

Review of Alternative Water Sources—Revised

Report Prepared for

SWCA Environmental Consultants



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SRK Consulting (U.S.), Inc.
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Table of Contents

1	Introduction	1
2	Proposed Alternatives: Potable Water Sources	3
2.1	Davidson Canyon Groundwater	4
2.1.1	Description	4
2.1.2	Advantages	4
2.1.3	Limitations	4
2.1.4	Feasibility	5
2.1.5	Summary	5
2.2	Ciénega Creek Groundwater	5
2.2.1	Description	6
2.2.2	Advantages	6
2.2.3	Limitations	6
2.2.4	Feasibility	6
2.2.5	Summary	7
2.3	Sonoita Creek Groundwater	7
2.3.1	Description	7
2.3.2	Advantages	7
2.3.3	Limitations	7
2.3.4	Feasibility	8
2.3.5	Summary	8
2.4	San Pedro River Groundwater	8
2.4.1	Description	8
2.4.2	Advantages	9
2.4.3	Limitations	9
2.4.4	Feasibility	9
2.4.5	Summary	10
2.5	Santa Cruz River Basin Groundwater	10
2.5.1	Description	10
2.5.2	Advantages	11
2.5.3	Limitations	11
2.5.4	Feasibility	12
2.5.5	Summary	12
2.6	Santa Rita Experimental Range Groundwater	13
2.6.1	Description	13
2.6.2	Advantages	13
2.6.3	Limitations	13
2.6.4	Feasibility	14
2.6.5	Summary	14
2.7	CAP Direct Delivery Water	14
2.7.1	Description	14
2.7.2	Advantages	14
2.7.3	Limitations	15
2.7.4	Feasibility	15
2.7.5	Summary	15
2.8	Tohono O’odham Nation Groundwater Direct Delivery	16
2.8.1	Description	16
2.8.2	Advantages	16
2.8.3	Limitations	16
2.8.4	Feasibility	17
2.8.5	Summary	17
2.9	RO Water from the Yuma Desalting Plant	17

2.9.1	Description	17
2.9.2	Advantages	18
2.9.3	Limitations	19
2.9.4	Feasibility	20
2.9.5	Summary	20
3	Proposed Alternatives: Non-potable Water Sources	21
3.1	Wastewater Effluent or Reclaimed Water	21
3.1.1	Description of Wastewater Effluent	21
3.1.2	Description of Reclaimed Water	24
3.1.3	Advantages	24
3.1.4	Limitation	25
3.1.5	Feasibility	25
3.1.6	Summary	25
3.2	Sierrita Mine Sulfate Plume Water	26
3.2.1	Description	26
3.2.2	Advantages	26
3.2.3	Limitations	26
3.2.4	Feasibility	27
3.2.5	Summary	27
3.3	Secretary of Interior Effluent and Managed Recharge Credit Recovery	27
3.3.1	Description	27
3.3.2	Advantages	27
3.3.3	Limitations	27
3.3.4	Feasibility	28
3.3.5	Summary	28
3.4	Deep Aquifer Brackish Water	28
3.4.1	Description	28
3.4.2	Advantages	29
3.4.3	Limitations	29
3.4.4	Feasibility	30
3.4.5	Summary	30
3.5	Sea Water	30
3.5.1	Description	30
3.5.2	Advantages	31
3.5.3	Limitations	31
3.5.4	Summary	32
4	Proposed Alternatives: Localized CAP Recharge and Recovery Water	33
4.1	Pima Mine Road Recharge Project	35
4.1.1	Description	35
4.1.2	Advantages	36
4.1.3	Limitations	36
4.1.4	Feasibility	36
4.1.5	Summary	36
4.2	Lower Santa Cruz and Avra Valley Recharge Projects	36
4.2.1	Description	37
4.2.2	Advantages	37
4.2.3	Disadvantages	37
4.2.4	Feasibility	37
4.2.5	Summary	38
4.3	FICO Groundwater Savings Facility	38
4.4	841 Facility	38
4.4.1	Description	38

4.4.2	Advantages.....	39
4.4.3	Limitations.....	40
4.4.4	Feasibility.....	40
4.4.5	Summary.....	40
4.5	Community Water Company, Future Recharge Project.....	40
4.5.1	Description.....	40
4.5.2	Advantages.....	41
4.5.3	Limitations.....	41
4.5.4	Feasibility.....	42
4.5.5	Summary.....	42
5	Summary and Conclusions.....	43
5.1	Summary.....	43
5.2	Conclusions.....	43
6	References.....	47
7	Acronyms.....	1
8	Qualifications of Key Technical Authors.....	2

List of Tables

Table 2-1	Production Range of the Yuma Desalting Plant.....	19
Table 3-1	Metropolitan Effluent Entitlement.....	22
Table 4-1	Permitted recharge capacity of localized CAP facilities (ac-ft/yr).....	33
Table 4-2	Types of Underground Storage Facilities.....	34
Table 5-1	Summary of Alternative Water Sources.....	44

1 Introduction

The proposed Rosemont Copper Company (Rosemont) operation will require approximately 3,800 gallons per minute (gpm) (6,132 acre-feet per year (ac-ft/yr)) of process water for mining and processing operations (Stantec Consulting, 2009) and approximately 4 gpm of potable water for showers, drinking, and toilets¹. For the life of the facilities, the total requirement is estimated to be 105,000 ac-ft. The Arizona Department of Water Resources (ADWR) has granted Rosemont a Mineral Extraction and Metallurgical Processing Groundwater Withdrawal Permit (ME Permit) to withdraw 6,000 ac-ft/yr from the Santa Cruz River basin, which is located west of the Santa Rita Mountains and west of the proposed mine site. The aquifer is within the Upper Santa Cruz River sub-basin of the Tucson Active Management Area (AMA) groundwater basin (WestLand Resources, 2007).

To offset groundwater pumping from the Upper Santa Cruz River sub-basin, Rosemont is purchasing water from the Central Arizona Project (CAP) and recharging it to the Santa Cruz groundwater basin. The difference in volume between pumped and recharged water will be a positive net gain that enables Rosemont to offset total project pumping by 105 percent (WestLand Resources, 2007).

With a view to reducing or eliminating potential impacts related to groundwater withdrawals from the Upper Santa Cruz sub-basin near the communities of Green Valley and Sahuarita, Arizona, the Coronado National Forest (CNF) identified 19 alternative water sources that alone or jointly might provide sufficient water quantity and quality for the proposed Rosemont operation. The alternative sources identified by the CNF can be divided into three water types on the basis of use:

- Potable Water, 9 potential alternative sources,
- Non-potable Water, 5 potential alternative sources, and
- Localized Central Arizona Project (CAP) Recharge and Recovery Water, 5 potential alternative sources.

This purpose of this report is to provide a brief review of each alternative water source that describes each alternative and summarizes its advantages and limitations, and the feasibility of acquiring and using that potential water. The availability and use of many of the alternatives require a legal opinion, which is not part of the present scope of work. Sections 2, 3, and 4 discuss the 19 alternative water sources. A Summary and Conclusions are provided in Section 5. References are provided in Section 6 and a list of acronyms is provided in Section 7. The qualifications of key authors are summarized in Section 8. All alternatives were evaluated by SRK technical staff under the direct supervision of Corolla K Hoag, R.G., unless stated otherwise.

¹ One acre-foot (ac-ft) equals approximately 325,851 gallons (gals). One acre-foot per year (ac-ft/yr) equals approximately 0.625 gallon per minute (gpm).

All of the areas reviewed in this report have limitations related to potential impacts to the environment, archaeological and historical sites, sensitive areas, viewscape, and so on—owing to the construction of a water delivery system: pipelines and purpose-built pumps for conveying water to the mine site and related infrastructure. All alternatives that include conveying groundwater to the Rosemont mine site will require construction of a reservoir or cistern for storage of the water.

For clarity, the terms *alluvium* and *basin fill* are used interchangeably in this report in their most generic form to include all unconsolidated to semi-consolidated material that will yield water to wells: stream and fan terrace deposits, floodplain alluvium, basin fill deposits, river alluvium, and lake-bed deposits. The term *well field* is used to describe at least one primary well, with at least one backup well in the same general location to provide water to an end user. There may be more than one well field associated with any alternative.

Bedrock underlying the alluvial deposits is not considered in this assessment owing to its low permeability and the unlikely event of locating a source of water with a sufficient yield and volume. Surface water flows (stream flow) also are not considered because surface water in Arizona generally is ephemeral and seasonal, even though there are perennial reaches in some streams.

2 Proposed Alternatives: Potable Water Sources

Rosemont personnel will require potable water for drinking, toilets, and showers. In addition, potable water can be used for industrial processes such as milling. The first five discussions in this section focus on using potable groundwater extracted from river channels. The remaining four discussions in this section consider other sources of groundwater.

Streams in Arizona are mainly ephemeral, severely limiting the use of surface water as a source of water. Nonetheless, owing to how surface water is defined in Arizona² groundwater withdrawn from a river channel may be regulated by the Arizona surface water code enacted by the state legislature on June 12, 1919, now known as the Public Water Code (ADWR, 2010a).

A further consideration is that the areas considered in this section are within the Gila Adjudication—one of the two general Arizona stream adjudications. The purpose of these judicial proceedings is to determine the nature, extent, and priority of water rights across the entire river system. In addition to confirming existing state-based surface water rights, the adjudications will quantify and prioritize reserved water rights for Indian and non-Indian federal lands. The latter classification includes military bases, national parks and monuments, and national forests. The adjudications will also determine which wells are pumping appropriable underground water (subflow) and, therefore, are subject to the jurisdiction of the court. The Gila Adjudication is being conducted in the Superior Court of Arizona in Maricopa County (ADWR, 2010a). The legal standing of taking water from the stream channels discussed below is not considered in this report. The water is considered groundwater for purposes of these discussions, although a legal opinion would be required to ensure that determination.

This section evaluates the areas listed below as potential sources of potable water:

- Davidson Canyon,
- Ciénega Creek,
- Sonoita Creek,
- San Pedro River,
- Santa Cruz River,
- Arizona State Land Department lands adjacent to the Santa Cruz River,
- Other private property adjacent to the Santa Cruz River,
- Santa Rita Experimental Range groundwater,
- Central Arizona Project direct delivery,
- Tohono O’odham Nation groundwater direct delivery, and
- Reverse Osmosis treated water from the Yuma Desalting Plant.

² “Waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwaters, wastewaters, or surplus water, and of lakes, ponds and springs on the surface” (A.R.S. § 45-101) (ADWR, 2010b).

2.1 Davidson Canyon Groundwater

Groundwater in alluvial channel deposits in Davidson Canyon is considered in this section as a source of potable water.

2.1.1 Description

The proposed Rosemont open pit and waste disposal facilities will be located in the upper Davidson Canyon watershed. The distance between a well field in the Davidson Canyon drainage and the Rosemont mine site varies because the canyon is not a point source; rather, it is an elongated feature that trends nearly north from its heading on the eastern slope of the Santa Rita Mountains to its confluence with Ciénega Creek north of U.S. Interstate 10. The distance between source and use areas, therefore, would depend upon the location in the canyon selected to extract groundwater. This analysis assumes an average distance of 6 miles.

Although there are perennial reaches, stream flow in Davidson Canyon is generally ephemeral and seasonal. The Tetra Tech (2010) hydrogeologic study of Davidson Canyon indicates that groundwater recharge is seasonal and varies in the upper and lower portions of the watershed. Groundwater recharge in the Davidson Canyon watershed primarily occurs through recharge of precipitation along the base of the mountain front and within the surface-water drainages (Tetra Tech, 2010). Storm events create runoff that infiltrates to the unconsolidated sediments in the drainage bottoms; this water can saturate the alluvial sediments to recharge the regional groundwater system and can flow laterally and downgradient through the stream channel system. Springs occur in Davidson Canyon where groundwater from deep regional sources or shallow, perched sources discharge at the ground surface. All of the observed seeps and springs in Davidson Canyon had measured flows of less than one gallon per minute (Tetra Tech, 2010).

2.1.2 Advantages

The alluvial aquifers in Davidson Canyon are expected to be unconfined at most locations. The estimated hydraulic conductivities of the alluvium are very high. Storativity is considerably higher than that of the bedrock and is approximately equivalent to specific yield. The quality of water would be suitable for industrial purposes and likely would be suitable for use as potable water, although it would require testing. The treatment options are commonly used technology if treatment is required. The possibility of a relatively short distance between well field and the proposed mine site is an additional advantage to securing water from this location.

2.1.3 Limitations

The groundwater in local, shallow perched alluvial aquifers in Davidson Canyon may not be available on a year-around, sustainable basis owing to natural fluctuations on an annual and seasonal time scale. Two perennial, free-flowing reaches of Davidson Canyon were designated in 2008 by the Arizona Department of Environmental Quality (ADEQ) as an *Outstanding Arizona Water* under

Arizona Administrative Code (A.A.C.) R18-11-112 (Tetra Tech, 2010). The U.S. Geological Survey operated a stream gage in Davidson Canyon Wash 0.2 miles upstream of the Interstate 10 crossing near Vail, Arizona (and about 1,000 feet north of the perennial stretch) between 1968 and 1981. During that period, the channel conveyed stream flow approximately 84 days per year and the flow exceeded one cubic foot per second less than 5 percent of the time (Tetra Tech, 2010); this intermittently flowing section of Davidson Canyon would not provide an adequate water supply on an annual basis. Furthermore, a certificate of in-stream flow rights was granted by ADWR to Pima County Flood Control District in December 1993 (No. 89090.0000). Therefore, the extraction of groundwater from Davidson Canyon is unlikely to be permitted.

