

Review of Alternative Water Sources

Report Prepared for
SWCA Environmental Consultants

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SRK Consulting (U.S.), Inc.
Suite 240, 3275 West Ina Rd.
Tucson, Arizona, USA 85741

Tel: 520.544.3688 Fax: 520.544.9853
E-mail: tucson@srk.com Web site: www.srk.com

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Authors
SRK Technical Staff (except as noted)

Reviewed by
Corolla K Hoag, R.G.

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1 Introduction

The proposed Rosemont Copper Company (Rosemont) operation will require approximately 3,800 gallons per minute¹ (gpm) of process water for mining and processing operations (Stantec Consulting, 2009) and approximately 4 gpm of potable water for showers, drinking, and toilets. For the life of the facilities, the total requirements are estimated to be 105,000 acre-feet (ac-ft). The Arizona Department of Water Resources (ADWR) has granted Rosemont a Mineral Extraction and Metallurgical Processing Groundwater Withdrawal Permit to withdraw 6,000 acre-feet per year (ac-ft/yr)² from the Santa Cruz basin, which is located west of the proposed mine site. The aquifer is within the Upper Santa Cruz sub-basin of the Tucson Active Management Area (AMA) groundwater basin (WestLand Resources, 2007).

In addition to pumping groundwater from the Upper Santa Cruz sub-basis, 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 is a positive net gain that enables Rosemont to offset total project pumping by 105 percent (WestLand Resources, 2007).

The Coronado National Forest (CNF) identified 21 alternative water sources that alone or jointly may provide sufficient water quantity and quality for the proposed Rosemont operation, thereby reducing or eliminating potential impacts related to groundwater withdrawals from the Upper Santa Cruz sub-basin. The CNF list is contained in Attachment A.

The alternative sources in the CNF list can be divided into three water types on the basis of use:

- Potable Water, 11 potential alternative sources;
- Localized Central Arizona Project (CAP) Recharge and Recovery Water, 5 potential alternative sources; and
- Non-potable Industrial Process Water, 5 potential alternative sources.

This purpose of this report is to provide a brief review that addresses in a general manner the potential for Rosemont using the alternative water sources identified by the CNF. To the extent possible, each review describes the water source and discusses the advantages and limitations to acquiring and using that source. Sections 2, 0, and 4 discuss the 21 alternative water sources. References are provided in Section 5. A list of acronyms is provided in Section 6. The qualifications of key authors are summarized in Section 7. All evaluated alternatives were prepared by SRK technical staff under the direct supervision of Corolla K Hoag, R.G., unless stated otherwise.

¹ 3,800 gallons per minute is approximately 6,132 acre-feet per year.

² One acre-foot equals 325,851 gallons.

2 Proposed Alternatives: Potable Water Sources

Rosemont personnel will require potable water for drinking water, toilets, and showers. The estimate for the quantity of potable water is based on the number of personnel working per day and the capacity in which they work. The following estimate of potable water requirements (Table 2.1) is based on the number employees (WestLand Resources, 2007) and the approximate potable-water use in gallons per person per day (gal/per/day), which is based on SRK professional experience at other mines. The general and administrative personnel use is estimated to be 20 gal/per/day for drinking water and toilets; the operational personnel use is estimated to be 25 gal/per/day for drinking water, toilets, and showers. The total potable water requirement is 5,780 gallons per day (gpd) or 4 gallons per minute (gpm).

Table 2.1 Estimated Potable Water Requirements

Rosemont Personnel	No. of Personnel ¹	Equivalent No. of Personnel/day	Potable Water Use (gal/per/day) ²	Potable Water Requirements (gpd)
General and Administrative	40	29	20	580
Mine Operations	284	142	25	3,550
Mill Operations	96	48	25	1,200
SX/EW Operations	36	18	25	450
Total Personnel	456	237		
Total gpd			95	5,780

Notes:

1–Westland Resources, 2007, p. 34. Personnel include general, administrative, engineering, and maintenance staff working 5 days per week 40-hrs per week and operations staff working two 12-hr shifts per day on a 4 days on/4-days off rotation.

2–Based on SRK professional experience.

