Groundwater Flow Modeling Conducted for Simulation of Rosemont Copper's Proposed Mine Supply Pumping Sahuarita, Arizona
Memorandum

To: Bev Everson
Cc: Tom Furgason
From: Kathy Arnold
Doc #: 8.6.9.1-029/09
Subject: Transmittal of Reports
Date: May 11, 2009

Rosemont is pleased to transmit three hardcopy versions as well as two CDs containing an electronic version of the following reports to the Forest Service for your review:

1. Heap Leach Facility Permit Design Report Volumes I and II, Tetra Tech
3. Groundwater Flow Modeling Conducted for Simulation of Rosemont Copper's Proposed Mine Supply Pumping Sahuarita, Arizona, E.L. Montgomery (CDs included at the back of reports)
4. Second Update to ADWR Model in Sahuarita/Green Valley Area, E.L. Montgomery (CDs included at the back of reports)

In addition, I am transmitting two hardcopies and one CD containing the electronic version of the reports to SWCA.

Note: Electronic copies did not include Emil Montgomery reports.
April 30, 2009
REPORT

GROUNDWATER FLOW MODELING CONDUCTED FOR SIMULATION
OF ROSEMONT COPPER’S PROPOSED MINE SUPPLY PUMPING,
SAHUARITA, ARIZONA

[Signature]

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1.0 INTRODUCTION

In accordance with arrangements with Rosemont Copper (Rosemont), Errol L. Montgomery & Associates, Inc. (Montgomery & Associates) has conducted groundwater flow modeling investigations for simulation of mine supply groundwater pumping from proposed locations near Sahuarita, Arizona. Investigations included development of a flow model suitable for evaluation of groundwater conditions in the area of proposed Rosemont water supply wells and for projection of groundwater level changes resulting from proposed mine-supply pumping. Location of the proposed Rosemont mine supply study area is shown on Figures 1 and 2.

Montgomery & Associates modified the latest version of the Arizona Department of Water Resources (ADWR) Tucson Active Management Area (TAMA) groundwater flow model for this investigation. ADWR provided Montgomery & Associates with the predictive version of the TAMA model on February 14, 2008. The TAMA model incorporates the previously published steady-state (1940) and transient (1941 through 1999) simulations (ADWR, 2006), and extends the model through a predictive period from 2000 through 2024.
The model is constructed using MODFLOW 2000 (Harbaugh and others, 2000). TAMA boundaries and geographic features are shown on Figure 1.

Preliminary work in support of the Rosemont water supply modeling included updating pumping and recharge in the TAMA model for the Sahuarita and Green Valley area for the period 2000 through 2037. A December 1, 2008 Montgomery & Associates technical memorandum submitted to ADWR entitled “Update to ADWR Model in Sahuarita/Green Valley Area” documents updates of simulated pumping and recharge to match reported data for the period 2000 through 2006 (Montgomery & Associates, 2008) and included limited revisions to predictive pumping and recharge for the period 2007 through 2037. A subsequent April 27, 2009 Montgomery & Associates technical memorandum submitted to ADWR entitled “Second Update to ADWR Model in Sahuarita/Green Valley Area” documents additional model updates to account for permitted and committed demands (Montgomery & Associates, 2009b) through 2037. The 2009 technical memorandum includes additional revisions to assumptions in the 2008 technical memorandum and is intended to wholly replace the first technical memorandum.

This current report documents local-scale modifications to the ADWR TAMA model, including grid refinement, aquifer parameter changes, and model layer thickness adjustments in the vicinity of proposed Rosemont mine supply groundwater pumping. Rosemont pumping is proposed to occur at two Rosemont properties located in Township 17 South, Range 14 East, Sections 17 and 21, respectively, as shown on Figure 2. Rosemont pumping is simulated for a 20-year period from 2012 through 2031. The simulated pumping rate is 5,400 acre-feet per year (AF/yr) for the first 8 years of operation (2012 through 2019), and 4,700 AF/yr for the last 12 years of operations (2020 through 2031). Model results presented herein include a comparison of simulated to observed groundwater level conditions in the study area and projections of groundwater level changes due to the proposed Rosemont pumping in the area.
2.0 PROJECT LOCATION

The study area encompasses approximately 355 square miles in the upper Santa Cruz basin, in an area located within Townships 16 and 18 South, and Ranges 12 and 15 East. The study area extends about 19.7 miles to the east and west, and about 18 miles to the north and south. This study area and the larger active model domain do not encompass the area of the proposed Rosemont pit, located on the east side of the Santa Rita mountains in an area that is considered hydraulically disconnected from the Santa Cruz basin groundwater flow system represented in the TAMA model. A location map of the study area is shown on Figure 2. Construction details on wells in the study area that are referenced in this report are presented in Table 1, based on information from ADWR well inventory databases.
3.0 SURFACE WATER CONDITIONS

Records from surface water gaging stations are available from the U.S. Geological Survey (USGS, 2008). Surface water in the vicinity of the Rosemont supply well study area is measured at Santa Cruz River at Continental (gage #09482000). Average annual streamflow at the Continental gage was retrieved from the USGS website (USGS, 2008) for the period 1941 through 2007 and is summarized in the 2009 technical memorandum (Montgomery & Associates, 2009b). Average annual flow rates range from 0.26 cubic feet per second (cfs) to 205.9 cfs for the period of record, excluding several years for which data was not available. Average annual flow was significantly higher than normal in years 1954, 1955, 1964, 1966, 1968, 1978, 1979, 1984, and 1993. Increased streamflow infiltration within the study area results from the increased streamflow. The USGS Continental gaging station is shown on Figure 3, along with the Rosemont study area.
4.0 HYDROGEOLOGIC FRAMEWORK

The Sahuarita area is in the Upper Santa Cruz Sub-basin of the TAMA, in the Basin and Range Lowlands Province of southern Arizona. The upper Santa Cruz basin is a broad, north-trending alluvial valley drained by the Santa Cruz River and its tributaries. In the study area, the upper Santa Cruz basin is bounded on the east by the Santa Rita Mountains and on the west by the Sierrita Mountains (Figure 1). These mountain ranges are comprised of complex configurations of igneous, sedimentary, and metamorphic rocks. The crystalline rocks which comprise these mountain ranges are collectively referred to as the “basement complex” because they also occur beneath the alluvial sediments in the valley between the mountain ranges.

At the deepest points, the upper Santa Cruz basin contains several thousand feet of alluvial materials eroded from the surrounding mountain ranges. The basin is filled primarily with alluvial and sedimentary deposits of Quaternary and upper Tertiary age (Davidson, 1973). The floor and sides of the basin are formed chiefly by low-permeability basement rocks that also comprise the mountain ranges which define the basin margins.

The Santa Cruz River and its tributaries are generally ephemeral throughout the study area, flowing only in response to periods of intense or prolonged rainfall. Precipitation tends to occur during mid- to late-summer and during the winter months. Based on climatological data, annual precipitation in the study area ranges from about 10 to 22 inches per year with an average of approximately 15 inches per year (Western Regional Climate Center, 2009). Most precipitation is lost through evapotranspiration and runoff, and the remaining fraction that infiltrates permeable recent alluvium moves downward to the aquifer as natural recharge.
4.1 HYDROGEOLOGIC UNITS

The principal units in the study area, in descending order, are: recent alluvium consisting of unconsolidated modern stream channel and floodplain sediments; Fort Lowell Formation of Quaternary age; Tinaja beds of Tertiary age; the Pantano Formation and the stratigraphically equivalent Helmet Fanglomerate of Tertiary age; and a bedrock complex of Precambrian to Tertiary age. Descriptions of geologic units in the vicinity of the study area are given by Anderson (1987), Cooper (1973), Davidson (1973), Montgomery & Associates (1992a, 1992b, 1994, and 1997), Malcolm Pirnie and Montgomery & Associates, (1998), and Pima Association of Governments (1983a and 1983b). The major hydrogeologic features of the study area are shown on Figure 4. Hydrogeologic sections A-A’ and B-B’, shown on Figures 5 and 6, respectively, from a 1998 hydrogeologic investigation of the area (Malcolm Pirnie and Montgomery & Associates, 1998), show the subsurface structure and relative disposition of the geologic units in the study area. Lithologic data from two test wells drilled on Rosemont properties, wells E-1 and RC-2 (Figure 2), are also used to characterize the site hydrogeology.

4.1.1 Recent Alluvium

The recent alluvium comprises stream channel and floodplain alluvium, and terrace deposits. The recent alluvium occurs chiefly beneath the channel and floodplain of the Santa Cruz River and tributary washes. In the upper Santa Cruz basin, thickness of recent alluvium ranges from zero at the contact with older rocks to probably no more than 100 feet (Davidson, 1973); the most extensive deposits occur along the floodplain of the Santa Cruz River. The alluvium consists chiefly of gravel and gravelly sand, silty gravel, and sand to sandy silt (Davidson, 1973). The most permeable recent alluvium consists of stream channel alluvium along the Santa Cruz River channel. Floodplain alluvium occurs outside the present river channel in some areas and contains substantial amounts of silt and clay; the floodplain alluvium is commonly underlain by coarser-grained, more permeable stream-channel
alluvium. Maximum thickness of the recent alluvium along the Santa Cruz River in the study area is about 80 feet (Figure 5). The recent alluvium provides the principal media for infiltration of ephemeral streamflow in the Santa Cruz River and its tributaries. Current groundwater levels throughout the study area occur below the base of the recent alluvium, except at the far north and south ends of the study area as shown on Figure 5.

