north of Denver, though in less detail.

At the time the MWSI was completed, Denver area water users were utilizing approximately 53,300 acre-feet of reuse water per year through various substitution arrangements and were directly reusing another 1,000 acre-feet for urban irrigation purposes (Table 2). About 80% of reuse was in the form of South Platte and Clear Creek exchanges; the balance consisted primarily of augmentation for alluvial wells in the Cherry Creek and Plum Creek Basins. As of 1999, less than 10% of the region's existing water supply was derived from reuse, but most water utilities were in the process of expanding reusable supplies.

TABLE N° 2 SUMMARY OF REUSE IN THE DENVER METRO AREA IN 1999 (ACRE-FEET PER YEAR).*

| Provider | Substitute | Direct Reuse | Total |
|-----------------|---------------|--------------|---------------|
| Denver Water | 22,000 | 0 | 22,000 |
| Aurora | 5,800 | 400 | 6,200 |
| Douglas County† | 2,400 | 600 | 3,000 |
| Thornton | 3,000 | 0 | 3,000 |
| Westminster | 3,700 | 0 | 3,700 |
| Arvada | 500 | 0 | 500 |
| Other‡ | 15,900 | 0 | 15,900 |
| TOTAL | 53,300 | 1,000 | 54,300 |

* Data from MWSI.

† Includes all Douglas County Water Resource Authority providers.

‡ Includes Brighton, Broomfield, Englewood, Golden/Coors, Northglenn, SACWSD, and miscellaneous providers.

Issues Associated with Reuse

Potential limits to reuse include its cost, storage requirements, public acceptance, instream flow and water quality effects, and agricultural concerns. These concerns are legitimate and will require effort to resolve. Reuse, however, remains an integral and viable water supply option for the Front Range.

Cost

Direct reuse (potable or non-potable) can be costly from both a capital and O&M (operations and maintenance) perspective. The CWCB estimates direct non-potable reuse to cost approximately \$7,000 per acre-foot, including infrastructure requirements. Costs for indirect potable reuse are estimated to be \$13,500 per acre-foot.⁴¹ Denver Water and Aurora both indicate that costs for their reuse projects are high, but are not yet in positions to provide firm values.*

The costs of a potable supply project using a combination of return flow from the Metropolitan Wastewater Treatment Plant (Metro) and diversions from the South Platte River will be high. The water quality in the South Platte River below Denver is variable due to upstream wastewater discharges, storm water events, and other forms of nonpoint source pollution. Designing a potable supply project to accommodate such water quality variability will be particularly challenging.

However, in areas where tertiary treatment of wastewater return flow is already required and where the water quality of the receiving stream is relatively high, the costs of potable reuse may be lower. Higher water quality standards in the future are likely to decrease the incremental expense of reuse. Furthermore, the CWCB estimates that some new supply projects may range between \$30,000 and \$40,000 per acre-foot for capital costs and an additional investment of \$1,000 per acre-foot for operations and maintenance—substantially more expensive than reuse.⁴²



Recycled water projects use "purple pipe" to convey supply from the treatment plant to the point of use.

* Both Denver Water and Aurora are well along with their reuse projects, but because they are complicated, the utilities are still in the process of developing reliable cost estimates, according to personal communications with representatives of Denver Water and city of Aurora, June 2010.

Storage Requirements and Utility Cooperation

Storage will be necessary to regulate the timing, treatment, and redistribution of reuse water. The amount of storage is dependent on not only the level of reuse activities and the number of participants involved, but also the willingness of the participants to develop an integrated approach to storage development and management.

Storage needs decline when systems are integrated. For example, Denver Water determined that it would need approximately 12,000 acre-feet of return flow storage to maximize its exchange yields and to reliably deliver 15,000 acre-feet of non-potable reuse water. In making this determination, Denver Water assumed that it would be using its own reusable return flow from the Metro treatment plant as a sole supply for its non-potable reuse plan. The authors of MWSI, by contrast, considered return flow storage requirements from an integrated perspective. Available supplies included Denver Water's reusable return flow, Aurora's reusable return flow, and free river supplies on the South Platte at the Burlington Ditch (with its headgate just upstream of the Metro outfall). These three supplies were used to meet Denver Water's and Aurora's exchange opportunities and to supply Denver Water's 15,000-acre-foot non-potable reuse project. The results of this analysis indicated that the total return flow storage requirement for meeting these three demands could be reduced to less than 3,000 acre-feet, illustrating the reduced storage requirements of integrated operations.

Public Acceptance of Potable Reuse

Direct potable reuse of wastewater is still uncommon in the U.S. In places where it has been implemented or seriously considered, public acceptance has been generally favorable, provided that adequate research, education, monitoring, and oversight activities are completed. A key focus of education is to explain the high level of water quality treatment being utilized to make the water safe to drink. Public acceptance of potable reuse in Front Range communities will take time, but already has grown over the past decade. Further education and outreach will help increase acceptance of potable reuse as a source of supply.