Surface water is defined in Arizona as “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). The first seven discussions in this report focus on using groundwater extracted from river channels. These waters, therefore, may be regulated by the surface water code enacted by the state legislature on June 12, 1919, now known as the Public Water Code (ADWR, 2010b). Further, these areas are within the one of two general Arizona stream adjudications—the Gila Adjudication. The purpose of this judicial proceeding 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 include 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, 2010b). 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 make that determination.

Streams in Arizona are mainly ephemeral, severely limiting the use of surface water as a source of potable water. This section evaluates the areas listed below as potential sources of potable water:

- Davidson Canyon,
- Ciénege 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.

The term *alluvium* is used in the following sections in its most generic form to include all unconsolidated to semi-consolidated material: 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 and one backup well in a single location to ensure a sustainable supply of groundwater. There may be more than one well field associated with any alternative.

The following sections were prepared by SRK Consulting technical staff under the supervision of Corolla K Hoag, R.G. The qualifications of key personnel can be found in Section 6.

2.1 Davidson Canyon Groundwater

Groundwater in perched channel deposits in Davidson Canyon is considered in this section as a source of potable water. The bedrock formations are not considered in this assessment owing to its low hydraulic permeability and the unlikely ability to locate and maintain a sustainable flow.

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 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. Groundwater recharge in Davidson Canyon watershed is primarily occurring through recharge of precipitation along the base of the mountain front and within the surface-water drainages (Tetra Tech, 2010). The Tetra Tech (2010) hydrogeologic study of Davidson Canyon and the assessment of impacts to springs by the proposed mine indicated that recharge is seasonal and varies in the upper and lower portions of the watershed. Wells and springs in the upper reaches of the watershed show isotopic values indicating winter recharge, while springs in the lower Davidson Canyon appear to be strongly influenced by summer rains. 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 discharges and flows at the ground surface. All of the observed seeps and springs in Davidson Canyon had minor flows of less than one gallon per minute (Tetra Tech, 2010). The groundwater sources attributed to mountain front recharge or stormwater recharge, or the water from seeps and springs that discharge to alluvial sediments are all possible sources of the 4 gpm of potable water needed by the proposed operation.

2.1.2 Advantages

Installing a well field in a Davidson Canyon sandy stream bottom would likely produce the required water quantity of 4 gpm. The quality of water 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. Use of Davidson Canyon groundwater would require the use of a cistern at the mine site for water storage. The relatively short distance required to deliver water to the proposed mine site is an additional advantage to securing potable water from this location.

2.1.3 Limitations

The groundwater in local, shallow perched or spring-fed sources may not be available on a year-around, sustainable basis owing to natural fluctuation on an annual and seasonal basis. 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 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 crossing near Vail, Arizona (and about 1,000 feet north of the perennial stretch) from February 1968 through 1981. During this time the channel conveyed flow about 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 be able to provide the daily requirements 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 area 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. If a tanker truck with an approximate capacity of 9,000 gallons were used, it would need to make five trips per week, adding to highway traffic and truck traffic in the vicinity of the mine site. The water quality would require testing to ensure that the U.S. EPA National Primary Drinking Water 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 stations, and a pipeline. The wells could be impacted during periods of drought with the result that a supply might not be sustainable.

2.1.4 Summary

The alternative to obtain potable water from Davidson Canyon groundwater is attractive because of the relatively short distance require to transport the water. It is possible because it is likely that wells could be installed to provide 4 gpm, and the quality would be acceptable or the water could be treated to acceptable standards. However, portions of the 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 negatively impact the viewscape. If used, a water truck would increase traffic in the vicinity of the mine site.

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 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). The use of Ciénega Creek water would require the use of a cistern at the mine site for water storage.

2.2.2 Advantages

Installing well field(s) in a sandy stream bottom of Ciénega Creek would likely produce the required water quantity of 4 gpm. The quality of water, although it would require testing, likely would be suitable for use as potable water. If treatment were required, treatment options would be commonly used technology.