4.1.2 Fort Lowell Formation

In general, the Fort Lowell Formation and Tinaja Beds are collectively referred to as basin-fill deposits. In the central part of the Santa Cruz basin, the Fort Lowell Formation and Tinaja beds are flat to gently-dipping; thickness ranges from a few feet at the margins of the basin to more than 1,200 feet, generally increasing with distance from the mountain areas (Cooley, 1973, and Oppenheimer and Sumner, 1980). Lithologic data from individual wells in the central part of the basin in the study area indicate that maximum thickness of the Fort Lowell Formation and Tinaja beds is more than 1,500 feet. In the upper Santa Cruz basin, the Fort Lowell Formation consists of a sequence of heterogeneous deposits of unconsolidated to weakly lithified, interbedded clayey silts, sandy silts, sands, and gravels (Davidson, 1973).

Lithologic data obtained from Rosemont wells E-1 and RC-2 indicates the thickness of the Fort Lowell Formation in the area ranges from about 180 to 210 feet in the vicinity of the Rosemont properties. At both wells, the depth to water is below the bottom of the Fort Lowell Formation, indicating the unit is unsaturated in the area. These data are presented in Montgomery & Associates (2007 and 2009a).

The Fort Lowell Formation and Tinaja beds comprise the principal aquifer in most parts of study area. In the vicinity of Rosemont’s proposed wells, the Fort Lowell Formation is generally unsaturated, and thus, the Tinaja beds comprise the principal aquifer. Reported pumping rates for wells perforated in the principal aquifer range from a few gallons per minute (gpm) near the basin margins to more than 3,000 gpm at some locations near the
Santa Cruz River. East from the Santa Cruz fault (Figure 4), pumping rates are generally much smaller. Proposed pumping rates for Rosemont’s proposed wells range from about 500 to 1,500 gpm.

4.1.3 Tinaja Beds

The Tinaja beds have been informally divided into the upper, middle, and lower Tinaja beds (Anderson, 1987). The Tinaja beds underlie the Fort Lowell Formation and consist of unconsolidated to poorly indurated, lenticular, interbedded, clayey silt, sandy silt, sand, and gravel strata. Most production water wells in areas east from the Santa Cruz fault produce groundwater chiefly from the upper part of the Tinaja beds and, where saturated, the lower part of the overlying Fort Lowell Formation. Based on lithologic data obtained from Rosemont test wells (Montgomery & Associates, 2007 and 2009a), thickness of the Tinaja beds in the Sahuarita area is more than 1,000 feet. Because the overlying Fort Lowell Formation is unsaturated in the area, the upper Tinaja beds will comprise the principal aquifer for Rosemont’s proposed water supply wells.

The upper Tinaja beds consist of clayey gravel to clayey silt in the central part of the Tucson basin. Outside the downfaulted part of the central basin, the upper Tinaja beds tend to be comprised of gravel or pebbly sand (Davidson, 1973). In the area of Rosemont’s proposed supply wells, the upper Tinaja beds consist of interbedded silty sand, sand, gravel, and clay (Montgomery & Associates, 2007 and 2009a). West of the Santa Cruz Fault, the upper Tinaja beds are on the order of 100 feet or less in thickness and are underlain by the lower Tinaja beds. East of the Santa Cruz Fault, the upper Tinana beds are on the order of a few to several hundred feet in thickness and are underlain by the middle Tinaja beds. Rosemont’s proposed supply wells are located east of the Santa Cruz Fault.

The middle Tinaja beds consist chiefly of moderately indurated, gypsiferous and anhydritic clayey silt to mudstone, with some cemented sands and gravels. In the area of
Rosemont’s proposed supply wells, the middle Tinaja beds consist chiefly of silty sand, mudstone, and siltstone (Montgomery & Associates, 2007 and 2009a). The middle Tinaja beds occur east from the Santa Cruz fault, and are absent west of the fault. Thickness of the middle Tinaja beds, where present, ranges from several hundred to a few thousand feet.

The lower Tinaja beds consist of a thick sequence of clayey silt, mudstone, gravel, and moderately lithified conglomerate. The lower Tinaja beds are more firmly cemented than the upper or middle Tinaja beds. In the study area, wells located east of the Santa Cruz fault were not drilled sufficiently deep to penetrate the lower Tinaja beds (Figure 6). On the west side of the Santa Cruz fault, the lower Tinaja beds have been penetrated by wells, but do not produce substantial quantities of groundwater.

### 4.1.4 Pantano Formation and Helmet Fanglomerate

Tertiary sediments lying below the Tinaja beds include the Pantano Formation and the stratigraphically equivalent Helmet Fanglomerate (Cooper, 1960). The Pantano Formation is comprised of reddish brown, poorly to moderately consolidated, silty, sandy conglomerate, with some sandstone, mudstone, and gypsiferous mudstone. In places, the sediments are interbedded with volcanic flows and tuffs and locally contain landslide debris and lenses of megabreccia (Anderson, 1987). Outcrops of the Pantano Formation near the basin margins are commonly strongly faulted and steeply-dipping. Near the basin margins, the thickness of the Pantano Formation ranges from zero to perhaps a few hundred feet. In the central part of the study area, the depth to the top of the formation is unknown, but is thought to be greater than 1,500 feet. Thickness of the Pantano Formation in the central part of the basin in the study area is unknown because very few wells penetrate the formation (Anderson, 1987). The Pantano Formation is generally poorly permeable.

The Helmet Fanglomerate appears in outcrop in the west part of the study area in or near the Sierrita Mountains and Helmet Peak, and has been mapped and described by the U.S.
Geological Survey (Cooper, 1960 and 1973). In the outcrop areas, the Helmet Fanglomerate is predominantly a matrix-supported, poorly-sorted conglomerate characterized by angular pebbles, cobbles, and boulders in a silty matrix. The Helmet Fanglomerate has been encountered at depth at many locations in the ASARCO Mission Mine area, northwest of Sahuarita, and is the principal aquifer for the Mission wellfield (located west from the Pima Mine Road recharge project shown on Figure 2). In the vicinity of the Mission production wellfield, thickness of the Helmet Fanglomerate may exceed 900 feet.

4.1.5 Bedrock Complex

For purposes of this report, the bedrock complex is informally defined as the strongly-lithified sedimentary rocks of Mesozoic and Paleozoic age, and volcanic and plutonic igneous rocks of Tertiary to Precambrian age which underlie the Pantano Formation and Helmet Fanglomerate. The bedrock complex occurs chiefly in and near the Sierrita Mountains in the west part of the study area, and in and near the Santa Rita Mountains in the southeast part of the study area. Except where abundantly fractured or weathered, the rocks which comprise the bedrock complex are poorly permeable and yield only small quantities of groundwater to wells. In the study area, the bedrock complex is believed to function as a relatively impermeable basal unit below the regional aquifer.

4.2 STRUCTURAL FEATURES

The study area lies in a north- to northeast-trending part of the upper Santa Cruz basin. The bedrock complex in the study area forms a structural depression lying generally between the Sierrita and Santa Rita Mountains. The principal geologic units that occur within the structural depression resulted from changing depositional environments prior to, during, and following the block-faulting episode that resulted in formation of the basin and the adjacent mountain ranges.
Placement of the Pantano Formation, Helmet Fanglomerate, and lower Tinaja beds occurred prior to formation of the upper Santa Cruz basin. As a result, these units are strongly faulted and tilted. These units are exposed along the margins of the basin and are buried in the central part of the basin by sediments deposited following formation of the basin structure. Pantano Formation outcrops along the east flank of the Sierrasita Mountains are the result of thrusting or gravity-induced sliding (Anderson, 1987). The middle and upper part of the Tinaja beds, the Fort Lowell Formation, and the recent alluvium were deposited during and following formation of the basin, and are often collectively referred to as basin-fill deposits. Generalized stratigraphic and structural relationships of the principal geologic units are shown in the hydrogeologic sections shown on Figures 5 and 6.

Davidson (1973) identified the Santa Cruz fault which parallels the Santa Cruz River (Figures 4 and 6). The Santa Cruz fault trends north-south and generally parallels the Santa Cruz River channel in the central part of the study area. Based on interpretation of drill cuttings and drillers logs for water wells and test holes, Davidson (1973) concludes that movement along the Santa Cruz fault postdates deposition of the Pantano Formation, the Helmet Fanglomerate, and the lower part of the Tinaja beds.
5.0 GROUNDWATER CONDITIONS

5.1 OCCURRENCE AND MOVEMENT OF GROUNDWATER

Patterns of groundwater movement in the study area are controlled by location and quantity of groundwater recharge and discharge, including groundwater pumped from wells, and by the hydraulic conductivity and saturated thickness of the aquifer media. Groundwater level measurements from the ADWR Groundwater Site Inventory were used to prepare late 2004 through early 2005 groundwater level contours as shown on Figure 7. Measured altitude of groundwater level in the basin fill sediments ranges from more than 3,000 feet above mean seal level (feet msl) in the south and along east and west boundaries, to less than 2,500 feet msl at the north end of the study area. Measured altitude of groundwater level in the area of Rosemont’s proposed pumping ranges from about 2,550 to 2,600 feet msl.

Direction of groundwater movement along the Santa Cruz River channel is generally parallel to the Santa Cruz River from south to north. In general, groundwater movement west of the river is toward the northeast, and groundwater movement east of the river is toward the northwest. Groundwater level altitude contours in the vicinity of the Rosemont properties indicate that groundwater flow gradient is toward the northwest.

5.2 GROUNDWATER RECHARGE

Within the Rosemont study area, groundwater recharge includes natural recharge due to infiltration of precipitation and surface runoff; incidental recharge due to agricultural irrigation and mine tailing seepage; and artificial recharge at Underground Storage Facilities (USFs), including wastewater treatment facilities.
5.2.1 Natural and Incidental Recharge

The principal source of recharge in the study area is from infiltration of streamflow along the Santa Cruz River channel and tributary washes. Another important source of natural recharge occurs along the mountain fronts as a result of infiltration of runoff originating in the mountain areas near the basin margins. These two sources are the principal components of natural groundwater recharge in the study area. Incidental recharge from agricultural irrigation, and seepage from mine tailing impoundments provides relatively less recharge to the aquifer in the study area.