Were it permitted and a sustainable supply identified, the use of groundwater from Davidson Canyon would require a water delivery system consisting of well field(s), pumping station(s), a pipeline, and accessory infrastructure. A pipeline could not be buried along its entire length because of the occurrence of crystalline bedrock near the surface. A surface pipeline plus pumping station(s) to raise water to the elevation of the mine site would be a visual impact to visitors to the canyon and would be subject to vandalism. For drinking water supplies, the water quality would require testing to ensure that the U.S. EPA National Primary Drinking Water Standards are met; if it did not, the water would require treatment. Water rights would need to be acquired, as would multiple permits for a well field, pumping stations, and a pipeline. The wells could be impacted during periods of drought with the result that the supply might not be sustainable.

2.1.4 Feasibility

The primary limit on the feasibility for Davidson Canyon alluvium as a source of potable water is obtaining the necessary permits because reaches of the canyon have been designated *Outstanding Arizona Waters*. In addition, Davidson Canyon alluvium is unlikely to be feasible as a continuous, sustainable water supply owing to natural fluctuation on both an annual and seasonal basis.

2.1.5 Summary

The alternative of obtaining water from Davidson Canyon alluvial aquifer is attractive because of the relatively short distance required to transport the water. It is not likely a feasible alternative, however, because portions of Davidson Canyon have been designated an *Outstanding Arizona Water* by ADEQ, which may pose difficulties obtaining water rights, permits from ADWR, and building a water delivery system. Drought could impact the wells and the sustainability of the supply. A pipeline would impact the viewscape.

2.2 Ciénega Creek Groundwater

Groundwater in perched channel deposits in Ciénega Creek is considered in this section as a source of potable water. The recharge mechanisms in Ciénega Creek are similar to those described in Section 2.1.1 for Davidson Canyon.

2.2.1 Description

The distance between the Ciénega Creek drainage and the Rosemont mine site varies because the drainage is not a point source; rather, it is an elongated feature that flows in a northerly direction, principally on the east side of the Empire Mountains. The distance between source and use areas, therefore, would depend upon the location in the drainage selected to extract groundwater. This analysis assumes an average distance of 10 miles. Although some reaches of Ciénega Creek are perennial, the stream flow is generally ephemeral. A large stretch of Ciénega Creek flows through the Las Ciénegas National Conservation Area, which is administered by the U.S. Bureau of Land Management (BLM).

2.2.2 Advantages

Installing well field(s) in a sandy stream bottom of Ciénega Creek likely would produce a limited quantity of potable water. The quality of water, although it would require testing, likely would be suitable for use as potable water. If treatment was required, treatment options would be commonly used technology, such as sparging, filtration, and chlorination.

2.2.3 Limitations

Natural and seasonal variations may limit the availability of sustained well yields except possibly within perennial reaches of Ciénega Creek. If a sustainable supply could be identified and the rights to the water could be purchased, Rosemont would need to install a well field and water conveyance system. A pipeline to transport the water from a well field in the Ciénega Creek drainage would cross private and state lands, and it could not be buried along its entire length because of the occurrence of crystalline bedrock near the surface. A surface pipeline plus pumping stations to raise the water to the elevation of the mine site, would be a visual impact to visitors to the area and would be subject to vandalism. The water quality would require testing to ensure that the U.S. EPA National Primary Drinking Water Standards are met; otherwise, the water would require treatment. Water rights would need to be acquired, as would multiple permits for a well field, pumping stations, and a pipeline. It is likely that the reach of the stream that traverses the Las Ciénegas National Conservation Area would be excluded from access. A further limitation is that in 1997 the Bureau of Land Management (BLM) applied for an in-stream flow right under state of Arizona water laws. The removal of groundwater from Cienega Creek basin could negatively impact this pending water right (BLM, 2010).

2.2.4 Feasibility

The primary limit on the feasibility for Ciénega Creek alluvium as a source of potable water is obtaining the necessary permits. Ciénega Creek alluvium is unlikely to be feasible as a continuous sustainable water supply owing to natural fluctuation on an annual and seasonal basis. Further limiting the feasibility is the impacts due to the required well field and the water delivery system.

2.2.5 Summary

Perennial reaches of the Ciénega Creek drainage could provide a source for potable water for the proposed Rosemont. The volume of water withdrawn from the alluvial aquifer would require acquisition of water rights and permits, and a water delivery system with a pipeline length of at least 10 miles. Drought could impact the wells and the sustainability of the supply. A pipeline would impact the viewscape.

2.3 Sonoita Creek Groundwater

Groundwater from Sonoita Creek is considered in this section as a source of potable water. The occurrence and recharge mechanisms in Sonoita Creek are similar to those described in Section 2.1.1 for Davidson Canyon.

2.3.1 Description

The distance between Sonoita Creek and the Rosemont mine site varies because the drainage is not a point source; rather, it is an elongated feature. The distance between source and use areas, therefore, would depend upon the location along the creek selected to extract groundwater. An average distance can be considered 14 miles south of the proposed Rosemont mine site. Sonoita Creek flows southwest through a narrow valley surrounded by mountains, passing through large sections of Nature Conservancy, state, and private lands. Sonoita Creek is located in the southwestern part of the Ciénega Creek groundwater basin, and is a tributary to the upper Santa Cruz River. Some reaches of Sonoita Creek are perennial, while other reaches are intermittent. The streambed alluvium, composed of unconsolidated silt, sand, and gravel deposits, may be up to 90-feet thick. The creek was dammed in 1968 to form a 265-acre reservoir that is surrounded by Patagonia Lake State Park.

2.3.2 Advantages

Some reaches of Sonoita Creek are perennial, while other reaches are intermittent. Installing a well field in a sandy stream bottom along Sonoita Creek would likely produce the required quantity of potable water if a sustainable source could be located, sufficient yield could be maintained, and the water rights could be acquired. The quality of water, although it would require testing, likely would be suitable for use as potable water. If treatment were required, the treatment options are commonly used technology.

2.3.3 Limitations

A pipeline to transport the potable water from a well field along Sonoita Creek may cross private, state and federal land, and it could not be buried along its entire length because of the occurrence of crystalline bedrock near the surface. A surface pipeline plus pumping station(s) to raise the water to the elevation of the mine site would be a visual impact to visitors to the area and would be subject to vandalism. The water quality would require testing to ensure that the U.S. EPA water quality

standards are met; otherwise, the water will require treatment. Water rights would need to be acquired, as would multiple permits for a well field, pumping station(s), and a pipeline. The wells could be impacted during periods of drought with the result that the supply may not be sustainable.

2.3.4 Feasibility

The primary limit on the feasibility on the use of Sonoita Creek alluvium as a source of potable water is obtaining the necessary permits. Sonoita Creek alluvium is unlikely to be feasible as a continuous sustainable water supply owing to natural fluctuation on an annual and seasonal basis. Further limiting the feasibility is the required well field and the surface conveyance pipeline.

2.3.5 Summary

Selected reaches of Sonoita Creek could provide a source for potable water for the proposed Rosemont. The volume of water withdrawn from Sonoita Creek alluvium would require acquisition of water rights and permits and a water delivery system with a pipeline an estimated length of 14 miles. Drought could impact the wells and the sustainability of the supply. A pipeline would impact the viewscape.

2.4 San Pedro River Groundwater

Groundwater from basin-fill formations along the San Pedro River is considered in this section as a source of potable water.

2.4.1 Description

The San Pedro River flows north for nearly 175 miles, from near Cananea, Mexico to its confluence with the Gila River in Maricopa County, Arizona. It has been divided into two hydrologic units: the Upper San Pedro Basin (nearly 100 mile of river from Cananea, Mexico north to The Narrows) and the Lower San Pedro Basin (about 76 mile of river from The Narrows north to the Gila River). Nearly half of the river is perennial. Data from June 2009 revealed that 45 percent of the 150 river miles mapped that year had flowing surface water (The Nature Conservancy, Center for Science and Public Policy, 2011).

Most of the upper San Pedro River, from the international border to the town of St. David (a 40-mile reach encompassing nearly 57,000 acres of public land in Cochise County), is within land designated as the San Pedro Riparian National Conservation Area (SPRNCA), which is administered by the BLM. The primary purpose for the special designation is to protect and enhance the desert riparian ecosystem, one of the most important, intact riparian areas in the United States. This process resulted in the prohibition of groundwater pumping, off-road vehicle use, and mineral development, and a moratorium on cattle grazing within the SPRNCA, as well as the retirement of thousands of acres of agricultural land that were formerly used for irrigation.

The proposed Rosemont mine site is west of the Upper San Pedro River Basin although it is outside the boundaries of the San Pedro River watershed. The distance between the Upper San Pedro River and Rosemont varies because the river is not a point source, rather it is an elongated feature that flows generally south to north. The distance between source and use areas, therefore, would depend upon the location along the river selected to extract groundwater. This analysis uses a conservative straight-line distance of 30 miles. Routing around intervening mountains and basins would likely double the distance.

Groundwater would be derived by installing a well field in unconsolidated or loosely consolidated basin-fill formations. Purchasing water from existing groundwater wells would be subject to any pre-existing legal requirements by ADWR based on quantity and intended use of the water.

2.4.2 Advantages

Installing a well field in basin-fill formations along the San Pedro River would likely produce the required volume of potable water and yield, if yields are similar to those measured in the Lower San Pedro River Basin. The quality of water likely would be suitable for use as potable water, although it would require testing. If treatment were required, treatment options are a commonly used technology.

2.4.3 Limitations

The principal limitation is that “The BLM asserts a Federal Reserve In-Stream Flow Water Right to the flows of the San Pedro River under Public Law 100-696, November 18, 1988 [Riparian National Conservation Area designation]. Removing groundwater from the Upper San Pedro Basin would likely negatively impact this water right.” (BLM, 2010).

Additional limitations are that pipeline to transport potable water from a well field along the San Pedro River would cross private, state, and CNF lands, and it could not be buried its entire length because of crystalline bedrock near the surface along much of the route. A surface pipeline plus pumping stations to raise the water to the elevation of the mine site would be a visual impact to visitors to the area and would be subject to vandalism. The water quality would require testing to ensure that the U.S. EPA water quality standards are met; otherwise, the water would require treatment. Water rights would need to be acquired, as would permits for a well field, pumping stations, and a pipeline. The wells could be impacted during periods of drought with the result that the supply may not be sustainable.

2.4.4 Feasibility

Assertions by the BLM to a Federal Reserve In-Stream Flow Water Right to the flows of the San Pedro River would make this alternative infeasible. Further limits on the feasibility for extracting groundwater from basin fill of the Upper San Pedro River, for use as a source of potable water, are existing water rights associated with the SPRNCA designation of the river corridor; the requirement

to sustain the local desert riparian ecosystem, which might be impacted by groundwater withdrawal; and the inferred difficulty in obtaining the necessary permits. In addition, without substantial testing it may not be possible to maintain a continuous, sustainable water supply owing to natural fluctuation on an annual and seasonal basis

2.4.5 Summary

The San Pedro River could provide a source for potable water for the proposed Rosemont mine; however, use of the water would require acquisition of water rights and groundwater withdrawal permits, and a water distribution system with a pipeline conservatively estimated to be 32 miles in length. Drought could impact the wells and the sustainability of the supply. A water-delivery system would impact the viewscape.

2.5 Santa Cruz River Basin Groundwater

Rosemont has acquired a 53-acre parcel along Santa Rita Road northwest of the Santa Rita Experimental Range within the Upper Santa Cruz sub-basin of the Tucson AMA groundwater basin. Rosemont also has secured a Mineral Extraction and Metallurgical Processing groundwater withdrawal permit (ME permit) to withdraw 6,000 ac-ft/yr from the Tucson AMA. The permit was issued by ADWR pursuant to A.R.S. Section 45-514. Groundwater extracted pursuant to an ME permit may be transported away from an active management area, such as the Tucson AMA, to another basin such as the Ciénega Basin, in accordance with A.R.S. Section 45-543.

In view of perceived impacts from extracting groundwater in the area near Sahuarita for use at the Rosemont mine site, this section of the report considers the general availability of groundwater from alternative areas of the Santa Cruz River groundwater basin, for use as an alternative source by Rosemont. Both private and Arizona State Land Department lands are included in this section.

2.5.1 Description

The Santa Cruz River Basin consists of approximately 21,250 km² in southern Arizona and 1,035 km² in Mexico (USACE, 2005). The Santa Cruz River basin is characterized by a wide valley broken by several broad, low hills and mountains. The basin area has a maximum length of approximately 175 miles and is about 80 miles wide at its widest point.