2.2.3 Limitations

Natural and seasonal variations may limit the availability of a sustained flow except within the 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 4 gpm of water from a well field in the Ciénega Creek drainage would cross private and stand 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, to move approximately 4 gpm, would be a visual impact to visitors to the area and would be subject to vandalism. If a tanker truck with an approximately 9,000-gallon container capacity were used, it would need to make five trips per week, adding to truck traffic in the vicinity of the mine site. 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. The wells could be impacted during periods of drought with the result that the supply is not sustainable. It is likely that the reach of the stream that traverses the Las Ciénegas National Conservation Area would be excluded from access.

2.2.4 Summary

Perennial reaches of the Ciénega Creek drainage could provide a source for potable water for the proposed Rosemont. The small volume of 4 gpm would require acquisition of water rights and permits, and a water delivery system with a pipeline an estimated length of at least 10 miles. Drought could impact the wells and the sustainability of the supply. A pipeline would negatively impact the viewscape. If used, a water truck would increase traffic in the vicinity of the mine site.

2.3 Sonoita Creek for Groundwater

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

2.3.1 Description

The distance between the 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. Sonoita Creek flows southwest through a narrow valley surrounded by mountains, passing through large sections of The 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 Ciénega Creek. 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. Patagonia Lake State Park surrounds this 2.5-mile reservoir. Reaches of Sonoita Creek are perennial, while other reaches are intermittent.

2.3.2 Advantages

Installing a well field in a sandy stream bottom along Sonoita Creek would likely produce the required water quantity of 4 gpm if a sustainable source could be located and the water rights, acquired. The quality of water, although it would require testing, likely would be suitable for use as potable water. If treatment were required, treatment options are commonly used technology. Use of Sonoita Creek water would require the use of a cistern at the mine site for water storage.

2.3.3 Limitations

A pipeline to transport 4 gpm of water from a well field along Sonoita Creek would cross Nature Conservancy, private, and CNF 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, to move approximately 4 gpm, would be a visual impact to visitors to the area and would be subject to vandalism. If a tanker truck with an approximate capacity of 9,000 gallons were used, it would need to make five trips per week, adding to highway traffic and truck traffic in the vicinity of the mine site. 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—if used. The wells could be impacted during periods of drought with the result that the supply would not be sustainable.

2.3.4 Summary

Selected reaches of Sonoita Creek could provide a source for potable water for the proposed Rosemont. The required volume of 4 gpm 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 negatively impact the viewscape. If used, a water truck would increase traffic in the vicinity of the mine site.

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 distance between the San Pedro River and the Rosemont mine site 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 assumes an average distance of 32 miles. Some reaches of the river are perennial, while other reaches are ephemeral. Most of the upper San Pedro River in Cochise County, Arizona, between the international border and the town of St. David (a 40-mile reach encompassing nearly 57,000 acres of public land), is within land designated as the San Pedro Riparian National Conservation Area, which is administered by the BLM.

Groundwater would be derived by installing a well field in unconsolidated or loosely consolidated basin-fill formations. Purchasing water from an existing groundwater well 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 in the San Pedro River Basin would likely produce the required water quantity of 4 gpm. 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

A pipeline to transport 4 gpm of 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. If a water truck with approximately 9,000-gallon container capacity were used, it would need to make five trips per week, adding to highway traffic and truck traffic in the vicinity of the mine site. The water quality would require testing to ensure that the U.S. EPA water quality standards are met; otherwise, the water will require treatment. Use of a cistern would be required at the mine site for water storage. 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 is not sustainable.

2.4.4 Summary

The San Pedro River could provide a source for potable water for the proposed Rosemont. The small volume of 4 gpm would require acquisition of water rights and groundwater withdrawal permits, and a water distribution system with a pipeline an estimated length of 32 miles. Drought could impact the wells and the sustainability of the supply. A pipeline would negatively impact the viewscape. If used, a water truck would increase traffic in the vicinity of the mine site.

2.5 Santa Cruz River Basin Groundwater

Groundwater from basin-fill formations in the Santa Cruz River Basin is considered in this section as a source of potable water.

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 and west of Nogales, and then flows 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 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. An average distance can be considered 15 miles. 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 based on quantity and intended use of the water.

2.5.2 Advantages

Installing a well field within the Santa Cruz River basin would likely produce the required water quantity of 4 gpm. If water treatment were required, treatment options are a commonly used technology. Use of Santa Cruz River basin water would require the use of a cistern at the mine site for water storage.