Rates of natural recharge from infiltration of streamflow in the study area are principally a function of the occurrence of streamflow and the hydraulic properties of the stream channel alluvium and underlying basin-fill deposits. The occurrence of streamflow is controlled chiefly by amount, intensity, and areal distribution of precipitation. Precipitation in the study area results chiefly from convective storms during the summer monsoon season during July through September and from frontal storms during the winter season during December through February. The Santa Cruz River and tributary washes are ephemeral and generally flow only in direct response to precipitation events.

Average annual natural recharge rates along the Santa Cruz River were estimated by Osterkamp (1973) as 320 to 370 acre-feet per mile (AF/mi) for the reach of the river channel in the study area. Burkham (1970) developed a methodology for estimating average annual volume of infiltration along the main stream channels of the Tucson Basin. Reach 1 of Burkham’s study overlaps with the Rosemont study area, as shown on Figure 3. For 1941 through 2007, Montgomery & Associates calculated an average annual stream channel infiltration of approximately 12,355 AF/yr for Reach 1 using Burkham’s methodology; calculated infiltration rates were used to update the TAMA model (Montgomery & Associates, 2009b). This annual average equates to 434 AF/mi for the 28.5 mile length of
Burkham’s Reach 1, a number that is likely substantially larger in the upstream portion of Reach 1 and less in the downstream portion of Reach 1, based on observations by Burkham.

Average annual recharge along the basin margins in and adjacent to the study area was estimated by Osterkamp (1973) to be 4,000 AF from the Sierrita Mountains to the west and 5,700 AF from the Santa Rita Mountains to the east.

Incidental recharge in the study area includes agricultural return flow from pecan grove irrigation and seepage from mine tailing impoundments near the west margin of the basin:

- Irrigation of pecan groves by Farmers Investment Company (FICO) occurs along the Santa Cruz River west and south from the Rosemont properties, as shown on Figure 2. Based on a reported annual groundwater withdrawal of 23,765 AF by FICO for 2006, and assuming an irrigation efficiency of 75 percent for pecan groves (ADWR, 1999), incidental recharge from irrigation of pecan groves in the study area is estimated to average approximately 5,941 Af/yr.

- Seepage from mine tailing impoundments in the study area historically or currently occurs from the Sierrita tailing (estimated at approximately 7,500 AF/yr in 2006); Esperanza tailing (estimated to no longer be discharging); and Twin Buttes tailing (estimated to no longer be discharging). Locations of the tailing impoundments are shown on Figure 2. Published seepage rates for the impoundments are presented in the 2009 technical memorandum (Montgomery & Associates, 2009b).

### 5.2.2 Recharge at Constructed Facilities

Artificial recharge is attributed to four USFs in the Rosemont study area: Pima Mine Road Recharge Project (PMR), Robson Ranch Quail Creek (RRQC), San Xavier Arroyos
Project (SXAP), and Sahuarita Wastewater Treatment Plant (SWWTP) (pending USF permit). Green Valley Wastewater Treatment Plant (GVWWTP) was historically recharging the aquifer; however, effluent from the plant is now recharged at RRQC. Recharge locations are shown on Figure 2. All four USF facilities are currently recharging the aquifer. Details of recharge data for the USFs and simulated recharge rates for the modeling period are presented in the 2009 technical memorandum (Montgomery & Associates, 2009b). Source water and reported 2007 recharge rates (most recent year available for all sites) simulated in the current model are as follows:

- PMR – Central Arizona Project (CAP) water: 21,506 AF/yr
- RRQC – effluent from Green Valley: 1,590 AF/yr
- SXAP – CAP water: 1,200 AF/yr
- SWWTP – effluent from Sahuarita: 50 AF/yr

5.3 GROUNDWATER WITHDRAWALS

Groundwater withdrawals for agricultural irrigation, mining, public water supplies, domestic uses, and recreational supplies in the study area have resulted in groundwater level declines in the area. Historic and present groundwater withdrawals are one of the principal factors influencing direction of groundwater movement in the study area. Approximate 2006 groundwater withdrawals (based on ADWR published data) by non-exempt well owners in the study area were approximately 82,000 AF:

- Agricultural – Farmers Investment Company (FICO) pumped approximately 30,000 AF for pecan grove irrigation at several pumping locations within the study area, shown on Figure 2.
Mining – Pumping associated with ASARCO Mission and Freeport-McMoran Sierrita mines for 2006 was 33,400 AF. Groundwater withdrawals by ASARCO occur from wells located west of the Santa Cruz River in the north-central part of the model study area, approximately west from the PMR recharge site (Figure 2). Groundwater withdrawals by Freeport-McMoran Sierrita occur from wells located in the Canoa Land Grant area in the south part of the study area, from wells located immediately west from Green Valley, and from wells located along the west edge of the Sierrita Mine tailings impoundment near the west margin of the basin (Figure 2).

Public and recreational supply – Pumping by public water providers in the study area during 2006 was 18,700 AF. Major water providers include: Community Water Company of Green Valley, Green Valley Domestic Water Improvement District, Las Quintas Serenas Water Company, Farmers Water Company, Rancho Sahuarita Water Company, and Quail Creek Water Company. Withdrawals include pumping for recreational purposes; predominantly for golf course irrigation.

Future groundwater withdrawals documented in the 2009 technical memorandum (Montgomery & Associates, 2009b) include the following proposed increases in groundwater pumping in the study area:

- Arizona State Land Department (ASLD) – Sahuarita Area Conceptual Plan: ASLD has submitted an application for an Analysis of Assured Water Supply to ADWR for a total committed demand of 14,973 AF/yr on state lands that are in the immediate vicinity of Rosemont’s properties. Pumping is simulated to begin in 2012 with full build-out reached in 2031.

- Sahuarita Water Company (SWC): SWC has submitted an application for modification to ADWR to increase SWC’s Designation of Assured Water Supply to 10,983 AF/yr to accommodate new residential developments. Pumping is simulated
to begin in 2010 with full build-out reached in 2037. At its closest point, the SWC service area is located approximately 2 to 3 miles west of the Rosemont properties.

5.4 HISTORIC GROUNDWATER LEVEL CHANGES IN THE STUDY AREA

Overall groundwater levels in the study area have declined because more groundwater has been withdrawn from the regional aquifer during the past several decades than has been replenished by recharge. Hydrographs of groundwater level changes for 32 wells in the vicinity of the Rosemont properties are shown on Figures 8 through 15. Locations of the selected wells are shown on Figure 7.

Trends in groundwater level changes vary by location within the Rosemont study area. Some general observations include:

- The rate of groundwater level decline has decreased since 1980, compared to the rate of decline from the previous 4 decades.

- Measured groundwater levels during the last 10 years for wells nearest the Rosemont properties are generally declining at a rate of 1 to 2 feet per year, shown on Figures 9, 10, and 11.

- Measured groundwater levels during the last 10 years for wells in the northern part of the study area are declining at similar rates as those nearest the Rosemont properties, but in some cases, are rising, as shown on Figures 8 and 13.

- Measured groundwater levels during the last 10 years for wells in the southern part of the Rosemont study area are declining at a faster rate than areas to the north, shown on Figures 12 and 14.
Groundwater recharge at PMR (Figure 7) and flood recharge along the Santa Cruz River have mitigated or reversed groundwater level declines in the central and northern portion of the Rosemont study area; relatively larger groundwater level declines to the south are associated with pumping in the Green Valley area.

Groundwater level hydrographs for wells on the Rosemont properties are shown on Figure 15. Both well RC-2 on the easternmost Rosemont property and well E-1 on the westernmost Rosemont property were constructed in 2007. Measured groundwater levels in these wells fluctuate seasonally, corresponding to the irrigation pumping cycles at the pecan groves in the study area. Groundwater levels for these wells are lowest in June and July and recover in the winter months to the highest observed levels. The groundwater levels in Figures 8 through 14 are generally measured once per year by ADWR during winter months, and therefore do not show the seasonal fluctuation caused by agricultural pumping in the area. Groundwater levels measured in the winter for wells E-1 and RC-2 are comparable to groundwater levels shown in hydrographs for Figures 8 through 14.

5.5 GROUNDWATER CONDITIONS IN THE IMMEDIATE VICINITY OF ROSEMONT PROPERTIES

Recent monitoring conducted by Montgomery & Associates on behalf of Rosemont indicates that groundwater levels in shallow residential wells located near the western Rosemont property are higher than groundwater levels measured in the deeper E-1 well on the western Rosemont property. Groundwater levels in the neighboring shallow wells also appear to vary less in response to seasonal agricultural pumping than groundwater levels in well E-1. Estimated average annual groundwater level altitudes in the shallow wells are shown on Figure 16 along with the average annual groundwater level altitudes measured in wells E-1 and RC-2 for comparison. As indicated in Figure 16, the average annual groundwater level altitudes in the shallow residential wells are approximately 60 feet higher.
in the area of E-1 on the west Rosemont property, a difference that decreases to a negligible amount to the east in the area of RC-2 on the eastern Rosemont property.

A hydrograph of continuously measured groundwater level altitudes in a shallow well that is being monitored in the vicinity of the westernmost Rosemont well E-1, is shown on Figure 17. This shallow well (D-17-14)17BDD is reported to be completed to a total depth of 345 below land surface (bls) and the deeper well E-1 is screened from 360 to 1,300 feet bls (Table 1). The observed annual groundwater level variation (non-pumping) in this well is approximately 28.5 feet, ranging from a maximum non-pumping depth of 173.5 feet bls in June 2008 to a minimum depth of 145 feet bls in March 2009, compared to approximately 100 feet of water level variation observed in well E-1 during the same period.