The Santa Cruz River is a tributary to the Gila River, which in turn is a tributary to the Colorado River. Groundwater enters the basin along the Santa Cruz River west of Nogales, flowing generally from south to north. Stream gradients in the basin range from about 29 feet per mile near Lochiel, to 18.5 feet per mile at Tucson, to 8 feet per mile at the Gila River confluence (USACE, 2005). Natural groundwater recharge occurs from infiltration of Santa Cruz River channel flow and mountain front recharge. The depth to bedrock in the center of the Upper Santa Cruz sub-basin exceeds 11,000 feet. The basin sediments make up multiple hydrologic units (typically three to five) with differing hydraulic properties.

The Santa Cruz River and principle tributaries are mostly ephemeral, being dry for long periods of time. Flows in the river are a result of direct or upstream precipitation or poor-quality irrigation drainage water in the basin. For a short distance downstream of Tucson, the river conveys a perennial flow of sewage effluent from a sewage treatment plant.

From the headwaters to the confluence with Los Robles Wash, the Santa Cruz River is a gaining river, meaning discharge generally increases with drainage area. Downstream from the confluence with the Gila River, the flood plain flattens and broadens out and becomes a losing river. In this reach flood flows are dramatically attenuated such that discharge decreases with an increase in drainage area. Flows originating in the upper reaches of the Santa Cruz River rarely reach the Gila River; when they do reach the Gila River, they are usually augmented by tributary flows originating in the lower part of the basin.

The distance between the Santa Cruz River Basin and Rosemont varies because the basin is a broad elongated feature, and therefore, would depend upon the location within the basin selected to extract groundwater. A straight-line distance between the center of the basin due west of Rosemont, across the Santa Rita Mountains to the proposed Rosemont mine site is approximately 7 miles. Going around the Santa Rita Mountains and developing a well field at other locations within the basin would be at a substantially greater distances. Groundwater would be derived by installing a well field or purchasing water from an existing user with groundwater rights. The use of groundwater would be subject to any pre-existing legal requirements by ADWR that would be based on quantity and intended use of the water.

The Arizona State Land Department (ASLD) holds 37.8 percent of the land in the Tucson Active Management Area in trust for public schools and other beneficiaries under the State Trust Land system. The department is required by the Arizona constitution to manage those lands to maximize benefits to state land trust beneficiaries. Within the Tucson AMA, the primary use is grazing (ADWR, 2010b). ASLD works with entities when developing land-use plans for the land it controls, evaluates proposals for the use of the land on the basis of those plans, and depends on local entities to implement them.

2.5.2 Advantages

Installing a well field in private or ASLD lands along the Santa Cruz River or purchasing water from an owner with existing water rights would likely provide the required volume and a sustainable yield of potable water. The quality of water would require testing because of effluent disposal in the river channel; if water treatment were required, treatment options are a commonly used technology.

2.5.3 Limitations

Rosemont would need to acquire land and possibly water rights either from others or the ASLD, apply for an ME Permit, and apply for the required permits for a well field and the water delivery

system. Rosemont would be required to prepare a plan for developing groundwater beneath ASLD land and secure ASLD plan approval.

Aquifer testing would be required to demonstrate a sustainable yield, although prolonged drought could impact the wells. Also, the water quality would require testing and likely would require treatment to ensure that the U.S. EPA National Primary Drinking Water Standards are met. Twenty-six groundwater contamination sites have been identified in the Tucson AMA. Volatile organic compounds associated with industrial and transportation activities are common at the contamination sites. In addition, elevated concentrations of certain naturally occurring constituents, including arsenic, fluoride and metals have been measured in wells. Elevated nitrate, sulfate and total dissolved solid concentrations have been detected in wells near mining and agricultural operations (ADWR, 2010b). Irrigation drainage to the river also contributes pollutants. The towns of Nogales and Tucson, Arizona and Sonora, Mexico discharge wastewater effluent to the river. This effluent recharges to the regional groundwater sources and locally affects water quality. Further, in 2009 the Tucson Water Department Water detected the trace organic contaminant, perfluorooctane sulfonate (PFOS) in several groundwater production wells. The origin of PFOS contamination in Tucson Basin groundwater is unknown although evidence suggests that municipal wastewater effluent that recharges the local aquifer via the Santa Cruz River is an important source. PFOS, the key ingredient in Scotchgard™ until 2003, is an anthropogenic perfluorinated chemical that is very persistent and a suspected human carcinogen.

A water delivery system with a pipeline of indeterminate length would be required to move the water from a site within the Santa Cruz River basin to the mine site. The pipeline could not be buried along its entire length because of the occurrence of crystalline bedrock near the surface in many areas. Above-ground reaches of the pipeline plus pumping stations to move and lift the water to the elevation of the mine site would be a visual impact and would be subject to vandalism. The waterline would cross private, state, and federal lands.

2.5.4 Feasibility

The primary limits on the feasibility of extracting groundwater from the Santa Cruz River basin fill are demonstrating a sustainable yield and obtaining the necessary water rights and permits. In addition, significant water treatment would be required to provide potable water. Further limiting the feasibility would be the required well field and a water-delivery system that would impact the viewscape.

2.5.5 Summary

Obtaining potable water from the Santa Cruz River basin is possible because it is likely that wells can be installed within the floodplain to provide a source of water. The cities of Nogales, Sonora and Tucson, Arizona discharge wastewater effluent to the Santa Cruz River. Therefore, treatment would be necessary to ensure that the quality meets acceptable standards. It would be necessary to obtain

water rights and permits from ADWR, and to build a water delivery system. Drought could impact the wells and the sustainability of the supply. A water delivery system with aboveground pipeline and pumping stations would impact the viewscape.

2.6 Santa Rita Experimental Range Groundwater

Groundwater from basin-fill formations and alluvial fan deposits beneath the Santa Rita Experimental Range facility is considered in this section as a source of potable water. Locations to the north and south of the facility are the main focus of this evaluation because of the reduced concentrations of groundwater users.

2.6.1 Description

The Santa Rita Experimental Range (SRER) consists of 53,159 acres approximately 35 miles south of Tucson and 13 miles east of Green Valley by road, at the foot of the northwest edge of the Santa Rita Mountains. SRER was established to protect the native rangeland from grazing, to conduct research on problems associated with livestock production and rangeland management, and to research ways to improve and manage the semiarid grasslands in the Southwest. SRER is the oldest research area, maintained by the U.S. Forest Service from 1903 until 1987, when administration of the site was taken over by the University of Arizona, College of Agriculture. Today it is regarded as a “laboratory to study southwestern agricultural sustainability for 100 scientists” (UANews, 2010).

2.6.2 Advantages

The SRER is a very large research facility that is likely to be underlain by adequate reserves and quality of groundwater to provide potable water to the mine site. By dead reckoning, an approximate center point of SRER is 7 miles west of the proposed Rosemont mine site, although the two sites are on opposite sides of the Santa Rita Mountains. The distance between a source of groundwater and mine site would depend upon the location of a well field. Sites at the north and south ends of the facility would be farther from the Rosemont mine site.

2.6.3 Limitations

Extracting groundwater does not appear to be a typical goal of SRER, which promotes itself as an outdoor laboratory to study rangeland and related disciplines. Given these goals, it seems unlikely that the University of Arizona would permit groundwater extracting at SRER. Provided an agreement could be negotiated with the University of Arizona to extract groundwater, aquifer testing would be required to demonstrate that well yields are sufficient to maintain a continuous sustainable water supply that would not be impacted by natural annual and seasonal fluctuations or by prolonged drought.

Although SRER and the mine site are approximately 7 miles apart by dead reckoning, a water delivery system of at least 25–30 miles would be required to move water from the SRER source to

the mine site because of the intervening Santa Rita Mountains. The waterline would cross private, state, and CNF lands. The exact length of a pipeline would depend upon the location of a well field. The pipeline could not be buried along its entire length because of the occurrence of crystalline bedrock near the surface in many areas. Above-ground reaches of the pipeline plus pumping stations to move and lift the water to the elevation of the mine site would be a visual impact and the pipeline would be subject to vandalism.

Water rights would need to be secured from the University of Arizona, and permits would be required from ADWR. Drought could impact the wells and the sustainability of the supply.

2.6.4 Feasibility

Using the Santa Rita Experimental Range for a source of potable water is not feasible owing to the purpose and goals of the SRER facility. Negotiating an agreement with the University of Arizona for extracting groundwater would be the principal limitation, as would obtaining the necessary permits from ADWR. Water treatment likely would not be required to provide potable water, were it possible to secure a contract with the university. Further limiting the feasibility of this alternative source of water is the required well field and the surface conveyance pipeline that would impact the viewscape.

2.6.5 Summary

The SRER covers a very large area, with a center-point distance of 7 miles from the proposed mine site, by dead reckoning. An adequate volume and quantity of water likely exists beneath SRER, but the use of this groundwater may not be in line with the purpose and goals of the SRER facility. A water delivery system would be required, and water rights and permits would be required. An aboveground pipeline would impact the viewscape.

2.7 CAP Direct Delivery Water

CAP direct delivery water is considered in this section as a source of potable water.

2.7.1 Description

CAP direct delivery, as the name implies, is the direct delivery of CAP water to an end user. Direct delivery is in contradistinction to recharge/recovery or replenishment uses of CAP water. The Water Consumer Protection Act, a local voter initiative passed in 1995, prohibits the direct delivery of CAP water to homes in Tucson, requiring instead that it be recharged to an aquifer. Other CAP customers, however, are able to deliver CAP water directly to their end users.

2.7.2 Advantages

Long-term CAP contract entitlements in 2008 totalled 1.415 million ac-ft, although the CAP system was capable of delivering 1.8 million ac-ft annually at that time. Thus, in 2008 CAP had excess

capacity that could have been available to Rosemont. Direct delivery of CAP water to the Rosemont mine site would offset the withdrawal of the groundwater.

2.7.3 Limitations

Rosemont is not an operational mine so it cannot use direct delivery CAP water at this time. Limitations to the future use of direct delivery CAP water to offset withdrawal of groundwater are: drought and/or declining flows in the Colorado River that could impact Rosemont's contract for year-to-year CAP excess water in order to accommodate higher priority CAP water users; problems created by short-term, planned CAP delivery system outages; and the possibility of a system failure.

Direct delivery of CAP water would require construction of a treatment plant and a water delivery system. The pipeline would cross private, state, and CNF lands. The exact length of a pipeline would depend upon the pipeline route. The pipeline could not be buried along its entire length because of the occurrence of crystalline bedrock near the surface in many areas. Above-ground reaches of the pipeline plus pumping stations to move and lift the water to the elevation of the mine site would be a visual impact and the pipeline would be subject to vandalism. Direct delivery would require a cistern or reservoir for above-ground water storage and a backup water supply in the event of a system failure, short-term outages, and changes in CAP delivery priorities.

Another limitation is that mines in Arizona are not required to use CAP water. Instead, they are subject to strict water conservation requirements (Tucson Water, 2011³).

2.7.4 Feasibility

There was excess capacity of CAP direct delivery water in 2008, which could have provided to Rosemont for a potable water supply. However, the following possible circumstances make it infeasible to rely on this source: drought and reduced flows in the Colorado River, future demands on CAP water that could limit the availability of water to downstream users, and the possibility of CAWCD changing delivery priorities. Further limiting the feasibility is the required surface conveyance pipeline with attendant infrastructure, and damage to the viewscape created by the pipeline and pumping stations.

2.7.5 Summary

The alternative of obtaining CAP direct delivery water to offset groundwater pumping is not feasible unless Rosemont could acquire a guaranteed CAP allocation of M&I water for the life of the mine. In addition, direct delivery of CAP water would require a cistern or construction of a reservoir for water storage, a treatment plant, and a pipeline and water delivery system.

³ Tucson Water web site, 5/11/2011, http://cms3.tucsonaz.gov/water/water_law

2.8 Tohono O’odham Nation Groundwater Direct Delivery

The Tohono O’odham Nation has groundwater resources, in addition to CAP allocations. This alternative evaluates the use of Nation groundwater at the Rosemont mine site.

2.8.1 Description

The Tohono O’odham Nation (Nation) is situated west of the proposed Rosemont mine site, with the Buenos Aires National Wildlife Refuge, Santa Cruz River sub-basin, and Santa Rita Mountains intervening. Its four non-contiguous segments of the reservation total more than 2.8 million acres, comparable in size to the state of Connecticut. Because of its size, the distance between Nation lands and the Rosemont mine site varies considerably. The straight-line distance between the Nation’s capital, Sells, Arizona, and the mine site is 67 miles. This analysis reviews the potential for obtaining potable water from the San Xavier District, which is an average distance of 25 miles from the mine site. This alternative would extract groundwater from basin-fill formations using an existing groundwater well field or developing a new well field.

2.8.2 Advantages

With testing, a source of groundwater with adequate volume and yield might be located within the San Xavier District and a well field installed. It is not likely that the groundwater would require treatment, but common technologies are available if treatment is required.