2.5.3 Limitations

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 CNF lands. If a water truck with approximately 9,000-gallon container capacity were used, it would need to make five trips per week, adding to highway traffic and truck traffic in the vicinity of the mine site.

Water rights would need to be acquired, as would permits for a well field and the water delivery system. The wells could be impacted during periods of drought with the result that the supply would not be sustainable.

The water quality would require testing and possibly treatment to ensure that the U.S. EPA National Primary Drinking Water Standards are met. Most water is suitable for most uses, although 26 groundwater contamination sites have been identified Tucson AMA Volatile organic compounds associated with industrial and transportation activities are common at the contamination sites. In addition, elevated concentrations of certain natural 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, 2010a). 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. 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.

2.5.4 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 4 gpm. 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. An aboveground pipeline would negatively impact the viewscape. If used, a water truck would increase traffic in the vicinity of the mine site.

2.6 Other Private Property Groundwater Adjacent to the Santa Cruz River

This alternative was not clearly understood by SRK. SRK contacted the CNF Rosemont team for additional information, but has not received a response. SRK infers that the Advantages and Limitations related to extracting groundwater from private property adjacent to the Santa Cruz River would be similar to those associated with using Santa Cruz River groundwater, as described in Section 2.5. In addition to those Advantages and Limitations, water rights would need to be secured from the owners of private property adjacent to the Santa Cruz River, which might incur the need to purchase or lease the land and/or purchase the groundwater rights.

2.7 State Land Groundwater Adjacent to the Santa Cruz River

Groundwater from the State Trust Land adjacent to the Santa Cruz River is considered in this section as a source of potable water.

2.7.1 Description

The Arizona State Land Department (ASLD) holds large amounts of land 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. In the Tucson AMA, the ASLD holds 37.8 percent of the land; the primary use is grazing (ADWR, 2010a). 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.

2.7.2 Advantages

Extracting groundwater from ASLD lands adjacent to the Santa Cruz River would have similar advantages to those described in Section 2.5.2. Installing a well field in ASLD lands along the Santa

Cruz River or purchasing water from an owner with existing water rights on state land would likely produce the required water quantity of 4 gpm. The quality of water would require testing; if water treatment were required, treatment options are a commonly used technology.

2.7.3 Limitations

The limitations associated with using groundwater from ASLD lands adjacent to the Santa Cruz River would be similar to those described in Section 2.5.3. In addition to securing a water rights contract with the ASLD and the required permits, Rosemont would be required to prepare a plan for developing the land and secure ASLD plan approval. Water delivery options would remain similar to those described in Section 2.5.1, with delivery distance depending upon the location of the well field. Drought could impact the wells and the sustainability of the supply. An aboveground pipeline would negatively impact the viewscape and would be subject to vandalism. If used, a water truck would increase traffic in the vicinity of the mine site.

2.7.4 Summary

Obtaining potable groundwater from ASLD lands along the Santa Cruz River is possible provided Rosemont can secure a contract with the department for the water rights. It is likely that both the water quality and quantity would be suitable, although treatment may be necessary. It would be necessary to obtain permits from ADWR, develop a well field, and build a water delivery system—or arrange for delivery to the mine site by tanker truck.

2.8 Santa Rita Experimental Range Groundwater

Groundwater from basin-fill formations and alluvial fan deposits within the Santa Rita Experimental Range is considered in this section as a source of potable water.

2.8.1 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 northwestern 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 on 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).

2.8.2 Advantages

The SRER is a very large research facility that is likely to be underlain by adequate reserves and quality of groundwater to provide 4 gpm of 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 source and mine site would depend upon the location of a well field.

2.8.3 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. 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 source to destination. 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. If a water truck with approximately 9,000-gallon capacity were used, it would need to make five trips per week, adding to highway traffic and truck traffic in the vicinity of SRER and the mine site. 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.

2.8.4 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 at beneath SRER, but the use of this groundwater may not be in line with the purpose of the SRER facility..A water delivery system or truck transport would be required, and water rights and permits would be required. An aboveground pipeline would negatively impact the viewscape. The use of water trucks would increase area traffic.