A hydrograph of continuously measured groundwater level altitudes in a shallow well that is being monitored in the vicinity of the easternmost Rosemont well RC-2, is shown on Figure 18. This shallow well 55-632039 is reported to be completed to a total depth of 380 feet bls and the deeper well RC-2 is screened from 359 to 1,211 feet bls (Table 1). The observed annual groundwater level variation in this well is approximately 10 feet, ranging from a maximum non-pumping depth of 232 feet bls in June 2008 to a minimum depth of about 222 feet bls in February 2009, comparable to the approximately 10 feet of water level variation observed in well RC-2 during the same period.

There is no indication of a perched shallow groundwater system in the vicinity of the Rosemont properties. Rather, the data indicates a measurable downward gradient chiefly due to pumping stresses from irrigation wells that are pumping from the deeper part of the aquifer, at the pecan groves west from the Rosemont properties. The downward vertical gradient is enhanced by fine-grained layers in the Tinaja beds which impede downward movement of groundwater, resulting in hydraulic head loss as the groundwater moves downward.
6.0 AQUIFER PARAMETERS

6.1 REGIONAL AQUIFER PARAMETERS

Transmissivity is defined as the ability of an aquifer to permit movement of groundwater through an aquifer in response to a hydraulic gradient, and is expressed as the rate of flow, in cubic feet per day, through a 1-foot wide vertical section of the aquifer at a 1:1 hydraulic gradient. In this report, transmissivity is expressed in units of feet squared per day per foot width of aquifer at a 1:1 hydraulic gradient (ft$^2$/d). Transmissivity is the product of hydraulic conductivity and vertical saturated thickness of the aquifer. Hydraulic conductivity is expressed as the rate of flow, in feet per day, through a square foot section of the aquifer at a 1:1 hydraulic gradient (ft/d).

The quantity of recoverable groundwater stored in an aquifer, or the quantity of water that can be added to storage, is a function of specific yield. The specific yield of an aquifer is the ratio of the volume of water which the aquifer will yield under gravity drainage to the total volume of the aquifer. Specific yield is generally expressed as a fraction or percentage and is dimensionless.

Aquifer transmissivity values computed from pumping tests at wells in the study area are shown on Figure 4 and summarized in Table 2. Computed transmissivity values range from less than 500 to about 53,500 ft$^2$/d, and in some cases, vary substantially over short distances. Estimates of transmissivity obtained from pumping tests are most available within a zone approximately 5 miles wide along and west from the Santa Cruz River, and are sparse outside that zone. Transmissivity data are also very sparse for the part of the study area south from Continental (Malcolm Pirnie and Montgomery & Associates, 1998).

Transmissivity tends to be largest near the Santa Cruz River channel and floodplain, and tends to be larger on the west side of the Santa Cruz fault than on the east side.
Transmissivity east of the fault is generally smaller, due to lower permeability of the Tinaja beds (Malcolm Pirnie and Montgomery & Associates, 1998).

Specific yield of an aquifer is much more difficult to quantify from pumping test results than is transmissivity, and most estimates of specific yield in the upper Santa Cruz basin are obtained from estimates for sediments which comprise the aquifer or from calibration of groundwater flow models. Anderson (1972) estimated that average specific yield for the aquifer in the upper Santa Cruz basin is about 15 percent. Travers and Mock (1984) assigned estimates of specific yield for the aquifer in the upper Santa Cruz basin for each square-mile section. In the vicinity of the study area, these estimated values of specific yield range from 3 to 17 percent; average is 9 to 10 percent.

6.2 RESULTS FROM PUMPING TESTS AT ROSEMONT WELLS

Pumping tests were conducted at Rosemont test wells (D-17-14)17bdd [E-1] and (D-17-14)21add [RC-2] during March and November 2007, respectively. Locations of these two wells are shown on Figure 4. Detailed pumping test results are provided in Montgomery & Associates (2007 and 2009a). Computed transmissivity in the vicinity of well E-1 is 2,670 ft²/d, and possibly larger. Computed transmissivity in the vicinity of well RC-2 is 1,340 ft²/d. Based on the results of pumping tests, the sustainable long-term pumping rates for production wells installed at these two locations were estimated to be approximately 1,500 gpm and 500 gpm, respectively.
7.0 GROUNDWATER FLOW MODEL

The Rosemont groundwater flow model (Rosemont model) documented in this report is based on the most recent ADWR model for the TAMA. The ADWR TAMA model (ADWR, 2006) was developed based on USGS models for Avra Valley (Hanson and others, 1990) and the Tucson basin (Hanson and Benedict, 1994). The ADWR TAMA model was calibrated to simulate equilibrium groundwater conditions based on 1940 groundwater levels and was calibrated to simulate transient groundwater conditions based on groundwater levels for the period 1941 through 1999. The model is constructed using MODFLOW 2000 (Harbaugh and others, 2000).

Montgomery & Associates was provided with a revised predictive version of the TAMA model by ADWR on February 14, 2008. The model version provided by ADWR was considered to be the most complete as of the date of receipt. The predictive ADWR model incorporates the previously published steady-state (1940) and transient (1941 through 1999) simulations (ADWR, 2006), and extends the model through a predictive period from 2000 through 2024. Initial work for Montgomery & Associates’ investigations included importing the ADWR TAMA MODFLOW 2000 input files into Groundwater Vistas (Rumbaugh and Rumbaugh, 2007), a graphical modeling interface. After the model input files were imported, updated pumping, recharge, mine tailing seepage, and streamflow data were obtained from various sources and were incorporated into the groundwater flow model. Montgomery & Associates’ changes to the ADWR TAMA model are documented in the technical memorandum, “Second Update to ADWR Model in Sahuarita/Green Valley Area” (Montgomery & Associates, 2009b). The 2009 technical memorandum documents updates to the model to reflect reported data through 2006, extension of the predictive period through 2037, and updates to all predictive stresses from 2007 through 2037. With the exception of changes documented in the current report, all model parameters, stresses, and boundary conditions remain unchanged from the 2009 technical memorandum.
The current report describes local-scale changes made to the model in the vicinity of the Rosemont properties and provides a basis for projecting future groundwater level changes due to proposed Rosemont pumping. Model modifications described in this report include: 1) refinement of model grid cell spacing in the vicinity of the proposed Rosemont supply wells, 2) revision of local lithology and hydraulic conductivity based on data obtained from drilling and testing of wells E-1 and RC-2, and 3) addition of Rosemont mine-water supply wells on the Rosemont properties.

\section*{7.1 MODEL GRID AND BOUNDARY CONDITIONS}

The ADWR TAMA model area encompasses the Upper Santa Cruz, Tucson, and Avra Valley basins, covering an area of 3,250 square miles (65 miles from south to north by 50 miles from east to west). The model grid for the most recent ADWR TAMA model contains 130 rows and 100 columns of grid cells, with a uniform grid spacing of 2,640 feet. For the current Rosemont model, the grid was refined to provide increased resolution of simulated groundwater levels and hydraulic gradients in the Rosemont supply well area. The refined grid, shown on Figure 19, is constructed with 155 rows and 135 columns of grid cells. In the region encompassing the proposed Rosemont supply wells, grid cell dimensions are 330 feet by 330 feet. Outside the area of the proposed Rosemont supply wells, grid cell spacing is specified at a maximum of 2,640 by 2,640 feet. To provide a stable numerical solution, the ratio of grid spacing between adjacent model cells is approximately 1.5 or less.

The grid is divided into 3 layers representing hydrogeologic units in the model domain. Layer 1 represents recent alluvium and the Fort Lowell Formation. Altitude of the base of Layer 1 is shown on Figure 20. In the vicinity of the Rosemont aquifer test wells E-1 and RC-2, altitude of the base of layer 1 was increased from the values used in the ADWR TAMA model to better represent the contacts of the Fort Lowell formation that are identified in the lithologic descriptions of drill cuttings from the wells (Montgomery & Associates,
2007 and 2009a). The area of increased layer 1 bottom altitude is shown on Figure 20. The layer 1 bottom altitude was increased to match the Fort Lowell contact encountered during drilling. Layer bottom was increased from 2,442 to 2,552 feet msl at well E-1 and from 2,500 to 2,609 feet msl at well RC-2; maximum model layer 1 bottom altitude increase was 110 feet in the area of well E-1. Layer 2 represents the upper Tinaja beds. Layer 3 represents the middle and lower Tinaja beds, and the underlying Pantano Formation.

Boundaries for each of the three model layers are shown on Figure 19. For each layer, model cells outside of the boundaries are specified as inactive cells. Model boundaries are defined chiefly by hydrogeologic barriers corresponding to mountains and hills surrounding Avra Valley, and the upper Santa Cruz and Tucson basins. Groundwater movement into the model domain occurs through a constant head boundary at the southern end of the upper Santa Cruz basin and a constant flux boundary at the southern end of Avra Valley. Groundwater movement out of the model domain occurs through a constant head boundary in northwestern Avra Valley near the Picacho Mountains and Picacho Peak. Distance from the south end of the Rosemont supply well study area to the constant head inflow boundary at the Santa Cruz County border is approximately 14.5 miles.

During grid refinement, existing cells are split in the east-west and north-south directions. With each well boundary cell split, pumping assigned to the original cell is relocated to the western and/or southern cell of the split cells. In the area of grid refinement, the distance of pumping relocation can be significant enough to affect model results. For this reason, Montgomery & Associates evaluated model wells within a 2-mile radius of the Rosemont properties and located pumping back to actual locations for each well. Pumping relocation during the grid refinement process for wells outside of a 2-mile radius and the primary grid refinement area do not significantly impact model results and were not relocated after refinement.
7.2 MODEL STRESS PERIODS AND INITIAL CONDITIONS

The current model includes steady-state, transient, and predictive simulation periods. The steady-state period (stress period 1) represents equilibrium groundwater conditions occurring in 1940. The transient simulation period extends from January 1, 1941, through December 31, 2006, and is divided into 66 one-year stress periods. The predictive simulation period extends from January 1, 2007 through December 31, 2037, and is divided into 31 one-year stress periods. Equilibrium groundwater conditions simulated in the steady-state stress period are used as initial conditions for the transient period. MODFLOW 2000 incorporates steady-state into the overall model as stress period 1.