2.8.3 Limitations

As a hedge against drought the San Xavier District uses or will begin to use CAP water for in-channel, groundwater recharge. The District and the BLM believe that replenishment of the aquifer with CAP water will ensure the reliability of the water supply available to the San Xavier Cooperative Farm during short-term, planned CAP delivery system outages. From that plan it might be inferred that an adequate supply of groundwater for District use is questionable. There is not a major drainage in the San Xavier District and, therefore, it may be problematic to locate a continuous sustainable water supply.

Another limitation would be the unlikely possibility of securing a sustainable source of water in times of drought. Water would need to be available in excess of that required by the District for residential, stock and agricultural uses, and water rights would need to be acquired from the Nation to secure that water on a long-term basis. It is possible other governmental entities may be involved in such negotiations.

Water treatment may be required to provide potable water and a well field would be needed to once a suitable source was identified. A water delivery system (pumping stations to move the water and raise it to the elevation of the mine site, a pipeline, and other infrastructure) would need to be built. A pipeline to transport the water from the San Xavier District to the Rosemont mine site could not be

buried along its entire length in areas where crystalline bedrock is near the surface. The waterline would cross private, state, Nation, and CNF lands. The above-ground segments of a pipeline and pumping stations would be a visual impact and subject to vandalism. The water quality would require testing to ensure that it meets the U.S. EPA National Primary Drinking Water standards; otherwise, the water would require treatment. The wells could be impacted during periods of drought.

2.8.4 Feasibility

The feasibility of acquiring a source of potable water from the San Xavier District of the Tohono O’odham Nation appears unlikely given the possibility that there is an insufficient volume of groundwater for the Nation’s own use.

2.8.5 Summary

The alternative of obtaining potable water from a Tohono O’odham Nation groundwater source likely would require purchasing groundwater from the Nation from an existing well field. It is probable that a potable water source could be identified and wells could be installed to provide potable water; it is further likely that the water quality would be acceptable or the water could be treated to acceptable standards. The wells would require a Tohono O’odham Nation contract, and the location would be subject to approval by the Nation. The transport distance could be on the order of 25 miles and would involve a water delivery system.

2.9 RO Water from the Yuma Desalting Plant

Reverse osmosis (RO) water from the Yuma Desalting Plant is evaluated in this section as a source of potable water.

2.9.1 Description

Yuma is approximately 235 miles southwest of the proposed Rosemont. The Yuma Desalting Plant (YDP) was constructed by the Bureau of Reclamation (USBR) under authority of the Colorado River Basin Salinity Control Act of 1974. Construction of the plant was completed in December 1991. As constructed, the plant has a capacity of 72.4 million gallons per day (mgd) (Yuma Desalting Plant/Ciénega de Santa Clara Workgroup, 2005). Prior to May 2010, the YDP had been operated on two only occasions: for 6 months in 1992–1993 at one-third capacity and for a 90-day Demonstration Run in 2007 at 10 percent capacity.⁴

The plant was built to treat agricultural drainage from the Wellton-Mohawk Irrigation & Drainage District (WMIDD), which averages more than 100,000 ac-ft/yr, because the saline drainage water would have raised the salinity of the Colorado River to an unacceptable level for delivery to

⁴ The YDP was constructed as three units and therefore can be run at 1/3, 2/3, or full capacity.

Mexico.⁵ Due to surplus, and then normal water-supply conditions in the Colorado River basin over the years, however, the untreated drainage water was bypassed around the Mexican diversion at Morelos Dam and allowed to flow into and create the Ciénega de Santa Clara, a wetlands in Mexico.

In 2009, as a result of recent drought and 50 percent depletion of storage in the two primary reservoirs, Lake Mead and Lake Powell, the USBR developed a plan for a pilot run of the plant to gather cost and performance data. The pilot program started on May 3, 2010 and in March 2011 USBR officials said the desalting plant operated continuously for the year without any substantial problems or down time, demonstrating the potential to augment Lower Colorado River supplies. The purpose of the pilot run was to operate the plant at one-third capacity for a period of one year to collect performance and cost data needed to consider potential future operation of the plant. The program was funded by the USBR, in collaboration with The Metropolitan Water District of Southern California, Central Arizona Water Conservation District and Southern Nevada Water Authority. At the conclusion of the pilot test the Yuma Sun (2011) reported, “Now the Yuma Desalting Plant will be mothballed once again while the results of the test are evaluated and options are considered for its use.”

The USBR (2011) reported, “The YDP recycled about 30,000 acre-feet of irrigation return flow water which was included in Colorado River water deliveries to Mexico. This resulted in the same amount of water conserved in Lake Mead and available to the sponsoring water agencies when needed in the future.” Before the pilot run started, an international agreement was reached with Mexico that provided additional water to the Ciénega de Santa Clara wetlands during the year-long program⁶.

2.9.2 Advantages

Treating water by RO is well-known and readily available technology. It is one of the most effective methods of not only removing salt ions, but bacteria and viruses as well. The plant capacity is sufficient to provide potable-water for the proposed Rosemont mine. The YDP recently underwent a pilot run. It produced more desalinated water from agricultural runoff than the 70 percent expected, and it concluded ahead of schedule and under budget.

Since the YDP is a process plant, the quantity and salinity of the product water and reject stream can be made to vary over a broad range. Table 2-1 illustrates some of the production ranges of the YDP.

⁵ Per treaty obligation, the United States is to ensure delivery of 1,500,000 ac-ft of water each year.

⁶ In what was to have been a temporary solution to the water-surplus problem, the 100,000 ac-ft/yr of water that flowed into the Ciénega de Santa Clara did not figure into the Mexican Colorado River allocation during those years (AWR, 2003).

Table 2-1 Production Range of the Yuma Desalting Plant

	YDP not operating	One third capacity operation	Two thirds capacity operation	Full capacity operation
Product water exiting the YDP				
Quantity (ac-ft)		23,438	42,392	64,598
Salinity (ppm)		122	148	160
Reject stream from the YDP				
Quantity (ac-ft)		8,669	15,679	23,892
Salinity (ppm)		7,818	7,747	7,715
Water sent to the Colorado River				
Quantity (ac-ft)		26,868	48,408	74,557
Salinity (ppm)		451	465	499
Flow to the Cienega at the International border				
Quantity (ac-ft)	109,100	82,232	60,692	35,543
Salinity (ppm)	2,820	3,347	4,093	6,206

Source: Annual flows from 2004 (Yuma Desalting Plant/Ciénega de Santa Clara Workgroup, 2005)

2.9.3 Limitations

Traditionally RO plants are used to produce potable water. The YDP is not authorized or equipped for this use. Instead the YDP is authorized and equipped to desalinate a portion of the bypass flow from the WMIDD to meet treaty obligations for delivery of Colorado River water to Mexico.

The YDP has been operated two times since its completion in 1991, for testing purposes only. Although maintained during the intervening years, the cost and operability of the YDP were tested in a year-long pilot program and the test results are now being evaluated. If the plant is made operational on a continuous basis, there appear to be multiple options for disposition of the treated water. The most obvious ones are:

- Discharged into the Colorado River for inclusion in treaty deliveries to Mexico;
- Combined with untreated irrigation drainage water and the total amount discharged into the Colorado River for inclusion in treaty deliveries to Mexico; and
- Purchased by the Arizona, California, and Nevada water authorities that cooperated in the USBR pilot test (and others), through contracts secured with the USBR.

As a source of potable water for the proposed Rosemont mine, the purpose of the desalting plant would need to be revised and the plant would need to become operational on a routine and continuous basis. Transport of treated, potable water to the proposed Rosemont mine site would require a 235-mile waterline (or utilizing an existing pipeline where present). The waterline would cross private, state, and CNF lands. Above-ground sections of the pipeline would be a visual impact

and subject to vandalism. Rosemont would be required to negotiate a water contract with the USBR, which manages the plant, as well as to secure multiple permits and rights-of-way for construction of pumping stations, a pipeline, and accessory infrastructure.

2.9.4 Feasibility

Utilizing the Yuma Desalting Plant is not a feasible alternative. The principal limitation is that the YPD is approximately 235 miles from the proposed Rosemont mine site. Other limitations that render the alternative infeasible are that larger state and municipal water authorities might have superior entitlement to available water supplies, and draught and reduced flows in the Colorado River might cause reallocation of water supplies.

2.9.5 Summary

RO is a readily available technology for desalting water. However, treated water from the YDP is not yet readily available because the plant is not fully operational. Should the plant be operated at full capacity, and should the purpose of treating saline water be redefined, the water required by the Rosemont mine would need to be purchased from the USBR and transported from Yuma to the mine site, an approximate distance of 235 miles.

3 Proposed Alternatives: Non-potable Water Sources

This section of this report evaluates proposed alternative sources of non-potable water. Rosemont will require approximately 5,000 ac-ft/yr of process water (WestLand Resources, 2007). The non-potable alternatives considered in this section are local community wastewater effluent and Tucson reclaimed water; Sierrita Mine sulfate plume water; Department of Interior effluent and managed recharge credit recovery; deep aquifer brackish water; and sea water.

3.1 Wastewater Effluent or Reclaimed Water

This section evaluates the alternative of using wastewater effluent from the municipalities of Green Valley, Nogales, and Tucson or reclaimed water from the City of Tucson in lieu of pumping groundwater for use at the proposed Rosemont mine. Tucson and Green Valley are in the Tucson AMA and Nogales is in Santa Cruz AMA. The Rosemont mine is situated only partly within the Tucson AMA (WestLand Resources, 2007).

The alternatives in this section are described separately. The advantages and limitations are described jointly because the advantages and limitations are similar for each. The information used to prepare this section was compiled from public documents and data, a telephone conversation and email with Ms. Karen Dotson⁷, and the observations of SRK technical staff at various domestic and foreign mining operations.

3.1.1 Description of Wastewater Effluent

Two types of water may be discharged by a wastewater treatment plant: effluent and reclaimed water. Both are non-potable. Effluent is wastewater that has been treated to minimum standards that enable discharge to the environment, per the Arizona Pollutant Discharge Elimination System.

Pima County owns and operates the wastewater system for most of Pima County. A total of 72,588 ac-ft of effluent was produced in eastern Pima County in 2007, of which 68,299 ac-ft (94 percent) were produced in the metropolitan area (City of Tucson and Pima County, 2009a). Table 4.1 shows how 2007 effluent was distributed among the metropolitan entities having effluent entitlements.

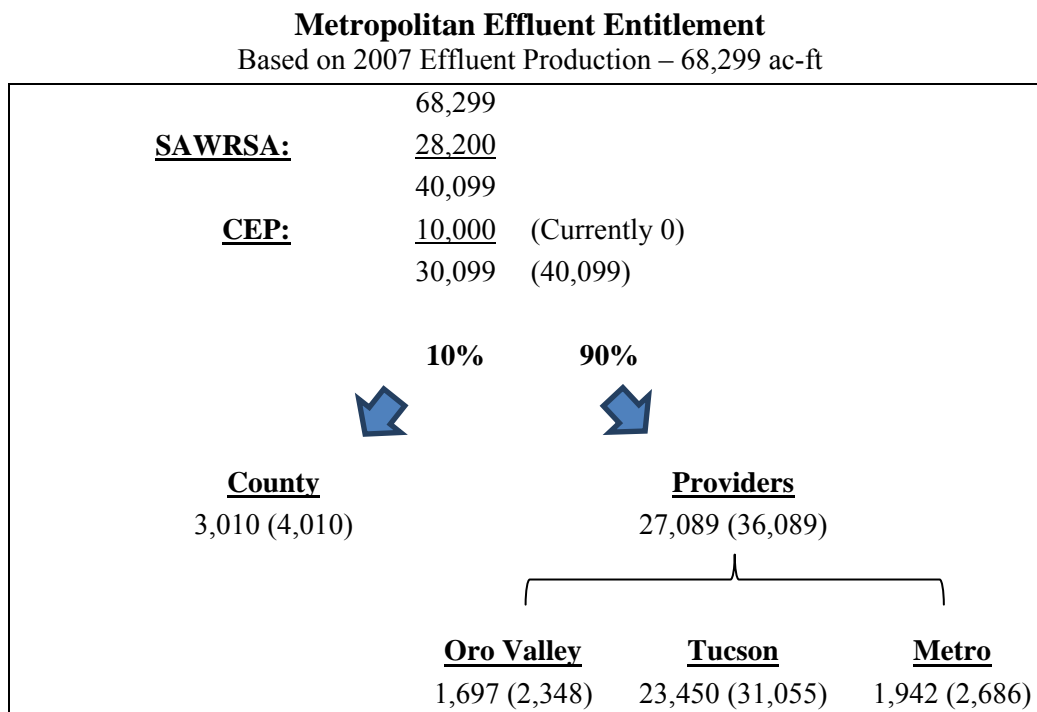
The community currently has the following three major methods of effluent utilization/disposal (City of Tucson and Pima County, 2009a):

- Use in the City of Tucson reclaimed water system,

⁷ Ms. Dotson is the Tucson Water Backflow Prevention/Reclaimed Water Program Coordinator. The conversation and email exchange occurred with C. Stone, R.G. (SRK) on October 14, 2010.

- Discharge to the Santa Cruz River, and
- Recharge in constructed facilities, the Santa Cruz River, and at the various outlying wastewater facilities.