2.9 CAP Direct Delivery Water

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

2.9.1 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. Direct delivery of CAP water to the proposed Rosemont mine site would require a cistern or reservoir for above-ground water storage and/or a backup for CAP direct delivery water should delivery priorities change.

2.9.2 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, the CAP appears to have sufficient available capacity to satisfy Rosemont's requirement for 4 gpm of potable water. Direct delivery of CAP water to the Rosemont mine site would offset the withdrawal of the groundwater.

2.9.3 Limitations

The Pima Mine Road Recharge Project (PMRRP), located approximately 15 mile south of Tucson on the Santa Cruz River flood plain, is the terminal CAP facility and the facility closest to the proposed Rosemont mine site. By dead reckoning, the PMRRP is approximately 16 miles northwest of the mine site. Direct delivery of CAP water to the mine site would require a Municipal & Industrial (M&I) contract with the Central Arizona Water Conservation District³ (CAWCD) for the required volume and 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. If a water truck with approximately 9,000-gallon capacity were used, it would need to make five trips per week, adding to highway traffic and truck traffic in the vicinity of the PMRRP and the mine site. A cistern or reservoir would be required at the mine site for water storage.

2.9.4 Summary

The alternative of obtaining CAP direct delivery water to offset groundwater pumping would be contingent upon acquiring a CAP allocation of M&I water. In addition, direct delivery of CAP water would require a cistern or construction of a reservoir for water storage, a treatment plant, and a transport system— either pipeline with attendant infrastructure or tanker trucks to haul the water to the mine site.

2.10 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.

2.10.1 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

³ The Central Arizona Water Conservation District is the entity that governs the Central Arizona Project.

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. The straight-line distance between the Nation's capital, Sells, Arizona, and the mine site is 67 miles. This analysis assumes an average distance of 50 miles. This alternative would extract groundwater from basin-fill formations using an existing groundwater well or a new well field.

2.10.2 Advantages

A well field would be installed on Nation lands to provide 4 gpm. With testing, it is likely that a potable source of groundwater could be found that would not require treatment. Common technologies are available if treatment is required.

2.10.3 Limitations

Water rights would need to be acquired from the Nation and a well field would need to be developed once a suitable source was identified. Commercial tanker trucks could transport the potable water from the well field to the Rosemont mine. Five trips per week, using tankers with a 9,000-gallon capacity would be required, increasing truck traffic on the highway and in the vicinity of the mine site. Alternatively 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 Tohono O'odham Nation lands 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, and likely would cross the Buenos Aires National Wildlife Refuge. The wells could be impacted during periods of drought. 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.

2.10.4 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 or new well field. It is probable that a potable water source could be identified and wells could be installed to provide 4 gpm; 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 permit, and the location would be subject to approval by the Nation. The transport distance could be on the order of 48 miles and would involve a water delivery system or additional truck traffic.

2.11 RO Water from the Yuma Desalting Plant

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

2.11.1 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. The saline drainage water would have raised the salinity of the Colorado River to an unacceptable level for delivery to 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 what was to have been a temporary solution to the problem, the 100,000 ac-ft/yr did not figure into the Mexican Colorado River allocation during those years (AWR, 2003).

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. The pilot program started on May 3, 2010. The purpose of the pilot run is to operate the plant at one-third capacity for a period of one year to collect performance and cost data. The program is being funded by the USBR, with contributions from a consortium of three water authorities in Arizona, California, and Nevada.

In total, about 21,700 ac-ft of desalted water will be produced during the pilot run. This water will be combined with 7,300 ac-ft of untreated irrigation drainage water and the total amount will be discharged into the Colorado River and included in treaty deliveries to Mexico. The pilot run will allow retention of 29,000 to 30,000 ac-ft of water in Lake Mead that otherwise would have been released as part of required deliveries to Mexico. Before the pilot run started, an international agreement was reached with Mexico that provides additional water to the Ciénega de Santa Clara wetlands during the year-long program.

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 2.2 illustrates some of the production ranges of the YDP.

