Lower Santa Cruz River (LSCR) Basin Study
Stakeholder Advisors Meeting
February 26, 2018
Comment and Recommendation Summary

Stakeholder Advisor Attendees	Organization
Evan Canfield	Pima County Regional Flood Control District
Mark Day	Attendee
Chuck Freitas	Tucson Regional Water Coalition, Tucson Water Citizens Advisory Committee (CWAC)
Hoshin Gupta	University of Arizona Hydrology and Atmospheric Sciences Department
Heide Kocsis	Arizona State Land Department
Val Little	TAMA Groundwater Users Advisory Council (GUAC)
Bill O'Brien	NextGen Engineering
Irene Ogata	Tucson Water
Greg Saxe	Pima County Regional Flood Control District
Beth Scully	Tucson Water
Mark Taylor	Westland Resources, Central Arizona Project Board Member
Selso Villegas	Tohono O'odham Nation
Kip Volpe	Vail Water Company
Jeff Yockey	Tucson Electric Power

LSCRB Study Attendees	Organization
Melanie Alvarez	Pima Association of Governments (PAG)
Lindsay Bearup	Bureau of Reclamation
Kathy Chavez	Pima County Office of Sustainability and Conservation
Lee Comrie	Pima Association of Governments (PAG)
Eve Halper	Bureau of Reclamation
Kathy Jacobs	University of Arizona/Center for Climate Adaptation Science and Solutions (CCASS)
Marie Light	Pima County Dept. of Environmental Quality
James MacAdam	Tucson Water
Mead Mier	Pima Association of Governments (PAG)
Ken Seasholes	Central Arizona Project

Purpose of the Stakeholder Advisor Meeting:

The purpose of the second Stakeholder Advisors Meeting on February 26, 2018 was to solicit input on the proposed supply-demand scenario combinations to be evaluated in the Study. A scenario is a set of assumptions used to help understand potential future conditions. Each combination consists of one scenario for future local climate ("supply scenarios") and one scenario for growth in the Central Arizona Project (CAP) Service Area (Pima, Pinal and Maricopa Counties) and availability of CAP supplies. These scenarios will be run through the CAP Service Area Model (CAP:SAM) to estimate future demand by water providers, and are referred to within the Study as "demand scenarios."

The supply scenarios selected by the LSCR Basin Study Project Team are: Best Case / Lower Emission Future; Worse Case / Higher Emissions Future, and Current climate (for the purposes of consistency with Arizona Department of Water Resources [ADWR] projections). The Best Case / Lower Emissions scenario will use the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP) 4.5, and the Worse Case / Higher Emissions Scenario will use IPCC RCP 8.5.

The "demand scenarios" are described fully in the table included in Appendix I. They are named according to the rate, type of growth pattern and assumptions about mining replenishment. The scenarios are: Baseline Growth; Slow Compact Growth; Slow Outward Growth; Rapid Outward Growth and Rapid Outward Growth with No Replenishment of Future Mine Pumping in Green Valley. Baseline Growth refers to the growth rate used by ADWR to estimate future water demand. Baseline Growth assumes the Arizona Department of Administration medium population growth series, the type of housing growth projected by each counties' Association of Governments and no change from the current climate. In Pima County, the current growth pattern is described as "mixed density," somewhere between compact and outward growth. Compact growth is associated with less dependence on groundwater within the LSCR Basin Study Area, which is identical to the Tucson Active Management Area – outward growth is associated with greater dependence on groundwater.

The proposed supply-demand scenario matrix presented to the Stakeholder Advisors is shown in Figure 1:

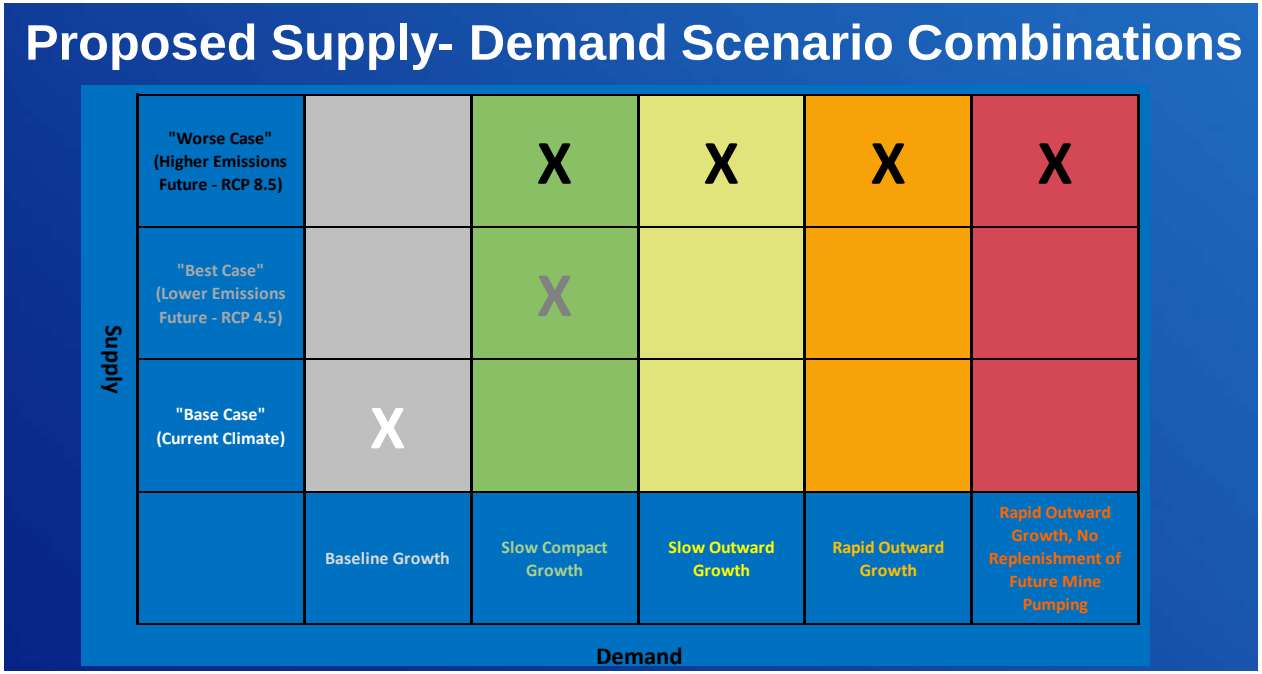

Figure 1 - Supply-Demand Scenarios Proposed to LSCR Basin Study Stakeholder Advisors

Stakeholder Advisors were asked to provide input on the following questions:

1. Do the proposed scenario combinations adequately describe the range of risk?
2. Should any scenario combinations be deleted?
3. Should any scenario combinations be added?

The meeting agenda, proposed supply/demand scenario combinations and presentations are available on the Pima Association of Governments LSCR Basin Study Website

Draft Summary of Stakeholder Recommendations:

1) There was consensus that the Rapid Outward Growth (with Replenishment of Future Mine Pumping in Green Valley) should be eliminated because (a) it is very similar to the Rapid Outward Growth without Replenishment of Future Mine Pumping in Green Valley scenario and therefore unlikely to provide critical information about the Active Management Area as a whole and (b) it would be straightforward to consider replenishment of future mine pumping in Green Valley as an adaptation measure.
2) After discussion about removing the Baseline Growth scenario (medium population series, mixed-density growth, no change in climate), there a recommendation to keep it, but to rename more appropriately as "Official Projections."
3) It was recommended that the Official Projections demand scenario be relocated in the middle of the columns within the matrix to better represent its position range of growth rates.
4) It was suggested that another scenario that assumes the same growth pattern as Official Projections, but under the Worse Case / Higher Emissions future be added to the matrix, so that impact of climate change alone could be identified for this growth scenario.
5) It was suggested that the Slow Outward Growth demand scenario be eliminated because the information it would provide can be reasonably approximated by looking at the results of Rapid Outward Growth in the early portion of the study period.

Draft Visual Summary - The Stakeholder Advisors recommended the following format for the supply-demand scenario matrix:

Draft Stakeholder Advisor Recommended Scenario Matrix, 2/26/2018

List of Draft Stakeholder Advisor Recommended Scenarios:

- **A** – Official Projections, medium population series, mixed-density growth, Current climate
- **B** – Slow, Compact Growth, Best Case climate
- **C** – Rapid, Outward growth, no mining replenishment Best Case climate
- **D** - Slow, Compact growth, Worse Case climate
- **E** – Medium population series, "mixed-density" growth, Worse Case climate
- **F** - Rapid, outward growth, no mining replenishment, Worse Case climate

Note – while Scenario E was not explicitly recommended, it was discussed positively by those remaining at the end of the meeting.