Table 3-1 Metropolitan Effluent Entitlement



Source: City of Tucson and Pima County, 2009a. The values shown in parentheses are the entitlements in 2007.

Values are in ac-ft

SAWRSA = Southern Arizona Water Rights Settlement Act

CEP=Conservation Effluent Pool

Green Valley Wastewater Effluent

The Green Valley Wastewater Treatment Plant (WWTP) is located south of Tucson, on the east side of the Santa Cruz River, within the Tucson AMA. It is owned and operated by Pima County. The Green Valley WWTP service area extends along both sides of Interstate 19. The facility primarily serves the retirement community of Green Valley and a small southern part of the Town of Sahuarita, both on the west of the Santa Cruz River, but it also serves some properties east of the river. Land use in the service area is primarily residential and commercial. The estimated service-area population in 2005 was 17,469 (PAG, 2006).

The Green Valley WWTP has a design capacity of 4.1 million gallon per day (mgd) (4,600 ac-ft/yr), with two treatment trains. The older, aerated lagoon system is a 2.1 mgd (2,3500 ac-ft/yr) treatment process that produces Class B effluent. The newer, Biological Nutrient Removal Oxidation Ditch is a 2.0 mgd (2,250 ac-ft/yr) treatment process that produces Class A+ effluent. Effluent is delivered to

the Robson Quail Creek recharge basins, disposed of via percolation, and reused on site (PAG, 2006).

Nogales Wastewater Effluent

The Nogales International Wastewater Treatment Plant (NIWWTP) is located on the east side of Highway 19, south of Green Valley and north of the community of Rio Rico. It is the primary treatment facility in the Santa Cruz AMA. The facility has an average monthly flow of 17 mgd (19,100 ac-ft/yr) (ADEQ, 2009), which comes from Rio Rico, Arizona; Nogales, Arizona; and Nogales, Sonora, Mexico. Several smaller package treatment plants provide treatment to developments within the Santa Cruz AMA, but with the exception of the Tubac Golf Resort, do not provide reused effluent (reclaimed water).

The USBR (2010) reported that treated effluent generated by the NIWWTP is a major source of water in the watershed. Effluent is discharged to the Santa Cruz River, however, because the shallow depth to bedrock and too few surface reservoirs make water storage in the watershed problematic. The Nogales Area Water Storage study is being conducted by the USBR, ADWR, and the City of Nogales to address these issues.

Tucson Wastewater Effluent

Tucson Water has three sources of water physically available for their use, one of which is effluent. The situation was described as follows (Tucson Water, 2008):

“In 2006, 69,067 ac-ft of effluent were produced from the metropolitan wastewater treatment plants in the Tucson area. ...the City of Tucson had entitlement to a total of 31,536 ac-ft (46 percent) of this effluent. Of this total, 11,983 ac-ft were reused as reclaimed water within the Tucson Water service area while the remainder (19,553 ac-ft) was discharged to the Santa Cruz River. In contrast, all of the effluent annually entitled to the Secretary of the Interior (28,200 ac-ft/yr) was discharged to the river and constitutes the majority of the perennial effluent flow observed in the Santa Cruz River.”

A fact sheet prepared by Tucson Water (2010) provides the following information on ownership of 2009 effluent in the Tucson Water service area, which totalled 66,411 ac-ft.

- City of Tucson 29,570 ac-ft
- Pima County 3,821 ac-ft
- Secretary of Interior (USBR) 28,200 ac-ft
- Oro Valley 2,242 ac-ft
- Metro Water 2,578 ac-ft

Updated projections of wastewater generation through 2030 indicate that annual effluent availability within the Long-Range Planning Area could approach 118,900 ac-ft/yr by 2030, and that the City of Tucson would have annual entitlement to approximately 61,000 ac-ft/yr by 2030 (Tucson Water, 2008).

3.1.2 Description of Reclaimed Water

Reclaimed water is effluent that has undergone additional treatment that makes it suitable for use in prescribed manners. In Arizona there are five classes of reclaimed water, depending upon the level of treatment. Class A and Class A+ reclaimed water have undergone the highest level of treatment: secondary treatment, filtration, nitrogen removal treatment, and disinfection. In addition, Class A+ reclaimed water requires a total nitrogen concentration of less than 10 milligram per litre. This level of treatment is required for reuse applications where there is a relatively high risk of human exposure to potential pathogens in the reclaimed water.

Tucson Reclaimed Water

Rosemont requires approximately 3,800 gallons per minute (6,132 ac-ft/yr) of fresh water for mining and processing operations (Stantec Consulting, 2009, p. 1). The reclaimed water produced by the City of Tucson is Class A, and soon it will be treated to the cleanest level, Class A+ (K. Dotson, personal communication, 14 October 2010).

Regarding long-term availability, Tucson Water (2008) stated:

“A key long-term planning assumption is that the reclaimed water system will supply at least 9 percent of Tucson Water’s projected total demand through 2050. Accordingly, reclaimed water demand in the Tucson Water service area is projected to increase from 11,983 ac-ft per year in 2006 to approximately 24,000 ac-ft per year in 2050.”

The Tucson Water reclaimed system currently utilizes 42 percent of Tucson Water’s effluent allocation and 27 percent of Pima County’s allocation (City of Tucson and Pima County, 2009a). In calendar year 2009, 17,249 ac-ft of reclaimed water was delivered to Tucson Water customers (Tucson Water, 2010).

3.1.3 Advantages

The use of effluent or reclaimed water is well suited for mining and processing operations—especially for the milling and concentrating facilities. Many mines in Arizona use water from their wastewater treatment facilities, although this component of water typically comprises a small percentage of their water needs. The majority of reclaimed water used at a mine site is pumped back from reclaimed-water ponds on conventional tailings facilities. The major advantage to using effluent or reclaimed water is that it limits the need to pump groundwater.

3.1.4 Limitation

The use of effluent or reclaimed water for mining and processing at Rosemont assumes that a sufficient volume of effluent or reclaimed water could be purchased and further, that it would be available on a guaranteed, continuing basis from one or more wastewater treatment plants during Rosemont's LOM. Existing long-term contracts with private parties typically secure the reclaimed water for reuse within the community that generates the water. As of 2007, the Green Valley wastewater treatment plant did not have a reclaimed delivery system for Green Valley effluent (Huckelberry, 2007). The NIWWTP system does not have a reclaimed water delivery system, and the Tucson Water reclaimed water delivery system does not extend to the area of the mine site.

Another limitation is that climate change and drought could potentially affect local rainfall and future flows of the Colorado River. Reduced flows in the river could make the supply of effluent to the mine site vulnerable if local municipalities increased their demand for available effluent.

The use of effluent or reclaimed water also is limited by the lack of infrastructure to deliver it to the mine site. If sufficient water could be purchased, transporting the required volume of water would require construction of a pipeline from a WWTP or pumping station in Tucson, Green Valley, or Rio Rico. The length of pipeline, by dead reckoning, would approach 40 miles from Tucson, 15 miles from Green Valley, and nearly 30 miles from the NIWWTP in Rio Rico. These distances are conservative because the pipeline would need to skirt or cross the intervening mountains, adding substantially to the pipeline length and attendant environmental damage. Additionally, the pipeline would cross private, state, and federal land, and potential archaeological sites; could not be buried along stretches where the depth to bedrock is shallow and, therefore, it would be subject to vandalism; and would require extensive permitting to construct and operate. In addition, a filtration plant would have to be built at the mine site or somewhere along the pipeline, and sludge disposal would be required. Should be it possible to purchase both effluent and reclaimed water, two separate conveyance systems might be required.

3.1.5 Feasibility

Utilizing wastewater effluent or reclaimed water for Rosemont process water is feasible for a portion of the required 5,000 ac-ft/yr. Rosemont would need to secure a long-term guaranteed source.

3.1.6 Summary

The use of reclaimed water for mining and processing operations at the Rosemont mine is unlikely to cause any difficulties in those operations, and its use would limit or preclude withdrawal of potable water from the groundwater aquifer in the Upper Santa Cruz Basin. A water delivery system would be required to transport water from the source(s) to the proposed mine (an approximate pipeline distance of up to 50 miles). While technically feasible, the use of reclaimed water would depend upon available excess capacity and the ability to obtain guaranteed water rights and permits.

3.2 Sierrita Mine Sulfate Plume Water

This section discusses using sulfate-impacted groundwater from the Sierrita mine as an alternative water source.

3.2.1 Description

Operation of tailings impoundments at the Freeport-McMoRan Copper & Gold Sierrita Operations (Sierrita) has resulted in a plume of sulfate-impacted groundwater that contains between 1,000 mg/L and 2,000 mg/L sulfate (ADEQ, 2006) and has impacted down-gradient wells owned by the CWC. In June 2006, Sierrita signed a Mitigation Order on Consent with the ADEQ by which Sierrita voluntarily committed to practically and cost effectively provide the owner/operator of an existing drinking water supply, that was impacted by the sulfate plume, with a drinking water supply with sulfate concentrations less than 250 parts per million (Sierrita, 2010). The 250 mg/L limit is based upon an EPA Secondary Maximum Contaminant Limit of 250 mg/L that is a taste consideration and is not federally enforceable (ADEQ, 2006).

This alternative proposes to convey impacted tailings water from pumpback wells at the toe of the tailings facility to a newly constructed large water cistern or tank and from there convey it in a pipeline to the Rosemont mine site.

3.2.2 Advantages

Tailings reclaim water is routinely recycled back to mill operations at similar operations in Arizona and elsewhere. The water is pumped back to the mill facilities from collection ponds downgradient of the tailings storage facilities, pumpback wells along the toe of the tailings storage facilities, or from pump barges on the impoundment. There are well-known treatment technologies for the removal of elevated sulfate from water. For use as process water, the sulfate-impacted groundwater likely would not require treatment unless other constituents were problematic.

3.2.3 Limitations

Sierrita is currently recycling all of the impacted tailings water for reuse in their processing circuit. Therefore, impacted water is not available from Sierrita for use at Rosemont. If excess tailings water were available, it would require transporting the water to the Rosemont mine site. The pipeline would require an approximately 16-mile corridor that would cross Interstate I-19, as well as private, state, and CNF land, through potentially sensitive areas such as archaeological sites. Moving the water to the Rosemont mine site would require the use of additional electric power and the construction of purpose-built pumping station(s) to overcome elevation changes, expansion of the line, and line loss due to friction. Permits would be required for construction of pumping stations, a pipeline, and accessory infrastructure.

3.2.4 Feasibility

Sierrita sulfate impacted groundwater is not feasible because Sierrita recycles all of the water for reuse in their processing circuit.

3.2.5 Summary

Excess sulfate-impacted groundwater is not available from Sierrita for use as process water at the Rosemont mine. Were excess water available it would require construction of a water delivery system that would cross I-19, private, state, and CNF land and permits for the construction.

3.3 Secretary of Interior Effluent and Managed Recharge Credit Recovery

The following section discusses the use of Southern Arizona Water Rights Settlement Act (SAWRSA) effluent entitled to the Secretary of the Interior and the managed recharge credits received as an alternative water source for use at the Rosemont mine.

3.3.1 Description

The Southern Arizona Water Rights Settlement Act of 1982 (Public Law 97-293) (SAWRSA), a water rights settlement with the Nation, and the Arizona Water Settlements Act of 2004 (Public Law 108-451), obligate up to 28,200 ac-ft/yr of secondary treated effluent produced at Tucson area wastewater treatment facilities to the U.S. Secretary of the Interior, through the USBR, for the Nation. The purpose of obligating the effluent is to assist in implementation of the settlement.

All of the effluent annually entitled to the Secretary of the Interior (28,200 ac-ft) is discharged to the Santa Cruz River and constitutes the majority of the perennial effluent flow observed in the river (Tucson Water, 2008). The USBR receives Managed Recharge Credit for 50 percent of the water recharged. The USBR has determined that current recharge projects do not fully utilize the SAWRSA effluent. Consequently the agency has implemented the SAWRSA—Effluent Utilization program to fully utilize the 28,200 ac-ft/yr of treated effluent in other Tucson projects (USBR, 2010).

3.3.2 Advantages

Excess effluent appears to be available for use in other projects. Secondary treated effluent can be used successfully at the proposed mine site.

3.3.3 Limitations

The USBR seeks to fully utilize the 28,200 ac-ft/yr of effluent in other Tucson projects. If it is incumbent upon the agency to use the effluent in the Tucson area, it likely would not be made available for use at the proposed Rosemont mine site. In addition, legal impediments may exist to

obtaining a contract for a secure source of SAWRSA effluent or to purchasing Recharge Credits for later use.

If a guaranteed source of water could be secured, a pipeline would be required to transport the water from the municipal treatment plants to the mine site, a straight-line distance of 40 miles. The pipeline would cross Interstate I-19 and possible I-10, as well as private, state, and CNF land, through potentially sensitive areas such as archaeological sites. Moving the water to the mine site would require the use of additional electric power and the construction of purpose-built pumping station(s) to overcome elevation changes, expansion of the line, and line loss due to friction. Permits would be required for construction of pumping stations, a pipeline, and accessory infrastructure.