7.3 AQUIFER PARAMETERS

Aquifer parameters specified in the model are hydraulic conductivity, transmissivity, specific yield, and storage coefficient. Parameters are assigned to each model layer depending on the layer type. A summary of transmissivity values obtained from aquifer pumping tests in the region is provided in Table 2. Locations of nearby aquifer pumping tests are shown on Figure 4. Construction details for selected wells are provided in Table 1. With the exception of the changes to the model described in the following text, aquifer parameters remain unchanged from the ADWR TAMA model.

7.3.1 Model Layer 1

Model layer 1 is identified as unconfined with hydraulic conductivity and specific yield specified. Within the study area, model hydraulic conductivity ranges from 2 to 250 ft/day; distribution of model hydraulic conductivity for layer 1 is shown on Figure 21. Specific yield ranges from 0.08 to 0.18; distribution of model specific yield for layer 1 is shown on Figure 22.
7.3.2 Model Layer 2

Model layer 2 is identified as confined/unconfined with hydraulic conductivity, specific yield, and storage coefficient specified. Depending on whether simulated water level in a given model cell is below or above the top of the layer, the model uses either specific yield or storage coefficient for that cell. In the vicinity of the Rosemont supply well study area, model hydraulic conductivity ranges from 1 to 81 ft/day; distribution of model hydraulic conductivity for layer 2 is shown on Figure 23. Specific yield ranges from 0.08 to 0.18, and storage coefficient is 0.0001 for the entire model area. Distribution of model specific yield for layer 1 is shown on Figure 24.

Review of lithology from Rosemont wells E-1 and RC-2 indicates that the Fort Lowell formation (model layer 1) is not saturated in the vicinity of the Rosemont properties (Montgomery & Associates, 2007 and 2009a). Therefore, transmissivity values obtained from aquifer testing at the E-1 and RC-2 wells represent aquifer parameters for model layers 2 and 3. Transmissivity assigned to the ADWR model in the vicinity of the Rosemont properties was determined to be too low in model layers 2 and 3. Calculated transmissivity at E-1 was 2,670 ft²/d. Calculated transmissivity at RC-2 was 1,340 ft²/d (Table 2). Based on the assumption that transmissivity decreases with depth due to compaction of the aquifer material and an understanding of the hydraulic properties of the Tinaja beds formation, and based on the upper Tinaja beds thickness represented in model layer 2, an assumption was made that two-thirds of the calculated transmissivity at each location is within layer 2, and one-third of the calculated transmissivity is in layer 3. In the area of the Rosemont properties, hydraulic conductivity values for the upper Tinaja beds (layer 2) were increased from those used in the ADWR model. The area of increased hydraulic conductivity is shown on Figure 23. Hydraulic conductivity was increased in this area from 4.0 ft/day in the vicinity of well E-1, to 4.4 ft/day, and from 1 ft/day in the vicinity of well RC-2, to 2.1 to 2.2 ft/day (Figure 23). As previously described, average layer thickness for the modified model layer area was increased up to 110 feet from the values in the ADWR model to better
represent the contact of the Fort Lowell formation. Current model transmissivity for layer 2 (calculated as hydraulic conductivity multiplied by current model layer saturated thickness based on measured groundwater levels) is approximately 1,783 ft²/d and 891 ft²/d, in the vicinity of wells E-1 and RC-2, respectively.

7.3.3 Model Layer 3

Model layer 3 is identified as confined/unconfined with transmissivity, specific yield, and storage coefficient specified. Transmissivity for model layer 3 is shown on Figure 25. The model assumes that transmissivity for layer 3 does not vary over time. However, depending on whether simulated water level in a given model cell is below or above the top of the layer, the model uses either specific yield or storage coefficient for that cell. In the vicinity of the Rosemont supply well study area, model transmissivity ranges from 30 to 2,440 ft²/day (Figure 25). Storage coefficient is 0.0001 for the entire model area; specific yield ranges from 0.05 to 0.09 in the Rosemont study area.

As previously described, an assumption was made that one-third of the total transmissivity at wells E-1 and RC-2 is in layer 3. In the area of the Rosemont properties, transmissivity values for the upper middle and lower Tinaja beds, and the underlying Pantano Formation (layer 3) were increased from those used in the ADWR model. The area of increased transmissivity is shown on Figure 25. Transmissivity was increased in this area from 875 ft²/day in the vicinity of well E-1, to 891 ft²/day, and from 80 and 130 ft²/day in the vicinity of well RC-2, to 446 ft²/day, as shown on Figure 25.

These changes combined with the changes to hydraulic conductivity in layer 2, and the relocation of the Ft. Lowell contact at the bottom of layer 1, improved the match between observed and simulated groundwater levels in the area; the observed and simulated groundwater level match in other parts of the regional model is unchanged. The changes are consistent with available pumping test data (Table 2).
7.4 COMPARISON OF OBSERVED AND SIMULATED WATER LEVELS

Contours of observed and simulated groundwater level altitudes for the 1940 steady-state simulation are shown on Figure 26; simulated steady-state groundwater levels are consistent with the 1940 simulated groundwater levels in the ADWR predictive TAMA model provided to Montgomery & Associates, although the match to measured groundwater levels is not excellent in the Rosemont supply well area. The quality of the measured 1940 groundwater level data in this area is unknown, and furthermore, the agricultural pumping that was occurring in the area in 1940 also may not be well represented by the model.

Contours of observed groundwater level altitudes for December 2004 through February 2005 are shown on Figure 7. In the vicinity of the proposed Rosemont supply wells, groundwater levels demonstrate as much as 100 feet of variability over the course of a year due to high-volume pumping of nearby agricultural wells in the pecan groves. Because ADWR groundwater level measurements are obtained during winter months when the agricultural pumping is at a minimum, the groundwater level contours reflect the highest groundwater level altitude surface for the year. All long-term data available for use in model calibration in the Rosemont property area is measured by ADWR in winter months. However, model-generated groundwater level altitude surfaces are based on annualized pumping, and represent the average between the extreme groundwater altitude lows in the summer months and groundwater altitude highs in the winter months. Therefore, seasonal variations in groundwater levels were factored in when comparing ADWR-measured winter-month groundwater levels to annual average model-simulated groundwater levels.

Model calibration was evaluated based on comparison of historic through current measured and simulated groundwater levels at wells in the Rosemont study area. Hydrographs of measured and simulated groundwater level altitudes from the refined model are provided on Figures 8 through 15. Hydrograph locations are shown on Figure 7. Seasonal variability of groundwater levels from continuous measurements at wells E-1 and
RC-2 (Figure 16) were used to evaluate measured groundwater levels for other wells obtained during winter months, for purposes of model calibration.

The match of observed and simulated groundwater level altitudes and groundwater level trends for hydrographs from wells within the Rosemont study area is reasonably accurate. To account for the difference between measured winter groundwater levels, and model-generated average groundwater levels, the seasonal groundwater altitude variations measured at wells E-1 or RC-2 were added to the hydrographs for wells in the vicinity of the Rosemont properties that are adjacent to the largest FICO wellfield (Figure 4). Model calibration is summarized as follows:

- Accounting for the seasonal variations shown in E-1 and the winter observed data, the model reasonably simulates average groundwater level altitude and groundwater level change for wells in the vicinity of the Rosemont properties, as shown on Figures 9 and 10. Late-time calibration is difficult to evaluate for wells in the vicinity of the Rosemont properties shown on Figure 11, as recent measured groundwater levels are unavailable, with the exception of well 21acd where the model is approximately 20 feet lower than observed.

- Match of observed and simulated groundwater levels is reasonable for wells located north and east from the Rosemont properties, shown on Figures 8 and 13. These wells are more distant from the seasonal influence of FICO pumping, with the exception of well 04bcb (Figure 8) where the average model groundwater levels are below the measured winter groundwater levels (note: well 04bcb is a City of Tucson supply well and groundwater levels in this area may also fluctuate in response to seasonal pumping demands from the well).

- For wells located south from the Rosemont properties, shown on Figures 12 and 14 (with the exception of well 07cdb1, which is located east from the Rosemont
properties but has no data collected since 1980), model calibration is reasonable. Observed groundwater level trends reasonably match the simulated levels. At well 01cda (Figure 14), simulated groundwater levels are substantially higher than observed levels. It should be noted that in this area south from Rosemont, continuous groundwater level data is not available to determine magnitude of seasonal fluctuations in response to agriculture pumping in this area to the south.

- Match of observed and simulated groundwater levels at Rosemont wells E-1 and RC-2 is reasonably accurate, as shown on Figure 15. Simulated groundwater levels provide an excellent match to the average observed groundwater level in well E-1. Simulated groundwater levels are approximately 20 to 25 feet below the average observed groundwater level in well RC-2.

7.5 SIMULATION OF ROSEMONT PUMPING 2012 THROUGH 2031

Rosemont mine-supply pumping was simulated from 2012 to 2019 at a rate of 5,400 AF/yr and from 2020 to 2031 at a rate of 4,700 AF/yr. Consistent with a demonstrated testing yield at well RC-2 of 500 gpm, pumping was simulated in the model at 806.5 AF/yr (500 gpm) at the eastern Rosemont property for the entire period of Rosemont pumping. The remaining pumping is evenly distributed between 3 wells on the western property, for both pumping periods, as shown in Table 3. Simulated pumping well locations are shown on Figures 27 through 36.