Instream Flow Issues

Instream flow requirements between upstream points of diversion and downstream points of return flow release can limit exchange potential for indirect reuse projects. Below Strontia Springs Dam, for example, federal permit conditions require Denver Water to bypass water during certain times of the year. Denver Water has access to approximately 10,000 acre-feet of storage in Chatfield Reservoir for use in recapturing bypass flows, but Denver Water's opportunities to exchange water recaptured in Chatfield back to Strontia Springs are limited by operational constraints that are designed to protect Chatfield recreational uses.

Currently, there is no formal instream flow protection requirement for the South Platte River below Chatfield Reservoir. While the CWCB is not pursuing an instream flow right, work is underway to develop and improve recreational amenities, wildlife habitat, and scenic values in the South Platte corridor. This effort includes an analysis of the amount of instream flow that may be necessary to maintain water quality, aquatic habitat, scenic values, and recreational activities, such as rafting and kayaking. Official instream flow requirements for the South Platte below Chatfield will reduce exchange potential.

Water Quality Issues

Water quality in the Denver metro reach of the South Platte River may be impacted by indirect reuse as a result of increased upstream diversions. Exchanges to upstream points of diversion could substantially reduce instream flows below Chatfield Dam at certain times of the year. These stream flow reductions would decrease the assimilative capacity of the stream, resulting in higher concentrations of pollutants from both point and nonpoint sources. Notably, the greatest exchange potential occurs during the spring and early summer, when stream flows are highest, and thus there is a substantial amount of dilution water available. It is unlikely that exchanges would substantially impact the operation of downstream wastewater treatment plants because effluent limits for those plants are typically based upon low stream flow conditions when there is little or no exchange potential.

Wastewater treatment plant.



Energy Implications of Reuse

Reuse typically uses less energy than some new water supply proposals, but it is certainly not zero. Because most utilities already treat wastewater to secondary or tertiary standards before discharging it to rivers, to implement reuse strategies, utilities only need to expend the incremental energy required to bring water from secondary or tertiary standards up to end-user standards.

For the WISE and Prairie Waters reuse projects to be both water- and energy-smart, they should commit to meeting a portion of their energy demands with renewable sources of energy. Regulated electric utilities in Colorado must meet a 30% renewable energy standard by 2020; that is, 30% of their electricity sold in Colorado must be generated by qualifying renewable resources. At a minimum, new water supply projects should meet the same standard; 30% of a water project's energy demands should be met with renewable sources of energy.

Agricultural Perspective

Indirect reuse in the Denver metro area would result in agricultural producers in the lower South Platte Basin using treated return flows for irrigation water. This gives rise to concerns regarding the potential environmental and economic impacts on crop production, public health, and worker safety. Acceptable water quality requirements for various agricultural applications are not well-defined and continue to be the subject of much debate. The primary concerns for irrigated agriculture in treated wastewater return flow are pathogenic organisms, nutrients, salinity, and trace elements. Although wastewater treatment plants must meet state water quality standards, the experience of agricultural users in other states suggests that reuse water can be a viable supply.

Future Reusable Water Supplies

According to the MWSI, the amount of water potentially available for reuse to the Denver area was approximately 133,000 acre-feet per year as of the late 1990s. Based on utilities' plans for development of additional water sources over the succeeding 30 to 50 years, the reusable return flow supply was expected to increase to about 268,000 acre-feet per year (Table 3).

TABLE N° 3 DENVER AREA REUSABLE SUPPLIES AND RETURN FLOWS (ACRE-FEET PER YEAR).*

| Provider† | Reusable Supply (1999) | Future Reusable Supply‡ |
|------------------|------------------------|-------------------------|
| Denver Water | 50,000 | 95,000 |
| Aurora | 26,000 | 38,000 |
| Douglas County | 11,000 | 46,000 |
| Thornton | 5,000 | 24,000 |
| Westminster | 4,000 | 5,000 |
| Arvada | 1,000 | 2,000 |
| Other | 11,000 | 18,000 |
| Subtotal | 108,000 | 228,000 |
| Reusable LIRF's§ | 25,000 | 40,000 |
| TOTAL | 133,000 | 268,000 |

* Data from MWSI.

† Same user groups as Table 2.

‡ Cumulative estimate, includes reasonably certain supplies.

§ Lawn irrigation return flows (LIRF).