3.3.4 Feasibility

Use of SAWRSA effluent is not feasible, principally because of the likely legal impediments to purchasing the effluent for use at Rosemont.

3.3.5 Summary

SAWRSA effluent obligated to the Secretary of the Interior for implementation by the Southern Arizona Water Rights Settlement Act, for the Tohono O’odham Nation, may be available, but the use of this effluent would require securing a long-term contract, constructing a pipeline to transport the water a minimum distance of 40 miles, and overcoming potential legal impediments to a contract.

3.4 Deep Aquifer Brackish Water

This alternative describes the advantages and limitations of using deep aquifer brackish groundwater as an alternative source of water for process water at the Rosemont mine. Brackish water typically has a dissolved solids concentration between 1,000 and 10,000 milligrams per liter (mg/L, or parts per million (ppm)).

3.4.1 Description

Deep brackish groundwater aquifers have been identified in many parts of Arizona, although not in the Santa Cruz or San Pedro river basins. Working with the Central Arizona Water Conservation District, Montgomery & Associates (2008) identified five areas with the potential for developing more than 10,000 ac-ft/yr from each, in a sustainable manner. Using that definition, they estimated more than 600,000,000 ac-ft of groundwater is stored in Arizona aquifers, generally at depth of less than 1,200 feet. Evaporite deposits, they concluded, are responsible for most salinity in northern Arizona aquifers, and agricultural irrigation is primarily responsible for brackish groundwater in southern Arizona. However, evaporites are also a factor in southern Arizona basins, such as Safford, Picacho, and the West Salt River. While there are dozens of brackish groundwater areas in Arizona, the M&A (2008) investigation suggests that only five or six areas have sufficient volume of brackish

water in storage to be of near-term interest for development of desalination projects. The area closest to the Rosemont mine site is located in Cochise County, straddling I-10. Nonetheless, this is a generalized discussion of water quality and water transport from a well field near this site to the proposed Rosemont because closer sources of brackish water might exist.

This alternative would require identifying a deep aquifer with brackish water, obtaining the needed water rights and permits, developing a well field to extract the water, treating the water, disposing of sludge from the treatment plant, and conveying it to the Rosemont mine site. Water treatment requirements and sludge disposal methods would depend upon the quality of the water (dissolved solids concentration) extracted from the deep aquifer and on the ore and the process used. There is usually some tolerance for lower quality process water, although there is no specific standard. The water would need to be tested against the process requirements to verify there is no interference with the process, and metallurgical testing would be required. Pumping requirements would depend upon distance and terrains crossed, such as those involving ecologically sensitive areas and elevation changes.

3.4.2 Advantages

The use of brackish water from a deep aquifer for mining and process water at the proposed Rosemont mine site is possible because such sources of water are known to exist beneath certain basins in southern Arizona, and in selected instances, brackish water can be used without treatment or with limited treatment. There are an estimated 60 to 75 million ac-ft of brackish groundwater in storage in the Gila River basin south of Phoenix, extending into Pinal County, with dissolved solids between 1,000 and 5,000 mg/L (M&A, 2008). The Willcox basin area in Cochise County contains an estimated 45 million ac-ft of brackish groundwater in storage, with similar concentrations of dissolved solids. Treatment technologies are commonly available. Pumping technologies and infrastructure are common and long distance pipelines are a common method of transporting fluids.

3.4.3 Limitations

Water rights would be required to extract brackish groundwater from a deep aquifer, and a permit would be required from ADWR/CDWR to pump approximately 5,000 ac-ft/yr. Pumping the required volume of water at a rate of 3,800 gpm from a deep aquifer would require considerable power consumption and specialized wells and pumps because the brine would be corrosive. Water treatment requirements and the volume of sludge to be disposed of would be unknown until a suitable deep aquifer is identified, and the water tested.

M&A (2008) pointed out the following major limitation:

“...in Arizona is the state’s classification of all aquifers as “Drinking Water Aquifers,” including those where salinity substantially exceeds that of sea water, or where yield rates to wells are less than one gallon per minute. Because brine injection into deep, saline aquifers is often the best, or only, feasible method of brine disposal, the ability to utilize Arizona’s abundant brackish

groundwater resources may depend on a reappraisal of the aquifer classification system in the state.”

A pipeline of approximately 75 miles would be required to convey brackish water from the Gila River and Picacho basins near Eloy to the mine site; a pipeline of approximately 55 miles would be required to convey water from the Willcox basin to the mine site. Moving the water to the mine site would require the use of additional electric power and the construction of purpose-built pumping station(s) to overcome elevation changes, expansion of the line, and line loss due to friction.

3.4.4 Feasibility

Use of deep aquifer brackish groundwater for Rosemont process is feasible. A permit from ADWR would be required and a pipeline of approximately 55 miles and pumping stations would be required. Segments of the pipeline might be routed along the I-10 right of way.

3.4.5 Summary

The production and treatment of brackish water from a deep aquifer are feasible because they involve common technologies. Water rights must be secured and permits will be necessary to use the deep aquifer groundwater. Pumping from a deep aquifer will have considerable power requirements and will require specialized equipment due to the corrosive nature of the brine. Water treatment and sludge disposal will be required, as will the construction and permitting of a pipeline and pumping stations.

3.5 Sea Water

The following section discusses the use of sea water as an alternative source of water for the Rosemont mine. The section was prepared by John T. Kline, B.S., M.A.O.M.

3.5.1 Description

Sea water in its native state contains about 35,000 mg/L (parts per million (ppm)) of salt. In comparison, groundwater contains generally less than 1,000 ppm of total dissolved salts.

Water at the mine site is needed for dust control, processing, and for potable-water uses (drinking, etc.). Untreated sea water is corrosive to steel and could not be used for processing. Further, the salts would interfere in the processing. Untreated sea water could not be used for dust control on roads because of possible groundwater contamination. Finally, untreated sea water is not suitable for drinking and other potable uses. This review, therefore, assumes that sea water is taken from its sources and treated at the coastline prior to pumping to the site.

There are two main processes used to remove salt from sea water, namely, distillation and RO (Ashley, 2009). RO is the more efficient process. This well-known and readily available technology

uses filtration of sea water followed by passing the sea water past high-pressure membranes. The salt is separated as highly concentrated brine and typically it is returned to the sea.

The nearest source of sea water to the Rosemont mine site is the Gulf of California (Sea of Cortez) at Puerto Peñasco, Mexico, which is the closest town on the Gulf. The approximate distance from the mine site to Puerto Peñasco is 250 miles via road. By dead reckoning, the distance is approximately 165 miles. The second source option is in the United States at a location near San Diego, California. The approximate pipeline distance between Tucson and San Diego is over 430 miles by dead reckoning.

3.5.2 Advantages

The use of treated sea water for industrial and drinking purposes is a well-known technology and has been used for many years. According to the U.S. Geological Survey (2009), “In 2002, there were about 12,500 desalination plants around the world in 120 countries. Among industrialized countries, the United States is one of the most important users of desalinated waters (6.5%), especially (sic) in California and parts of Florida.”

“In November 2009, Connecticut-based Poseidon Resources Corporation won a key regulatory approval to build a \$300 million water desalination plant at Carlsbad, north of San Diego California” (Energy Recovery, Inc., 2008). The plant is designed to produce 50 million gallons of drinking water per day (34,700 gpm) for southern California users. This plant alone will produce approximately 10 times the daily needs of Rosemont.

Pumping long distances is also a well-known and commonly used technology. It is done in the oil and gas industry, and water is commonly pumped from its source to its end users through steel, concrete, and high-density polyethylene pipelines.

3.5.3 Limitations

Environmental, right-of-way, access, permitting, and other similar issues are associated with treating sea water and transporting it from the source area to the Rosemont mine site. Environmental issues include the impacts the brine may have on the local environment where the salt is discharged (California Coastal Commission, 2004), and impacts associated with construction of a pipeline and pumping stations along the pipeline corridor. The pipeline path in the U.S. is across mountain ranges, private fee lands, Indian Nation lands, federal lands, and an interstate boundary. The pathway in Mexico traverses Mexican federal land and private land, and would cross an international boundary.

Pipelines installed on the surface are subject to weathering due to movement and changes in temperature. They also provide a barrier to the movement of hunters, off-road vehicles and other transportation, and migratory animals. The inherent movement of the lines causes wear and stress that can cause line failure. Theft of water and vandalism can also occur to the pipeline and pumping

stations. Therefore, the water line would have to be buried along most or all of its route, some of which would be along rights-of-way for existing roads. The pipeline would also cross through potentially sensitive areas such as archaeological sites, rivers and streams, mountains, town sites, and highways.

Moving the water from the coast to the mine site would require construction of purpose-built pumping stations to overcome elevation changes, expansion of the line, and line loss due to friction.

Finally, numerous permits would be required to secure sea water, dispose of brine, construct a pipeline and pumping stations, and there may be a need to have an international agreement with Mexico if the water source is from the Gulf of California.

3.5.4 Summary

The production of water for mining and processing from seawater is possible because it is a commonly used technology. The water would require treatment, with attendant disposal of large quantities of salt brine. The long distances required to pump the treated water are substantial but not uncommon for pumping oil and natural gas. Limitations include the following issues:

- The water line would cross through potentially sensitive areas such as archaeological sites, rivers and streams, town sites, and highways;
- The water line would have to be buried;
- Numerous permits would be required;
- Brine disposal would be necessary at the treatment plant in Mexico or California;
- A determination would need to be made regarding legal ownership of the water rights; and
- International agreements may be required.

4 Proposed Alternatives: Localized CAP Recharge and Recovery Water

The purpose of the Central Arizona Project (CAP) recharge and recovery program is to allow renewable surface water supplies, such as Colorado River water, to be stored underground now for recovery later during periods of reduced water supply (CAP, 2010). To encourage the direct use of renewable water supplies, the recharge program restricts the type of water that may be stored long-term to renewable water supplies that cannot be used directly.

The Central Arizona Water Conservation District (CAWCD) has developed and currently operates six recharge projects, with one additional project under development that has an expected completion date in 2011. The localized, Tucson Active Management Area (AMA), recharge facilities have a cumulative permitted capacity of 91,000 ac-ft/yr and include the Avra Valley, Pima Mine Road and Lower Santa Cruz Recharge Projects. The other three existing facilities and the project under development are in the Phoenix AMA. The permitted and cumulative recharge capacities of the localized facilities are shown in Table 3.1.

Table 4-1 Permitted recharge capacity of localized CAP facilities (ac-ft/yr)

Project Name	Year Complete	Permitted Capacity	Cumulative Capacity
Avra Valley	1996-97	11,000	11,000
Pima Mina Road	1998-99	30,000	41,000
Lower Santa Cruz	2000	50,000	91,000

Source: CAP (2010)

The three main CAP contract categories are Non-Indian municipal and industrial (M&I), Non-Indian agricultural (NIA), and Indian. Almost all NIA subcontracts have been declined or terminated, and CAP water is used pursuant to the Department’s recharge program. As of October 2009, CAP annual subcontract totals were:

- M&I Subcontracts 620,678 ac-ft/yr
- Indian Contracts 555,806 ac-ft/yr
- Non-Indian Agricultural Subcontracts 9,026 ac-ft/yr
- Currently Uncontracted Water 155,787 ac-ft/yr
- Other Project Water Under Contract 73,703 ac-ft/yr

There are two types of CAP storage facilities: the Underground Storage Facility (USF) and the Groundwater Savings Facility (GSF). The USF physically stores water in the aquifer through direct recharge. A GSF uses surface water (CAP water) instead of groundwater.

The type of recharge water stored in a USF varies; it may be CAP water, precipitation, effluent, or other. The most common type of USF is a constructed storage facility that uses infiltration (spreading) basins in which the water is spread out over a large surface area that allows the water to infiltrate or seep into the alluvial material and eventually reach the aquifer. Infiltration basins are typically located adjacent to stream channels where infiltration rates are high due to the porous nature of the soils. Another type of constructed USF involves the use of injection (recharge) wells where water is forced directly into the aquifer through a borehole. This recharge method is less common than infiltration basins because of its higher operational expense.

The Managed USF is one where water is discharged into a streambed and allowed to flow naturally down the channel without the assistance of any construction. Water infiltrates (percolates) into the aquifer below the stream channel (Arizona Water Banking Authority (AWBA), 2010). The types of USFs are given in Table 3.2

Table 4-2 Types of Underground Storage Facilities

Underground Storage Facilities (physically stores water in aquifer through direct recharge)		
Constructed USF		Managed USF
Spreading Basin	Injection Well	Discharge to a streambed

Source: CAP (2010)

A GSF, on the other hand, is established when the AWBA partners with an entity (farmer or irrigation district) that would have pumped groundwater to grow a crop, and provides CAP water in-lieu of pumping groundwater. The AWBA gets a long-term storage credit for groundwater that is not pumped (AWBA, 2010). The AWBA has a lower priority to CAP water than entities with municipal and industrial (M&I) subcontracts (AWBA, 2011).