7.6 MODEL RESULTS

Projections of groundwater level altitudes, groundwater level drawdown, and the contribution of Rosemont pumping to groundwater level drawdown were evaluated at the
end of 10 years and at the end of 20 years of Rosemont pumping, years 2021 and 2031, respectively.

### 7.6.1 Projected Groundwater Level Altitude

Contours of projected groundwater level altitude at the end of 10 years of Rosemont pumping (year 2021) are shown on Figure 27; projected groundwater altitude within 2 miles of the Rosemont properties ranges from about 2,386 feet msl at the western Rosemont property to about 2,640 feet msl 2 miles southeast from the eastern Rosemont property. Contours of projected groundwater level altitude at the end 2021 for the scenario without Rosemont pumping are shown on Figure 28; projected groundwater altitude within two miles of the Rosemont properties ranges from about 2,450 feet msl southwest from the western Rosemont property to about 2,650 feet msl 2 miles southeast from the eastern Rosemont property.

Contours of projected groundwater level altitude at the end of 20 years of Rosemont pumping (year 2031) are shown on Figure 29; projected groundwater altitude within 2 miles of the Rosemont properties ranges from about 2,288 feet msl at the western Rosemont property to about 2,630 feet msl 2 miles southeast from the eastern Rosemont property. Contours of projected groundwater level altitude at the end 2031 for the scenario without Rosemont pumping are shown on Figure 30; projected groundwater altitude within 2 miles of the Rosemont properties ranges from about 2,385 feet msl southeast from the western Rosemont property to about 2,640 feet msl 2 miles southeast from the eastern Rosemont property.

A review of simulated and observed groundwater level hydrographs for wells E-1 and RC-2 (Figure 15) indicates that the model provides a reasonably accurate match to the average observed data at E-1 and is approximately 25 feet below the average observed data.
at RC-2. For purposes of projecting groundwater level altitudes it would be appropriate to adjust projected groundwater level altitudes upward by 25 feet in the vicinity of well RC-2.

The projected groundwater level altitudes are considered representative of annual average levels. Future groundwater level altitudes are expected to vary seasonally above and below the projected average, corresponding to the 100 feet of seasonal variation measured at well E-1 and the 10 feet of variation measured at well RC-2. These variations are expected to decrease as FICO agricultural pumping begins to convert to residential supply pumping in the next 10 years (described in the 2009 technical memorandum, Montgomery & Associates, 2009b).

7.6.2 Projected Groundwater Level Drawdown Since Start of Rosemont Pumping

Projected groundwater level drawdown since start of simulated Rosemont pumping was evaluated as the subtraction of model projected groundwater levels at the end of 10 and 20 years (2021 and 2031) of Rosemont pumping from model simulated groundwater levels at start of Rosemont pumping (end of year 2011).

Contours of projected groundwater level drawdown at the end of 10 years of Rosemont pumping (year 2021) are shown on Figure 31; projected groundwater drawdown within two miles of the Rosemont properties ranges from about 12 feet to about 88 feet at the western Rosemont property. Contours of projected groundwater level drawdown at the end of 2021 for the scenario without Rosemont pumping are shown on Figure 32; projected groundwater level drawdown within two miles of the Rosemont properties ranges from about 0 feet to about 30 feet to the east and north from the Rosemont properties.

Contours of projected groundwater level drawdown at the end of 20 years of Rosemont pumping (year 2031) are shown on Figure 33; projected groundwater drawdown within two miles of the Rosemont properties ranges from about 30 feet to about 187 feet at
the western Rosemont property. Contours of projected groundwater level drawdown at the end 2031 for the scenario without Rosemont pumping are shown on Figure 34; projected groundwater level drawdown within two miles of the Rosemont properties ranges from about 20 feet to about 125 feet northeast from the western Rosemont property.

The projected groundwater level drawdown is considered representative of annual average drawdown. Future groundwater level drawdown is expected to vary seasonally above and below the projected average, corresponding to the 100 feet of seasonal variation measured at well E-1 and the 10 feet of variation measured at well RC-2. These variations are expected to decrease as FICO agricultural pumping begins to convert to residential supply pumping in the next 10 years (described in the 2009 technical memorandum, Montgomery & Associates, 2009b).

### 7.6.3 Projected Groundwater Level Drawdown Due to Rosemont Pumping

Projected groundwater level drawdown due to Rosemont pumping was evaluated as the subtraction of model projected groundwater levels with Rosemont pumping from model projected groundwater levels without Rosemont pumping, at the end of years 2021 and 2031.

Contours of projected groundwater level drawdown due to Rosemont pumping at the end of 10 years of Rosemont (year 2021) are shown on Figure 35; projected groundwater level drawdown within 2 miles of the Rosemont properties ranges from about 5 feet to about 80 feet at the western Rosemont property. Contours of projected groundwater level drawdown due to Rosemont pumping at the end of 20 years of Rosemont (year 2031) are shown on Figure 36; projected groundwater level drawdown within 2 miles of the Rosemont properties ranges from about 10 feet to about 107 feet at the western Rosemont property. Maximum extent of projected groundwater level drawdown due to Rosemont pumping delineated by the 1-foot drawdown contour (Figure 36) is approximately 10 miles north from the western Rosemont property.
7.6.4 Estimates of Shallow Groundwater Level Changes

As previously demonstrated, model results are representative of the aquifer system within the upper and middle Tinaja beds, which is the main aquifer system in the area of the Rosemont properties east from the Santa Cruz fault. Model simulated groundwater levels are lower than those observed in shallow wells in the vicinity of the west Rosemont property, as described in Section 5.5 and shown on Figure 16. Other than data from the shallow residential wells near the Rosemont properties, there is insufficient data to characterize the shallow groundwater levels and modify the model to defensibly represent the downward vertical gradients observed. However, for purposes of determining projected groundwater level altitudes in shallow wells, it is expected that future shallow groundwater level estimates can be determined by adding approximately 60 feet to model projected groundwater levels in the area of the west Rosemont property, decreasing to 0 feet added in the area of the east Rosemont property. Estimates for future shallow groundwater level drawdown and for the contribution of Rosemont pumping to future drawdown are expected to be consistent with model projections, although there may some lag time as the drawdown propagates upward to the shallow portion of the aquifer.

As described in Section 5.5, annual variation of shallow groundwater levels is less than that observed in wells E-1 and RC-2. Future shallow groundwater level altitudes are expected to vary seasonally, corresponding to the 30 feet of seasonal variation measured at the shallow well near the Rosemont west property and the 10 feet of seasonal variation measured at the shallow well near the Rosemont east property. These variations are expected to decrease as FICO agricultural pumping begins to convert to residential supply pumping in the next 10 years (described in the 2009 technical memorandum, Montgomery & Associates, 2009b).
8.0 SUMMARY

Use of the updated ADWR TAMA model provides an efficient method for projecting local impacts in the area of the proposed Rosemont mine supply pumping while accounting for groundwater level impacts due to substantial regional pumping and recharge stresses within the area surrounding the Rosemont properties. Much of the work to update the regional pumping stresses in the ADWR TAMA model was collaborative with Dale Mason of ADWR. The TAMA model provides a publicly-reviewed platform which will facilitate peer review of the Rosemont model.

Results of this study provide a basis for determining potential groundwater level impacts to wells in the area which may occur during the 20-year Rosemont pumping period. Impacts will be focused in the immediate area around the proposed Rosemont pumping locations. Substantially larger and longer-term pumping as a result of planned residential development in the area will become the dominant groundwater level influence in the larger area.
9.0 REFERENCES CITED


TABLE 1. RECORDS OF SELECTED WELLS IN THE VICINITY OF ROSEMONT PROPERTIES

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<th>CADASTRAL LOCATION</th>
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<th>DEPTH (feet)</th>
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<th>REPORTED PUMPING RATE (gpm)</th>
<th>LAND SURFACE ALTITUDE (ft, msl)</th>
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<td>650</td>
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<td>---</td>
<td>D</td>
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<tr>
<td>(D-19-13) 16BAD</td>
<td>S-3</td>
<td>PHELPS DODGE SIERRITA, INC.</td>
<td>623113</td>
<td>MIN</td>
<td>5/9/1969</td>
<td>813</td>
<td>24</td>
<td>0-735</td>
<td>725-811</td>
<td>4,000</td>
<td>2,950</td>
<td>D,G</td>
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</tr>
<tr>
<td>(D-19-13) 17DDD</td>
<td>S-4</td>
<td>PHELPS DODGE SIERRITA, INC.</td>
<td>623114</td>
<td>MIN</td>
<td>1/7/1969</td>
<td>900</td>
<td>24</td>
<td>0-900</td>
<td>240-889</td>
<td>4,000</td>
<td>2,978</td>
<td>D,G</td>
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<td>(D-19-13) 20CDA</td>
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<td>PHELPS DODGE SIERRITA, INC.</td>
<td>623115</td>
<td>MIN</td>
<td>11/16/1969</td>
<td>900</td>
<td>24</td>
<td>0-803</td>
<td>793-900</td>
<td>4,000</td>
<td>2,990</td>
<td>G</td>
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<td></td>
</tr>
</tbody>
</table>

--- = Data not available

**WATER USE:**

IND = Industrial  
UTIL = Utility  
MUN = Municipal  
MON = Monitoring  
IRR = Irrigation  
T = Test  
C = Commercial  
S = Stock  
MIN = Mining  
PROD = Production  
DOM = Domestic  
SUBD = Subdivision  
U = Unused  
MINEX = Mineral Exploration

**DEPT, BL = Feet below land surface**

**gpm = Gallons per minute**

**ft, msl = Feet above mean sea level**

**LOG TYPE**

D = Driller  
G = Geologist  
J = Gamma Ray  
C = Caliper  
E = Electric  
N = Neutron  
T = Temperature  
V = Field Velocity  
Z = Other  
K = Dipmeter  
L = Lithologic