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

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

Table 2.2 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 Ciénega 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)

2.11.2 Advantages

Treating water by reverse osmosis 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 satisfy the potable-water requirements of the proposed Rosemont mine. The YDP is currently undergoing a pilot run. In October 2010, the Department of Interior reported that the plant appears to be operating better than expected and operating costs are coming in under budget.

2.11.3 Limitations

The YDP was operated two times since its completion in 1991 for testing purposes only. Although maintained during the intervening years, the operability of the YDP is uncertain, requiring a year-long pilot test that is currently underway.

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.

As a source of potable water for the proposed Rosemont, 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 the use of five commercial tankers per week, each with an approximate capacity of 9,000 gallons and each making a 235-mile round trip per week. Water also could be transported to the proposed mine site by constructing pumping stations and 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. A cistern would be required at the mine site for water storage and truck traffic would increase locally and at the mine site. Rosemont would be required to negotiate a water contract with the USBR, which manages the plant, as well as secure multiple permits and rights-of-way for construction of pumping stations, a pipeline, and accessory infrastructure if a pipeline is selected as the means of transporting the water.

A final limitation to this alternative concerns the issue of diverting the bypass drainage water now delivered to the Ciénega de Santa Clara wetlands to the YDP. Desalted water from the plant will be delivered to Mexico as part of an international treaty to provide 1.5 million ac-ft annually of water—allowing more Colorado River water to remain in Lake Mead. This change would be implemented to reduce or eliminate the risks of water shortage to area water users. The YDP was originally designed to treat the saline WMIDD water, but circumstances resulted in delivery of that water to the Ciénega de Santa Clara wetlands, and the wetlands are now sustained by the flow. Should the YDP become fully operational and treat all of the drainage water, the water would no longer be available to sustain the wetlands and would result in severe environmental impacts to the Ciénega.

2.11.4 Summary

Reverse osmosis 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 operability of the YDP be confirmed by the present pilot program, 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. Diverting flows from the Ciénega de Santa Clara wetlands could become contentious because of real or perceived environmental impacts to the wetlands.

3 Proposed Alternatives: Localized CAP Recharge and Recovery Water

The purpose of the 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 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 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 3.1 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 Underground Savings Facility (USF). The USF is one that physically stores water in the aquifer through direct recharge. The type of recharge water 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 (AWBA, 2010). The types of USFs are shown in Table 3.2

Table 3.2 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 Groundwater Savings Facility (GSF) is one that uses surface water (CAP water) instead of groundwater. The Arizona Water Banking Authority (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).

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-water⁶ contract from the CAWCD to purchase CAP water on a year-to-year basis (the only timeframe in which excess water can be purchased), and is investigating and contracting other CAP sources to ensure their total commitment. For the excess-water contract, Rosemont entered into three water-storage agreements with the CAWCD to store the purchase 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. These alternatives, listed below, were evaluated by SRK Consulting technical staff under the supervision of Corolla K Hoag.

⁶ “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 (sic) not constitute an assured water supply” (www.cap-az.com/operations/excess-contracts, accessed October 21, 2010).

- 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.

3.1 Pima Mine Road Recharge Project

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

3.1.1 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; they 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.

3.1.2 Advantages

The PMRRP is one of the three CAWCD-operated facilities currently used by Rosemont to store CAP water. The PMRRP is the storage facility closest to Green Valley where Rosemont's groundwater wells are 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.

3.1.3 Limitations

Rosemont requested to store additional CAP water at the PMRRP. The facility, however, does not have surplus recharge capacity because of use by existing customers (City of Tucson and Tohono

O'odham Nation). Consequently, Rosemont must store water at facilities in the northern portion of the Tucson AMA.

3.1.4 Summary

Rosemont has entered into an agreement to purchase excess water from the CAWCD on a year-to-year basis and has an existing agreement to store water at the PMRRP. The PMRRP facility is closest to Green Valley where Rosemont's groundwater wells are located. Use of this facility allows 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.

3.2 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.

3.2.1 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.

3.2.2 Advantages

The LSCR and the AVR 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.

3.2.3 Disadvantages

The LSCR and AVR locations are north of the Green Valley/Sahuarita area from which Rosemont will be pumping groundwater for use at the proposed mine site.