Rosemont has committed to acquire sufficient Colorado River renewable surface water supplies to be delivered through the CAP canal to the Tucson Active Management Area (TAMA) to offset 105 percent of the total projected mine usage, or approximately 105,000 ac-ft. To implement this plan, Rosemont obtained an excess-water⁸ contract from the CAWCD to purchase CAP water on a year-to-year basis (the only timeframe for which excess water can be purchased), and is investigating and contracting other CAP sources to ensure their total commitment.

A major limitation to using CAP excess water is pointed out on the CAP website (CAP, 2011):

⁸ “Excess water is a specifically defined category of CAP water that can only be made available for delivery one year at a time. It is the most junior priority within the CAP water priority hierarchy and, as such, it will be the first supply to be reduced if a shortage is declared. Having a CAP Excess Water contract and an approved delivery schedule does not constitute an assured water supply” (www.cap-az.com/operations/excess-contracts, accessed October 21, 2010).

“Having a CAP Excess Water contract and an approved delivery schedule does not constitute an assured water supply. It is important to note that the CAP excess water supply is expected to decline significantly in upcoming years, and should not be relied upon in planning future demands.”

For the excess-water contract, Rosemont entered into three water-storage agreements with the CAWCD to store the purchased CAP water at CAWCD-operated USFs: the Pima Mine Road Recharge Project facility, the Avra Valley Recharge Project facility, and the Lower Santa Cruz Recharge Project facility.

This section evaluates localized recharge and recovery facilities for Rosemont to bank their CAP water.

- Pima Mine Road Recharge Project facility,
- Lower Santa Cruz Recharge Project facility,
- Avra Valley Recharge Project facility
- FICO groundwater savings facility,
- 841 Facility (Tohono O’odham Nation recharge), and
- Future Community Water Recharge Project facility.

4.1 Pima Mine Road Recharge Project

The section describes the Pima Mine Road Recharge facility as a recharge and recovery facility for use by Rosemont.

4.1.1 Description

The Pima Mine Road Recharge Project (PMRRP) is one of the three localized CAP recharge projects in Pima County. The facility is situated approximately 15 mile south of Tucson on the Santa Cruz River flood plain. Developed by the CAWCD in cooperation with the City of Tucson, the project has two operational components: the original, pilot-scale facility and a newer, full-scale facility. Full-scale operation of the pilot basins began in September 2000, and full-scale operation of the expansion basins began in December 2001. Combined, the two facilities encompass 37 acres of spreading basins and have a maximum permitted annual recharge capacity of 30,000 ac-ft.

The Reach 6 portion of the CAP aqueduct provides water to the PMRRP facility. It is at the terminus of the CAP pipeline. Infiltration rates at the PMRRP pilot facility typically range from 1.9 to 5.8 feet/day, but are much higher following surface maintenance. The expansion basins were not excavated as deep as the pilot basin and, therefore, infiltration rates are substantially lower; they range from 0.7 to 4.2 feet/day. Maintenance typically consists of scraping and ripping the basin surfaces to break up the crust and increase infiltration into the underlying basin-fill formations.

4.1.2 Advantages

The PMRRP is one of the three CAWCD-operated facilities currently used to store the excess CAP water purchased by Rosemont. The PMRRP is the storage facility closest to Sahuarita where Rosemont's proposed groundwater production wells will be located. Recharge of CAP water allows Rosemont to replenish a greater volume of groundwater than it proposes to pump for use at the proposed mine site. Use of this particular facility to recharge CAP water allows Rosemont to replenish the aquifer in the area of their groundwater wells. Recharge also offsets subsidence caused by groundwater pumping.

4.1.3 Limitations

Although Rosemont entered into three water storage agreements with CAWCD to store its purchased CAP water at CAWCD operated USFs (the Pima Mine Road Facility, the Avra Valley Facility, and the Lower Santa Cruz facility) and specifically requested that as much of this water as possible be stored in the southernmost facility, Pima Mine Road, CAWCD was, for the most part, unable to accommodate this request because existing customers (City of Tucson and Tohono O'odham Nation) were using all of the existing capacity. Therefore, most of the water for 2007, 2008, and 2009 was stored at the Lower Santa Cruz facility. The Lower Santa Cruz facility is farther from Sahuarita than is the Pima Mine Road facility, and consequently is less able to offset groundwater pumping from Rosemont's Sahuarita well field.

4.1.4 Feasibility

Although the Pima Mine Road facility is the optimum recharge facility, utilizing this facility at present is not feasible because the facility currently does not have surplus recharge capacity.

4.1.5 Summary

Rosemont has entered into an agreement to purchase excess CAP water from the CAWCD on a year-to-year basis and has three water storage agreements that include storing water at the PMRRP. The PMRRP facility is closest to Sahuarita where Rosemont's proposed production wells will be located. Use of this facility would allow Rosemont to replenish the aquifer in the area of their groundwater wells, but Rosemont cannot store additional water there because the facility lacks surplus recharge capacity. The water must be stored at facilities farther north.

4.2 Lower Santa Cruz and Avra Valley Recharge Projects

The section describes the Lower Santa Cruz and Avra Valley Recharge facilities and their advantages and limitations as recharge and recovery facilities for use by Rosemont. These recharge facilities are similar; therefore, the discussions have been combined.

4.2.1 Description

The Lower Santa Cruz Recharge Project (LSCRCP) and the Avra Valley Recharge Project (AVRP) are two of three CAP recharge and recovery projects in Pima County. The facilities were developed using state demonstration funds. The projects are both located in the northwest portion of the Tucson AMA, north of Tucson near the Marana Airport, and west of the Tangerine Road exit off I-10.

The LSCRCP consists of three spreading basins with an approximate total area of 30 acres. Full-scale operation began in June 2000. The LSCRCP was developed also in partnership with the Pima County Department of Transportation and Flood Control District (Pima County), and was constructed in conjunction with a flood control levee along the Santa Cruz River. Water is delivered to the LSCRCP site via an open channel irrigation canal. The project has a permitted capacity of 50,000 ac-ft/yr and a total storage capacity of 600,000 ac-ft. Delivery capacity is 65 cubic feet per second (cfs). The infiltration rate at LSCRCP is exceptional, exceeding 7 feet per day. Only two of the basins are needed at one time to store deliveries of over 60 cfs, allowing the third basin to be in a drying cycle.

The AVRP was the CAP's first recharge project. It was conceived as part of the Northwest Tucson AMA Replenishment Program, a cooperative effort of the local water entities that began in 1994. CAP constructed the facility and began operating a 2-year pilot program in 1996. The AVRP began full-scale operation in March 1998. The project consists of approximately 11 acres of recharge basins. It has a permitted capacity of 11,000 ac-ft/yr and a delivery capacity of 12 cfs.

Spreading basins become clogged over time, slowing infiltration. Maintenance is required when infiltration rates decrease; harrows may be used to break up the clogging layers. Eventually the surfaces require scraping to improve surface infiltration into the underlying basin-fill formations.

4.2.2 Advantages

The LSCRCP and the AVRP are two of the three CAWCD-operated facilities currently used by Rosemont to store CAP water. The recharge of CAP water allows Rosemont to replenish a greater volume of groundwater than it proposes to pump for use at the proposed mine site. Recharge also offsets subsidence caused by groundwater pumping.

4.2.3 Disadvantages

The LSCRCP and AVRP locations are north of the Sahuarita area where Rosemont will be extracting groundwater for use at the proposed mine site.

4.2.4 Feasibility

It is feasible to utilizing the Lower Santa Cruz and Avra Valley Recharge Projects to store Rosemont CAP water because they have the capacity. However, the two recharge basins are 40 miles north of the proposed Rosemont well field, while the Pima Mine Road facility is much closer.

4.2.5 Summary

Rosemont has entered into an agreement to purchase excess water from the CAP on a year-to-year basis, and has an existing agreement to store water at both the LSCR and AVR. The recharged water replenishes groundwater in the area of recharge, but these two facilities are not adjacent to the Sahuarita area of proposed Rosemont well field.

4.3 FICO Groundwater Savings Facility

A Groundwater Savings Facility (GSF) is not a recharge facility. Its benefit lies in using CAP water instead of pumped groundwater. The FICO GSF would use CAP water to offset part of their almost 35,000 ac-ft/yr groundwater allotment, most of which (just over 29,000 ac-ft in 2008) is required to irrigate its pecan orchards in the Sahuarita-Green Valley area (FICO, 2010). However, the facility is not yet in operation (Inside Tucson Business, 2010) and a proposed date to construct the CAP pipeline southward to the facility does not appear to be eminent. This does not appear to be an alternative source of water or an alternative recharge facility for Rosemont.

4.4 841 Facility

This section describes the water rights of 841 Facilities specified by the Arizona Indian Water Rights Settlement Agreement in the Tucson Active Management Area (AMA) and the *Stipulation of Parties to the Tohono O'odham Settlement Agreement and Request for Entry of Judgment and Decree* (Superior Court of Arizona, Maricopa County, 2006) with respect to Rosemont Copper Company securing a water rights contract for CAP water from the Tohono O'odham Nation. Only the Tohono O'odham Nation is considered in this discussion due to the remoteness of the proposed Rosemont mine site from other Indian Nations.

4.4.1 Description

An 841 Facility is a federally recognized Indian community within Arizona that qualifies to accrue long-term storage credits, as stipulated in Arizona Revised Statute (A.R.S.) §45-841.01, *Accrual of long-term storage credits; Indian water rights settlements*, for storage of the unused portion of its Colorado River water entitlement. The statute is intended “to further the implementation of Indian water rights settlements in this state” (A.R.S §45-841.01 (B)). The statute codifies the conditions under which an Indian community may participate in the accrual of long-term storage credits for the delivery of its CAP water to the holder of grandfathered groundwater rights in an AMA or for off-reservation storage of its CAP water.

The Arizona Indian Water Rights Settlement Agreement specifies that the Tohono O'odham Nation shall have the following rights to CAP water in the Tucson AMA:

- 37,800 ac-ft/yr: total CAP Indian priority water currently under contract

- 28,200 ac-ft/yr: total new CAP NIA⁹ priority water

The Indian Water Rights Settlement Agreement specifies three agreements with the Tohono O’odham Nation in the Tucson AMA: Tucson Agreement, FICO Agreement, and ASARCO Agreement.

Among its many provisions, the 2006 ASARCO Agreement with the Nation provides for (1) the Nation to deliver up to 10,000 ac-ft/yr of CAP water to ASARCO to replace groundwater pumping by ASARCO on or near the San Xavier Indian Reservation, (2) ASARCO to construct and maintain the infrastructure for delivery of CAP water, and (3) the Nation to earn long-term storage credits for ASARCO’s use of CAP water in substitution for groundwater.

Pursuant to A.R.S. §45-841 (C)(2), the holder of grandfathered groundwater rights who accepts delivery of CAP water from an 841 Facility must “use the water delivered off of Indian community lands on a gallon-for-gallon substitute basis instead of [using] groundwater that otherwise would have been pumped pursuant to the grandfathered groundwater rights from within an active management area.”

Section 9 The Nation’s Right to Lease CAP Water of the *Stipulation of Parties to the Tohono O’odham Settlement Agreement and Request for Entry of Judgment and Decree* (Superior Court of Arizona, Maricopa County, 2006) states:

9.1 The Nation may lease CAP water to other water users outside of the Nation’s Reservation for a term not to exceed 100 years in accordance with section 309(c) of the Settlement Act.

9.2 For leases with terms in excess of 25 years, the Nation shall offer the lease to users within the Tucson Management Area. If the Nation receives no proposals from users within the Tucson Management Area, the Nation may offer the lease to users outside the Tucson Management Area but within the CAP service area, subject to a right by Qualified Entities within the Tucson Management Area of making counteroffers. A counteroffer matches or is superior to a proposal from an entity outside the Tucson Management Area if it matches the price and other substantive terms of the proposed transaction.

4.4.2 Advantages

The principal advantages inherent in A.R.S. §45-841 are that the holders of grandfathered groundwater rights (such as ASARCO) agree to use CAP water in lieu of pumping grandfathered groundwater, or the CAP water is stored for future use; and the 841 Facility accrues long-term storage credits from the AWBA for CAP water they are not presently able to use.

⁹ As explained in Section 3, almost all non-Indian agricultural (NIA) subcontracts have been declined or terminated and CAP water is used pursuant to the Department’s recharge program.

4.4.3 Limitations

The principal limitations to Rosemont securing a CAP water contract from an 841 Facility are that Rosemont does not hold grandfathered groundwater rights, and under these terms of the Southern Arizona Indian Water Rights Settlement is not eligible to secure a water supply contract with an 841 Facility. Another limitation is that Rosemont is outside the Tucson AMA service area; should they secure 841 CAP water, their contract could be superseded by a superior counteroffer from a water user in the Tucson AMA.

4.4.4 Feasibility

Securing a CAP water contract from an 841 Facility (e.g., Tohono O’odham Nation) is not feasible because Rosemont does not hold grandfathered water rights, which is a major requirement.

4.4.5 Summary

The Tohono O’odham Nation may have excess CAP water that it can lease or store. However, requirements of the Arizona Indian Water Rights Settlement Agreement and the *Stipulation of Parties to the Tohono O’odham Settlement Agreement and Request for Entry of Judgment and Decree* place severe limitations on potential water users who do not have grandfathered groundwater rights or are outside the Tucson AMA.