TABLE 2. SUMMARY OF AQUIFER TEST PARAMETERS IN THE VICINITY OF THE ROSEMONT SUPPLY WELLS

<table>
<thead>
<tr>
<th>CADASTRAL LOCATION</th>
<th>ADWR REGISTRATION NUMBER</th>
<th>WELL IDENTIFIER</th>
<th>DATE OF TEST</th>
<th>TRANSMISSIVITY (ft²/d) a</th>
<th>TRANSMISSIVITY (gpd/ft) b</th>
<th>AQUIFER THICKNESS (feet)</th>
<th>K (ft/d) c</th>
<th>SOURCE OF DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>(D-16-13) 35BBB</td>
<td>607787</td>
<td>M-6</td>
<td>07/22/1981</td>
<td>1,470</td>
<td>11,000</td>
<td>220</td>
<td>6.7</td>
<td>Malcolm Pirnie and Montgomery &amp; Associates, 1998</td>
</tr>
<tr>
<td>(D-16-13) 35BDD</td>
<td>607790</td>
<td>M-10</td>
<td>04/09/1982</td>
<td>1,260</td>
<td>9,400</td>
<td>78</td>
<td>16</td>
<td>Malcolm Pirnie and Montgomery &amp; Associates, 1998</td>
</tr>
<tr>
<td>(D-17-13) 01ACC</td>
<td>611142</td>
<td>Well No. 12</td>
<td>05/3/2007</td>
<td>8,730</td>
<td>65,000</td>
<td>---</td>
<td>---</td>
<td>Brown &amp; Caldwell, 2007</td>
</tr>
<tr>
<td>(D-17-13) 01BAC</td>
<td>611145</td>
<td>Well No. 19</td>
<td>05/10/2007</td>
<td>18,000</td>
<td>135,000</td>
<td>---</td>
<td>---</td>
<td>Brown &amp; Caldwell, 2007</td>
</tr>
<tr>
<td>(D-17-13) 01CDD</td>
<td>611144</td>
<td>Well No. 14</td>
<td>05/25/2006</td>
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<td>73,000</td>
<td>---</td>
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<td>Brown &amp; Caldwell, 2007</td>
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<tr>
<td>(D-17-13) 25CCD</td>
<td>608518</td>
<td>AN-1</td>
<td>05/21/1905</td>
<td>15,400</td>
<td>115,000</td>
<td>1,885</td>
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<td>Malcolm Pirnie and Montgomery &amp; Associates, 1998</td>
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<td>70,000</td>
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<td>Malcolm Pirnie and Montgomery &amp; Associates, 1998</td>
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<td>619904</td>
<td>SC-032A</td>
<td>03/--/1973</td>
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<td>(D-17-14) 17BDD</td>
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<td>E-1</td>
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<td>AN-2</td>
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<td>43,000</td>
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<td>07/06/1982</td>
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<td>400,000</td>
<td>540</td>
<td>99</td>
<td>Malcolm Pirnie and Montgomery &amp; Associates, 1998</td>
</tr>
<tr>
<td>(D-18-13) 04BDC</td>
<td>608529</td>
<td>I-6</td>
<td>01/ /76</td>
<td>10,700</td>
<td>80,000</td>
<td>186</td>
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<td>(D-18-13) 28BBB</td>
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<td>90,000</td>
<td>120</td>
<td>100</td>
<td>Malcolm Pirnie and Montgomery &amp; Associates, 1998</td>
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</table>

a  ft²/d = feet squared per day  
b  gpd/ft = gallons per day per foot  
c  ft/d = feet per day  
--- = no data available
### TABLE 3. SUMMARY OF SIMULATED ROSEMONT PUMPING FOR THE PERIOD 2012 THROUGH 2031

<table>
<thead>
<tr>
<th>YEAR</th>
<th>STRESS PERIOD</th>
<th>ROSEMONT EAST WELL</th>
<th>ROSEMONT WEST WELL 1</th>
<th>ROSEMONT WEST WELL 2</th>
<th>ROSEMONT WEST WELL 3</th>
<th>TOTAL</th>
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<td>2012</td>
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<td>1,531.2</td>
<td>1,531.2</td>
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<tr>
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<td>1,531.2</td>
<td>1,531.2</td>
<td>5,400</td>
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<td>1,531.2</td>
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<td>1,531.2</td>
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<td>5,400</td>
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<tr>
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<td>1,531.2</td>
<td>1,531.2</td>
<td>5,400</td>
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<tr>
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<td>1,531.2</td>
<td>1,531.2</td>
<td>5,400</td>
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<td>1,531.2</td>
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<td>1,297.8</td>
<td>4,700</td>
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<td>4,700</td>
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<td>4,700</td>
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<td>1,297.8</td>
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<td>1,297.8</td>
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<td>1,297.8</td>
<td>1,297.8</td>
<td>1,297.8</td>
<td>4,700</td>
</tr>
</tbody>
</table>

Rosemont East Well is located near well RC-2, at model coordinates 179509.39, 98716.78 in cell (113,99)
Rosemont West Well 1 is located near well E-1 at model coordinates 171308.62, 103841.30 in cell (98,75)
Rosemont West Well 2 is located at model coordinates 169937.67, 103582.33 in cell (99,70)
Rosemont West Well 3 is located at model coordinates 169009.55, 104461.4 in cell (96,68)
LOCATION MAP AND EXTENT OF ROSEMONT STUDY AREA

EXPLANATION
- Continuous Measurement Hydrograph Location and Well Identifier
- GWSI Hydrograph Location and Well Identifier
- Model Simulated Twin Buttes Tailing Seepage Cells
- Model Simulated Sierrita Tailing Seepage Cells
- Model Simulated Esperanza Tailing Seepage Cells
- Rosemont Property
- Recharge Project Boundary
- No-Flow Boundary
- FICO Wellfield Area
- FICO Agricultural Area

LOCATION MAP AND EXTENT OF ROSEMONT STUDY AREA

ROSEMONT COPPER
ERROL L. MONTGOMERY & ASSOCIATES, INC.
WATER RESOURCE CONSULTANTS

FIGURE 2
No-Flow Boundary

Contour of Measured Water Level Altitude, in feet above mean sea level

2,600

FIGURE 7

EXPLANATION

- Well Location for 2004-2005 Water Level Data
- Location of Groundwater Level Hydrograph and Well Identifier
- Location of Groundwater Level Hydrograph and Well Identifier Without 2004-2005 Water Level Data

Model Simulated Twin Buttes Tailing Seepage Cells
Model Simulated Sierrita Tailing Seepage Cells
Model Simulated Esperanza Tailing Seepage Cells
Rosemont Property
Recharge Project Boundary
No-Flow Boundary

Contour of Measured Water Level Altitude, in feet above mean sea level
FIGURE 8. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 01BAA, (D-17-14) 02BAA, (D-17-14) 03BAA, AND (D-17-14) 04BCB, PIMA COUNTY, ARIZONA
FIGURE 9. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 05CDA1 AND 05CDA2, (D-17-14) 06ACD, (D-17-14) 07DDD, AND (D-17-14) 08BDD2, PIMA COUNTY, ARIZONA
FIGURE 10. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 17DDB, (D-17-14) 17DCC, (D-17-14) 18ADC, AND (D-17-14) 19DBD, PIMA COUNTY, ARIZONA
FIGURE 11. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 21ACD, (D-17-14) 28DDA, (D-17-14) 29CCA, AND (D-17-13) 13ADB, PIMA COUNTY, ARIZONA
FIGURE 12. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 31BAC, (D-18-14) 08ADD, (D-17-15) 07CDB1, AND (D-18-14) 06DBA, PIMA COUNTY, ARIZONA
FIGURE 13. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-15) 06BAC, (D-16-13) 35ABB, (D-16-14) 19CCD, AND (D-16-14) 30CCD2, PIMA COUNTY, ARIZONA
FIGURE 14. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 30BBA, (D-17-13) 36BCC, (D-18-13) 01CDA, AND (D-18-13) 24BCB1 and 24BCB2
PIMA COUNTY, ARIZONA
FIGURE 16. GROUNDWATER LEVEL HYDROGRAPHS FOR WELLS (D-17-14) 17BDD [E-1] AND (D-17-14) 21ADD [RC-2]
PIMA COUNTY, ARIZONA
Shallow Monitor Well

(Explanatory notes)

Average Annual Groundwater Level Altitude, in feet above mean sea level, as measured in shallow monitor wells
Altitude of Land Surface: 2,724 feet above mean sea level

Depth to groundwater, in feet (pressure transducer measurement)

FIGURE 17. HYDROGRAPH OF DEPTH TO GROUNDWATER AT SHALLOW MONITOR WELL (D-17-14)17BBD, IN THE VICINITY OF WELL E-1, PIMA COUNTY, ARIZONA
EXPLANATION

Altitude of Land Surface: 2,824 feet above mean sea level
- Depth to groundwater, in feet (pressure transducer measurement)

FIGURE 18. HYDROGRAPH OF DEPTH TO GROUNDWATER AT SHALLOW MONITOR WELL 55-632039, IN THE VICINITY OF WELL RC-2, PIMA COUNTY, ARIZONA
EXPLANATION

Altitude for Base of Model Layer 1, in feet above mean sea level

- 2,279 - 2,300
- 2,301 - 2,350
- 2,351 - 2,400
- 2,401 - 2,450
- 2,451 - 2,500
- 2,501 - 2,550
- 2,551 - 2,600
- 2,601 - 2,650
- 2,651 - 2,700
- 2,701 - 2,750
- 2,751 - 2,800
- 2,801 - 2,850
- 2,851 - 2,861