Future Plans for Reuse

According to the CWCB’s recent study of IPPs, immediate plans for additional Denver area and northern Front Range reuse total between 20,000 and 28,000 acre-feet.⁴³ According to the MWSI, future plans for reuse in the Denver metro area alone total 171,000 acre-feet per year by 2050. This consists of substitution and exchange agreements as well as some non-potable direct reuse. Adding the metro area WISE Partnership project to Denver Water’s direct reuse (10,000 acre-feet), and substituting the Prairie Waters project for Aurora’s direct reuse (10,000 acre-feet)* — neither of which were envisioned when MWSI was completed — we estimate future reuse at 184,300 acre-feet per year (Table 4). Importantly, this estimate does not include the reuse opportunities available to water utilities north of the Denver metro area, which MWSI estimated to be about 15,000 acre-feet.

TABLE N° 4 SUMMARY OF REUSE PLANS IN THE DENVER METROPOLITAN AREA (ACRE-FEET PER YEAR).*

| Provider(s) † | Substitute (Future) | Direct Reuse (Future) | Total (Future) |
|----------------|---------------------|-----------------------|----------------|
| Denver Water | 42,400 | 25,000‡ | 67,400 |
| Aurora | 8,200 | 10,000‡ | 18,200 |
| Douglas County | 23,500 | 3,500 | 27,000 |
| Thornton | 24,500 | 4,000 | 28,500 |
| Westminster | 4,900 | 1,500 | 6,400 |
| Arvada | 1,900 | 3,300 | 5,200 |
| Other | 28,600 | 3,000 | 31,600 |
| TOTAL | 134,000 | 50,300 | 184,300 |

* Data from MWSI.

† Same user groups as Table 2.

‡ Modified from MWSI estimates, see explanation in text.

* The MWSI estimated Aurora’s future plans for reuse at 7,000 acre-feet. The first phase of the Prairie Waters Project is 10,000 acre-feet, so the actual increase to Aurora’s future reuse plans is 3,000 acre-feet.

Estimate of Front Range Reuse

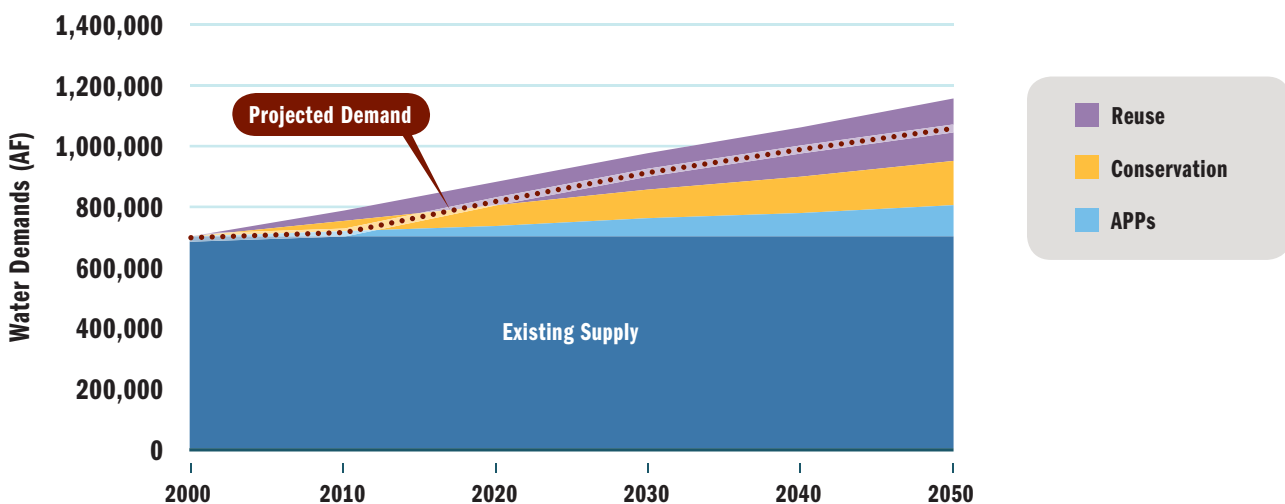
Ultimate levels of reuse could exceed 500,000 acre-feet per year.

Ultimate levels of reuse could potentially exceed 500,000 acre-feet per year, assuming that providers: 1) develop the full amount of reusable supplies currently included in their water supply plans; 2) obtain decrees to reuse all of their legally reusable return flows; 3) reuse to extinction all of their legally reusable supplies via substitution, non-potable reuse, and potable reuse; and 4) have sufficiently large demands for water.

For the purposes of this report, we assume that reuse, direct and indirect, in the Denver metro area will reach 184,300 acre-feet by 2050, and that reuse north of Denver will reach 15,000 acre-feet, for a total of 199,300 acre-feet. This quantity is represented by the reuse wedge in Figure 7.

FIGURE N° 7 ESTIMATE OF FRONT RANGE WATER NEEDS INCLUDING THE ACCEPTABLE PLANNED PROJECTS, CONSERVATION, AND REUSE STRATEGIES.

Existing and future plans for reuse along the Front Range could total 199,300 acre-feet annually by 2050.





A fine catch.