3.2.4 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 Green Valley/Sahuarita area of proposed Rosemont pumping.

3.3 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 the approximately 30,000 ac-ft/yr of groundwater required to irrigate its pecan orchards in the Sahuarita-Green Valley area; however, the facility is not yet in operation (Inside Tucson Business, 2010). This does not appear to be an alternative source of water or an alternative recharge facility for Rosemont.

3.4 841 Facility

This section describes the water rights of 841 Facilities specified by the Arizona Indian Water Rights Settlement Agreement in the Tucson 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.

3.4.1 Description

A 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 NIA⁷ 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

⁷ 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.

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.

3.4.2 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.

3.4.3 Limitations

The principal limitations to Rosemont securing a CAP water contract from a 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 because 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.

3.4.4 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.

3.5 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).

3.5.1 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 7 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).

3.5.2 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 the Rosemont Mine well site, 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 mines and farms.

3.5.3 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).

3.5.4 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.

4 Proposed Alternatives: Non-potable Industrial Process Water

This section of this report evaluates proposed alternative sources of non-potable water suitable for industrial processing. Rosemont will require approximately 6,132 ac-ft/yr of process water. 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.

The following sections were prepared by SRK technical staff under the direct supervision of Corolla K Hoag, R.G.

4.1 Waste Water 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 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 Dotson⁸, and the observations of SRK technical staff at various domestic and foreign mining operations.

4.1.1 Description of 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.

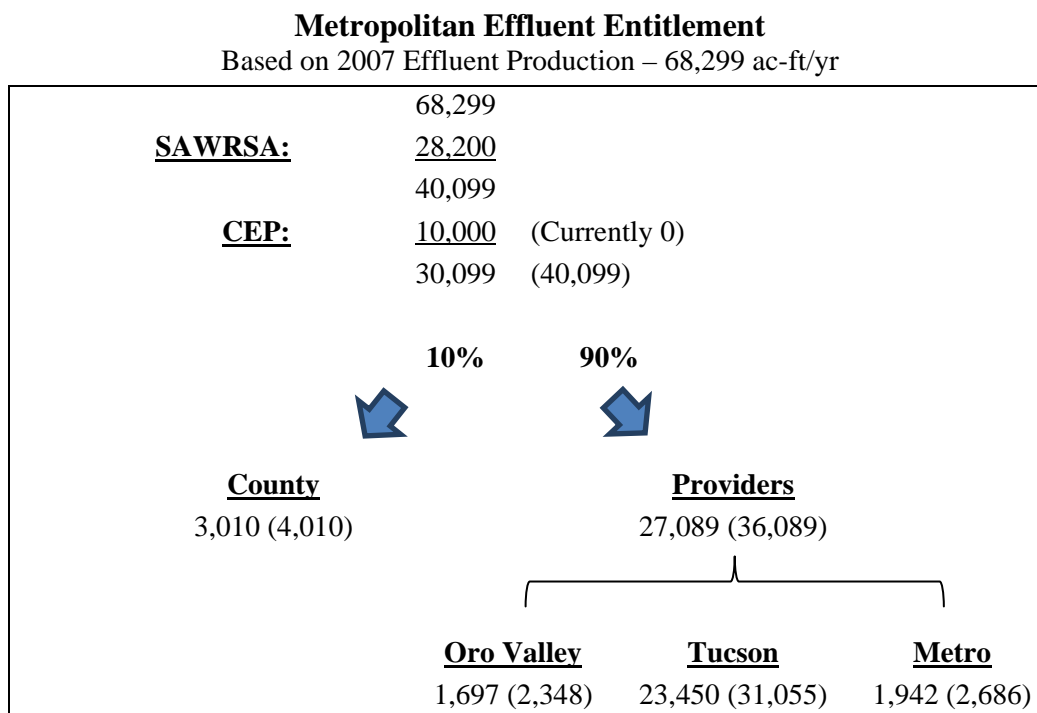
Pima County owns and operates the wastewater system for most of Pima County. A total of 72,588 ac-ft of effluent was produced in eastern Pima County in 2007, of which 68,299 ac-ft (94 percent) were produced in the metropolitan area (City of Tucson and Pima County, 2009a). Table 4.1 shows how 2007 effluent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

⁸ 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.