Area of Refined Layer Bottom Altitude

No-Flow Grid Cells
Simulated Hydraulic Conductivity for Model Layer 1, in feet per day

- 2 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100
- 101 - 120
- 121 - 140
- 141 - 160
- 161 - 180
- 181 - 200
- 201 - 220
- 221 - 240
- 241 - 250

No-Flow Grid Cells

EXPLANATION

Rosemont Property
Simulated Specific Yield for Model Layer 1

- 0.08
- 0.09
- 0.10
- 0.11
- 0.12
- 0.13
- 0.14
- 0.15
- 0.16
- 0.17
- 0.18

EXPLANATION
- Rosemont Property
- No-Flow Grid Cell
Simulated Hydraulic Conductivity for Model Layer 2, in feet per day

- 1 - 11
- 12 - 21
- 22 - 31
- 32 - 41
- 42 - 51
- 52 - 61
- 62 - 71
- 72 - 81

Area of Refined Hydraulic Conductivity

No-Flow Grid Cells

EXPLANATION

Simulated Hydraulic Conductivity for Model Layer 2, in feet per day

- 1 - 11
- 12 - 21
- 22 - 31
- 32 - 41
- 42 - 51
- 52 - 61
- 62 - 71
- 72 - 81

Area of Refined Hydraulic Conductivity

No-Flow Grid Cells

EXPLANATION

Simulated Hydraulic Conductivity for Model Layer 2, in feet per day

- 1 - 11
- 12 - 21
- 22 - 31
- 32 - 41
- 42 - 51
- 52 - 61
- 62 - 71
- 72 - 81

Area of Refined Hydraulic Conductivity

No-Flow Grid Cells

EXPLANATION

Simulated Hydraulic Conductivity for Model Layer 2, in feet per day

- 1 - 11
- 12 - 21
- 22 - 31
- 32 - 41
- 42 - 51
- 52 - 61
- 62 - 71
- 72 - 81

Area of Refined Hydraulic Conductivity

No-Flow Grid Cells
FIGURE 24

EXPLANATION

- Rosemont Property
- Simulated Specific Yield for Model Layer 2
  - 0.08
  - 0.09
  - 0.10
  - 0.11
  - 0.12
  - 0.13
  - 0.14
  - 0.15
  - 0.16
  - 0.17
  - 0.18

- No-Flow Grid Cells

SIMULATED SPECIFIC YIELD FOR MODEL LAYER 2
Simulated Transmissivity for Model Layer 3, in square feet per day

- 30 - 250
- 251 - 500
- 501 - 750
- 751 - 1,000
- 1,001 - 1,250
- 1,251 - 1,500
- 1,501 - 1,750
- 1,751 - 2,000
- 2,001 - 2,250
- 2,251 - 2,440

Area of Refined Transmissivity
No-Flow Grid Cell
FIGURE 26. COMPARISON OF OBSERVED AND SIMULATED WATER LEVELS, CIRCA 1940, STEADY-STATE SIMULATION
No-Flow Boundary

Contour of Projected Groundwater Level Altitude, in feet above mean sea level

2,520
2,540
2,560
2,580
2,600
2,620
2,640
2,660
2,680
2,700
2,720
2,740
2,760
2,780
2,800
2,820
2,840
2,860
2,880
2,900
2,920
2,940
3,000

PROJECTED GROUNDWATER LEVEL ALTITUDE AT END OF 2021 (SP82) WITH ROSEMONT PUMPING

FIGURE 27
FIGURE 29

EXPLANATION

- **Simulated Location for Rosemont Supply Well**
- **Model Simulated Twin Buttes Tailing Seepage Cells**
- **Model Simulated Sierrita Tailing Seepage Cells**
- **Model Simulated Esperanza Tailing Seepage Cells**
- **Rosemont Property**
- **Recharge Project Boundary**
- **No-Flow Boundary**

**Contour of Projected Groundwater Level Altitude**, in feet above mean sea level

PROJECTED GROUNDWATER LEVEL ALTITUDE AT END OF 2031 (SP92) WITH ROSEMONT PUMPING

ERROL L. MONTGOMERY & ASSOCIATES, INC.
WATER RESOURCES CONSULTANTS
TUCSON, ARIZONA
2009

FIGURE 29

TUC-GIS\132.0903\ModelingFigures\SimulatedGWalt2031_WithPumping\04April2009
FIGURE 30

EXPLANATION

- Rosemont Property
- Recharge Project Boundary
- No-Flow Boundary
- Contour of Projected Groundwater Level Altitude, in feet above mean sea level

Model Simulated Twin Buttes Tailing Seepage Cells
Model Simulated Sierrita Tailing Seepage Cells
Model Simulated Esperanza Tailing Seepage Cells
Simulated Location for Rosemont Supply Well

PROJECTED GROUNDWATER LEVEL ALTITUDE AT END OF 2031 (SP92) WITHOUT ROSEMONT PUMPING

ERROL L. MONTGOMERY & ASSOCIATES, INC.
WATER RESOURCE CONSULTANTS
TUCSON, ARIZONA
2009

FIGURE 30
No-Flow Boundary
Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise.)

EXPLANATION
Simulated Location for Rosemont Supply Well
Model Simulated Twin Buttes Tailing Seepage Cells
Model Simulated Sierrita Tailing Seepage Cells
Model Simulated Esperanza Tailing Seepage Cells
Rosemont Property
Recharge Project Boundary
No-Flow Boundary
Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise.)

* Note: Positive groundwater level contours at Pima Mine Road Recharge Project reflect cessation of simulated recharge at end of 2020.
No-Flow Boundary

Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise.)

TUC-GIS\1232.0903\Modeling\Figures\SimulatedGWdrawdown2021_NoPumping\04May2009

PROJECTED GROUNDWATER DRAWDOWN AT END OF 2021 (SP82) WITHOUT ROSEMONT PUMPING

EXPLANATION

- Simulated Location for Rosemont Supply Well
- Model Simulated Twin Buttes Tailing Seepage Cells
- Model Simulated Sierrita Tailing Seepage Cells
- Model Simulated Esperanza Tailing Seepage Cells
- Rosemont Property
- Recharge Project Boundary
- No-Flow Boundary

* Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise.)

* Note: Positive groundwater level contours at Pima Mine Road Recharge Project reflect cessation of simulated recharge at end of 2020.
**No-Flow Boundary**

Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise)

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**EXPLANATION**

Simulated Location for Rosemont Supply Well

Model Simulated Twin Buttes Tailing Seepage Cells

Model Simulated Sierrita Tailing Seepage Cells

Model Simulated Esperanza Tailing Seepage Cells

Rosemont Property

Recharge Project Boundary

No-Flow Boundary

Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise)

* Note: Positive groundwater level contours at Pima Mine Road Recharge Project reflect cessation of simulated recharge at end of 2020.
No-Flow Boundary
Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise)

Helvetia Road
Duval Mine Road
Box Canyon Road
Santa Cruz River
Continental Road
San Xavier Indian Reservation
Pima Mine Road
Recharge Project*
Green Valley
Sahuarita
WWTP
Santa Rita Road
Robson Ranch
Quail Creek
San Xavier Arroyos Project

EXPLANATION
Simulated Location for Rosemont Supply Well
Model Simulated Twin Buttes Tailing
Seepage Cells
Model Simulated Sierrita Tailing
Seepage Cells
Model Simulated Esperanza Tailing
Seepage Cells
Rosemont Property
Recharge Project Boundary
No-Flow Boundary

Contour of Projected Groundwater Drawdown, in feet (Negative indicates groundwater level rise)

* Note: Positive groundwater level contours at Pima Mine Road Recharge Project reflect cessation of simulated recharge at end of 2020.

PROJECTED GROUNDWATER DRAWDOWN AT END OF 2031 (SP92) WITHOUT ROSEMONT PUMPING

FIGURE 34
No-Flow Boundary
Contour of Projected Groundwater Level
Drawdown, in feet, due to Rosemont pumping

Helvetia Road
Duval Mine Road
Santa Cruz River
Continental Road
San Xavier Indian Reservation
Box Canyon Road
Santa Rita Road
Recharge Project Boundary
Recharge Project
Green Valley
Sahuarita
San Xavier Arroyos Project
Pima Mine Road
Santa Cruz River
Santa Rita Range
San Xavier Indian Reservation
San Xavier Arroyos Project
Pima Mine Road
San Xavier Indian Reservation

EXPLANATION
Simulated Location for Rosemont Supply Well
Model Simulated Twin Buttes Tailing Seepage Cells
Model Simulated Sierrita Tailing Seepage Cells
Model Simulated Esperanza Tailing Seepage Cells
Rosemont Property
No-Flow Boundary
Contour of Projected Groundwater Level Drawdown, in feet, due to Rosemont pumping

PROJECTED GROUNDWATER LEVEL DRAWDOWN DUE TO ROSEMONT PUMPING AT END OF 2021 (SP82)

FIGURE 35

No-Flow Boundary
Contour of Projected Groundwater Level

Drawdown, in feet, due to Rosemont pumping

Helvetia Road
Duval Mine Road
Box Canyon Road
Santa Cruz River
Continental Road
San Xavier Indian Reservation
Pima Mine Road
Recharge Project
Green Valley
Sahuarita
Santa Rita Road
Robson Ranch
Quail Creek
San Xavier Arroyos Project

EXPLANATION
Simulated Location for Rosemont Supply Well
Model Simulated Twin Buttes Tailing Seepage Cells
Model Simulated Sierrita Tailing Seepage Cells
Model Simulated Esperanza Tailing Seepage Cells
Rosemont Property
Recharge Project Boundary
No-Flow Boundary
Contour of Projected Groundwater Level Drawdown, in feet, due to Rosemont pumping

PROJECTED GROUNDWATER LEVEL DRAWDOWN DUE TO ROSEMONT PUMPING AT END OF 2031 (SP92)