4.5 Community Water Company, Future Recharge Project

This section describes the proposed CAP water delivery system of the Community Water Company of Green Valley (CWC), which would enable the CWC to take and use its allotment of CAP water. This evaluation is based upon the following sources of information: the USBR website, the Community Water Company website, and a Revised Draft Environmental Assessment and its appendices (ERO Resources Corporation, 2009).

4.5.1 Description

The CWC is a non-profit, member-owned co-op, incorporated in 1975 by the water users of Green Valley. It began operations in 1977. The CWC has a contract for delivery of 2,858 ac-ft/yr of CAP M&I water to its service area, but it has not been able to use its allocation because the CAP pipeline extends only to the Pima Mine Road recharge basin. The pipeline would need to be extended to the CWC service area in Green Valley, an approximate added length of 8 miles. Consequently, the CWC’s annual CAP allocation has been available for purchase as excess CAP water. With construction of a water delivery system and recharge facility (pipelines, a recharge basin, a booster station, and other related infrastructure), CWC’s allocated CAP water would be delivered to the CWC service area for direct use or recharge.

Rosemont has proposed to fund the water delivery system, and in return, the CWC plans to give Rosemont priority for use of CWC's CAP water and available recharge storage capacity for the first 15 to 20 years of the system's operation, unless it is needed by CWC. Additional water supplies that Rosemont may obtain also would be recharged to utilize the maximum recharge capacity. The maximum capacity for the 36-inch mainstem pipeline was established at 30,000 ac-ft/yr. The full recharge capacity of the CWC recharge basin would be 5,000 ac-ft/yr.

The proposed water delivery system required preparation of an Environmental Assessment (ERO Resources Corporation, 2010) under National Environmental Policy Act rules and regulations. On July 18, 2010 the company posted a letter on its website informing members and customers of the USBR's finding regarding the water delivery project (CWC, 2010). The letter states, in part,

“After almost two years of environmental evaluations and studies ... the Bureau of Reclamation has issued a *"Finding of No Significant Impact"* for the Community Water Company of Green Valley Central Arizona Project Water Distribution System and Recharge Facility.”

The finding enables the CWC to move forward with construction of the water delivery system. Following the first 15 to 20 years, it is expected that CWC would continue to recharge its CAP water at the site, along with other CAP water supplies from potential participants, such as the Green Valley Domestic Water Improvement District and other participants in the Upper Santa Cruz Providers and Users Group (USC/PUG).

4.5.2 Advantages

Use of CWC's proposed water delivery system to convey and store CAP water has multiple advantages. It would enable Rosemont to replenish groundwater at the CWC recharge storage facility in the vicinity of Well 11 and eventually in the vicinity of Rosemont's proposed well field, a 53-acre parcel of land located on Davis Road, Sahuarita. The water delivery system would secure future supplies of water for the CWC service area and for other members of the USC/PUG. Based on nearly a year of monitoring, from February 27, 2009 to January 8, 2010, parts of the Green Valley/Sahuarita area have had up to 1.4 inches of subsidence (ADWR, 2010c). Recharging groundwater would help maintain the local aquifer and reduce subsidence that has been occurring over the past 50 years in the area due to over pumping by local farms and mines.

4.5.3 Limitations

Construction of the water delivery system will require several years to complete. Construction will include securing permits from state and local entities, acquiring pipeline rights of way, and a commitment of substantial funds. The total cost for the Pima Mine Road Recharge Project in 2001 was \$11 million. The Avra Valley Recharge Project, about a third of size of the Pima facility, cost \$790,000 in 1998 (CAP, 2010).

4.5.4 Feasibility

Utilizing the proposed future Community Water Project's CAP pipeline extension and recharge facility is feasible; however, the system is at least several years in the future and the construction costs will require a substantial commitment of funds.

4.5.5 Summary

Rosemont has signed an expression of interest with the CWC to construct a water delivery system that will extend the CAP pipeline to the CWC service area in the Green Valley/Sahuarita area. The project would deliver CWC's CAP allocation to their service area and, by enabling Rosemont to recharge groundwater at the CWC recharge storage facility, help sustain the aquifer and reduce land subsidence in that area.

5 Summary and Conclusions

5.1 Summary

This report provides a review of 19 alternative water sources identified by the Coronado National Forest. The review is intended to evaluate the potential of the different sources to provide an adequate volume and yield of groundwater that might offset groundwater pumping at the site near Sahuarita, Arizona that is presently intended for development by Augusta Resources Corporation for the proposed Rosemont mine site.

The alternatives were grouped into three classes on the basis of water type:

- Potable Water, 9 potential alternative sources,
- Non-potable Water, 5 potential alternative sources, and
- Localized Central Arizona Project (CAP) Recharge and Recovery Water, 5 potential alternative sources.

Many of these alternative water sources may have associated jurisdictional and/or legal issues, which are beyond the scope of this report, and consequently are generally not discussed herein. Additional considerations include identifying a groundwater source within a given area having an adequate volume and sustainable yields; securing long-term, guaranteed water rights; potential drought and reduced flows in streams and the Colorado River, which could cause water authorities to reprioritize water allocations.

Table 5-1 summarizes the findings of this review.

5.2 Conclusions

Of the 19 alternative water sources reviewed herein, nine are not feasible alternatives to replace groundwater withdrawals from Rosemont Copper Company's planned well field near the town of Sahuarita, Arizona. Of the 19 reviewed, six alternatives may be feasible although water rights and jurisdictional and legal implications may change that assessment. The remaining four alternatives are of uncertain feasibility; inquiries made to appropriate owners and agencies may clarify this uncertainty.

Table 5-1 Summary of Alternative Water Sources

Alternative	Principal Advantage	Principal Limitation	Feasibility
Potable Water Sources			
Davidson Canyon Groundwater	Closest source of water to Rosemont mine site	Two reaches designated <i>Outstanding Arizona Water</i> in 2008.	NO—unlikely to be permitted due to <i>Outstanding</i> designation; unlikely to have sufficient volume and yield
Ciénega Creek Groundwater	Reasonable distance to Rosemont mine site	BLM 1997 application for in-stream flow water right; volume and yield along stream unlikely to be sufficient.	NO—unlikely to be permitted due to BLM application for in-stream flow rights
Sonoita Creek Groundwater	Reasonable distance to Rosemont mine site	Difficulty obtaining necessary permits due to local opposition	UNCERTAIN—may be difficult to obtain permits
San Pedro River Groundwater	Likely to have sufficient volume and well yield	BLM asserts a Federal Reserve In-Stream Flow Water Right to the San Pedro River; further asserts groundwater removal might negatively impact stream flow and BLM water right.	NO—unlikely to be permitted due to BLM assertion of water rights
Santa Cruz River Basin Groundwater	Likely to have sufficient volume and well yield	Multiple contamination areas due to effluent, mine and agricultural discharges	YES—volume and yield, permits, and identifying an uncontaminated zone (or water treatment) are likely.
Santa Rita Experimental Range Groundwater	Likely to have sufficient volume and well yield	Extraction of groundwater may not be in line with purpose and goals of SRER; perceived to impact rangeland, subject of SRER study.	UNCERTAIN—inquiries could be made of SRER and UA.
CAP Direct Delivery	CAP had excess capacity in 2008	Rosemont is not operational so cannot accept direct delivery of	UNCERTAIN—inquiries could be made of CAP for future deliveries

Alternative	Principal Advantage	Principal Limitation	Feasibility
		CAP water	
Tohono O’odham Nation Groundwater Direct Delivery	Likely to have sufficient volume and well yield	An adequate volume of groundwater for District use is questionable.	NO—an adequate supply is not confirmed.
RO Water from Yuma Desalting Plant	At full operating capacity, the RO plant could supply the needs of the proposed Rosemont mine.	The plant is not operational; large state and municipal water authorities might acquire superior entitlements when the commercial operation commences; the timing is uncertain; the distance to the proposed mine site is over 200 miles.	NO—the plant is not operational; other water authorities might have superior water entitlements; the distance is too great.
Non-potable Water Sources			
Wastewater Effluent or Reclaimed Water	Use of effluent and wastewater are well suited for mining and processing.	Long-term contracts typically secure reclaimed water for reuse within the community that generates it.	YES—provided a long-term guaranteed source could be secured.
Sierrita Mine Sulfate Plume Water	Tailings reclaim water is routinely recycled back to mill operations.	Sierrita recycles all of the impacted water for reuse in their process circuit.	NO—none is available.
Secretary of Interior Effluent and Managed Recharge Credit Recovery	Excess effluent appears to be available.	Legal impediments may exist to obtaining a contract; USBR seeks to utilize the effluent in other Tucson projects, so it may not be available outside Tucson area.	UNCERTAIN—inquiries could be made of DOI and USBR.
Deep Aquifer Brackish Water	Nearby basins contain an estimated 45 to 75 million ac-ft of brackish water.	Power consumption to pump from a deep aquifer and possibly treat the water would be enormous; disposal of brine sludge could be	YES—provided a long-term guaranteed source could be secured and environmental issues resolved.

Alternative	Principal Advantage	Principal Limitation	Feasibility
		problematic.	
Sea Water	Treating sea water for industrial and drinking purposes is a well-known technology.	The distance from California and transboundary issues conveying water from Mexico; disposal of brine sludge could be problematic.	NO—distances and transboundary issues would make conveying water from the source areas unfeasible.
Localized CAP Recharge and Recovery Water			
Pima Mine Road Recharge Project	Rosemont has an existing agreement with CAWCD to store water at the PMRRP.	The PMRRP does not have adequate capacity to store Rosemont water.	YES—provided CAWCD makes storage capacity available to Rosemont.
Lower Santa Cruz and Avra Valley Recharge Projects	Rosemont has an existing agreement with CAWCD to store water at the LSC and AV recharge projects.	The facilities are too far from Rosemont’s planned production well field in Sahuarita.	YES—Rosemont presently recharges its CAP excess water at the LSC facility.
FICO Groundwater Savings Facility	Using CAP water instead of pumping groundwater.	CAP delivery to FICO has not been constructed; the timing is unknown for FICO becoming a GSF.	NO—the GSF facility does not exist.
841 Facility	Holders of grandfathered groundwater rights agree to use CAP water in lieu of pumping groundwater.	Rosemont does not hold grandfathered groundwater rights.	NO—Rosemont does not quality.
Community Water Company, Future Recharge Project	Local recharge would reduce subsidence in the area; Rosemont could eventually replenish groundwater in the vicinity of its proposed well field.	Construction of the water delivery system will require several years to complete.	YES—Rosemont is working with the CWC to construct the CAP pipeline extension.

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7 Acronyms

A.R.S.	Arizona Revised Statute
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AMA	Active Management Area
ASLD	Arizona State Land Department
AVRP	Avra Valley Recharge Project
AWBA	Arizona Water Banking Authority
BLM	U.S. Bureau of Land Management
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CEP	Conservation Effluent Pool
cfs	cubic feet per second
CNF	Coronado National Forest
CWC	Community Water Company (of Green Valley)
Sierrita	Freeport-McMoRan Copper & Gold, Inc.
gal/per/day	gallons per person per day
gpd	gallons per day
gpm	gallons per minute
GSF	Groundwater Savings Facility
HCP	Habitat Conservation Plan
LSCR	Lower Santa Cruz Recharge Project
M&I	Municipal & Industrial
mgd	million gallon per day
Nation	Tohono O’odham Nation
NIA	Non-Indian agricultural water
NIWWTP	Nogales International Wastewater Treatment Plant
PFOS	perfluorooctane sulfonate
PMRRP	Pima Mine Road Recharge Project
ppm	parts per million
RO	reverse osmosis
SAWRSA	Southern Arizona Water Rights Settlement Act
SRER	Santa Rita Experimental Range
USBR	U.S. Bureau of Reclamation
USF	Underground Storage Facility
WMIDD	Wellton-Mohawk Irrigation & Drainage District
WWTP	Wastewater Treatment Plant
YDP	Yuma Desalting Plant

8 Qualifications of Key Technical Authors

John Kline B.S., M.A.O.M., has a degree in chemistry and has worked for 35 years in the copper mining industry as technical manager, environmental permitting, operations managers, and Project manager. His specific work in the field of water management and treatment includes:

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Ms. Hoag is a Principal Geologist at SRK's Tucson office and is licensed as a registered geologist in Arizona and Texas. She has conducted geological and hydrogeological investigations for various mining operations and remedial or environmental permitting activities on behalf of clients subject to state and/or federal regulations. Her expertise included permit negotiations and Aquifer Protection Permit applications, water quality monitoring and assessment; compliance monitoring and reporting on new and existing APP and Underground Injection Control permits; geologic drilling and sampling to support geochemical assessment of waste rock, tailings, and heap leach dumps acid rock drainage and metal leaching. Mining geology experience includes gold/copper exploration sampling/drilling, preparation of geological models and resource estimates for porphyry copper and molybdenum deposits in Arizona and New Mexico. Database auditing and QA/QC sampling verification, feasibility studies for new mine and expansion developments.