- Use in the City of Tucson reclaimed water system,
- Discharge to the Santa Cruz River, and
- Recharge in constructed facilities, the Santa Cruz River, and at the various outlying wastewater facilities.

Table 4.1 Metropolitan Effluent Entitlement



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

SAWRSA = Southern Arizona Water Rights Settlement Act

CEP=Conservation Effluent Pool

Green Valley Waste Water 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), with two treatment trains. The older, aerated lagoon system is a 2.1 mgd treatment process that produces Class B effluent. The newer, Biological Nutrient Removal Oxidation Ditch is a 2.0 mgd 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 Waste Water 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 (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 Waste Water 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) 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 by 2030, and that the City of Tucson would have annual entitlement to approximately 61,000 ac-ft by 2030 (Tucson Water, 2008).

4.1.2 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).

4.1.3 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.

4.1.4 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 continual, round-the-clock operation of a large fleet of commercial water trucks (semi-trucks with approximately 9,000 gal container capacity or 500 trucks/day) or 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—or it would require driving a tunnel through the Santa Rita Mountains. 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 it be possible to purchase both effluent and reclaimed water, two separate conveyance systems undoubtedly would be required.

4.1.5 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 be dependent upon available excess capacity and the ability to obtain water rights and permits.

4.2 Sierrita Mine Sulfate Plume Water

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

4.2.1 Description

Operation of a tailings impoundment 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 in a pipeline to the Rosemont mine site.

4.2.2 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.

4.2.3 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.

4.2.4 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.

4.3 Secretary of Interior Effluent and Managed Recharge Credit Recovery

The following section discusses the use of 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.

4.3.1 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 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).

4.3.2 Advantages

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

4.3.3 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 would not be available for use at the proposed Rosemont mine site. If a secure source of water could be obtained, 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. An additional limitation would be the legal impediments that may exist to obtaining a contract for a secure source of SAWRSA effluent or to purchasing Recharge Credits for later use.

4.3.4 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 for use at the proposed Rosemont mine site. 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.

4.4 Deep Aquifer Brackish Water

This alternative describes the advantages and limitations of using brackish water as an alternative source of water for process water at the Rosemont mine.

4.4.1 Description

The CNF did not provide a location for a deep aquifer for withdrawal of brackish water; therefore, the evaluation of this alternative discusses water quality and water transport from a well field to the proposed Rosemont in general terms.

The 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, possibly treating the water, and pumping it to the Rosemont mine site. Water treatment requirements and sludge disposal methods would depend upon the quality of the water pumped from the deep aquifer. There is usually some tolerance for lower quality process water, although there is no specific standard. The concentration of tolerable salts is highly dependent on the ore and the process used. 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.

4.4.2 Advantages

The use of brackish water from a deep aquifer for mining and process water at the proposed Rosemont 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. If required, treatment technologies are commonly available. Pumping technologies and infrastructure are common and long distance pipelines are a common method of transporting fluids.

4.4.3 Limitations

Water rights would be required to extract brine from a deep aquifer, and a permit would be required from ADWR/CDWR to pump approximately 6,132 ac-ft/yr. Pumping the required volume of water at a rate of 3,800 gpm from a deep aquifer will require considerable power consumption and specialized wells and pumps will be required because the brine will be corrosive. Water treatment requirements and the volume of sludge to be disposed of will be unknown until a suitable deep aquifer is identified, and the water rights and permits are secured.

4.4.4 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.

4.5 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.

4.5.1 Description

Sea water in its native state contains about 35,000 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.

4.5.2 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.

4.5.3 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.

4.5.4 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.

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6 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
LSCRIP	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

7 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:

- Manager of Plant Operations, where he was responsible for operation and maintenance of a 14,000 gpm water production system;
- Manager of an Environmental Water Testing Laboratory;
- Technical Manager where he conducted test on mine solutions treatment by ion exchange and reverse osmosis; and
- Manger of an in-situ copper mining leach project in which a membrane filtration system was designed to treat mine water effluents.

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.

Attachment A

List of Alternative Water Sources Provided by the Coronado National Forest