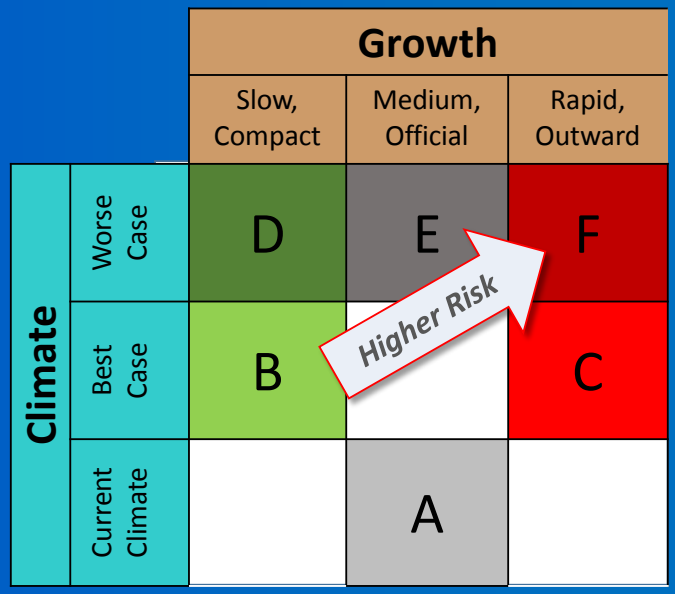

Figure 2- Stakeholder Advisor Recommended Scenario Matrix

Summary of questions and comments and related group discussion

(Where necessary, acronyms in original comments have been defined in *italics)*

	Questions and Comments Received at Stakeholder Meeting	Discussion
A	The objective of the study is to perform a stress test on our water supplies. As proposed, the scenarios lean too heavily on the Worse Case climate scenario. It may appear that we are prejudicing the study towards trying to modify behaviors. Is there a way to have a middle ground?	The Stakeholder Advisors agreed to be strategic about the scenarios to be evaluated. Evaluating several scenarios using the Worse Case climate was suggested to highlight the differences between demand scenarios. If the group feels that the proposed matrix should be changed, these changes will be recommended to the Project Team. We may want to evaluate a "middle ground" scenario across the range of climates to find the "trigger points" that identify when and where adaptation actions are needed.
B	Do we want to isolate climate impacts independent of demand? If we know the relationship between Best Case and Worse Case climate for the slow, compact growth demand scenario, can this relationship be generalized across the other demand scenarios?	It is hard to say if the relationship between one pair of scenarios can be generalized to other pairs. While there is value in pair-wise comparisons, we need to ask ourselves which factors we want to isolate. It seems logical to include the two most extreme scenarios as the "end-members," then the question is, what are we interested in? Once we decide that, we can select the pairs that provide that information.
C	What is the benefit of showing the Rapid Outward Growth scenario without replenishment of future mine pumping?	These scenarios were intended show the impact of the recharge projects planned for the Green Valley area. However, the planned Green Valley recharge project is relatively small compared to the LSCR Basin Study Area (Tucson Active Management Area), so there may not be much difference in the groundwater model output between these two demand scenarios. A more important comparison is the between Slow Compact Growth and Rapid Outward Growth because the latter is more likely to rely on groundwater to meet demand. If there is interest, replenishment of future mine pumping in Green Valley can be analyzed as an adaptation measure.
D	Does the Baseline growth scenario that assumes no climate change have value? Should it be removed? If kept, should it be re-named?	The Baseline growth demand scenario allows for comparison with existing water management plans. The climate Base Case (also referred to as Current climate) was included to maintain consistency with ADWR's projections, which do not account for climate change. Baseline growth reflects the officially adopted Arizona Department of Administration medium population projection series and the current trend toward "mixed density" housing, which is somewhere between compact and outward growth. It also assumes a declining rate of gallons per household per day, which is the current trend. After discussion about removing the Baseline

Questions and Comments Received at Stakeholder Meeting		Discussion
		scenario, there was agreement to keep it, but to rename it as "Official Projections," as it would be informative and consistent with Arizona state agency projections. It was suggested that when describing the Official Projections demand scenario, an explanatory footnote should be included, detailing the specific assumptions. It was also suggested that an additional combination that uses the same demand scenario pattern with the Worse Case / Higher Emissions climate be added to the matrix, so that impact of climate change could be isolated through a comparison.
E	How and when will the Basin Study assess water for the environment including the Santa Cruz River and groundwater dependent riparian ecosystems?	The surface water hydrology model will project evapotranspiration, streamflow and mountain block recharge for the Best Case and Worse Case climate scenarios. Impacts to flow in the Santa Cruz River, other streams and riparian areas will be evaluated after the selected supply/demand scenarios combinations are run for the surface water, groundwater and CAP:SAM models to identify areas of declining groundwater. Changes to effluent discharge into the Santa Cruz River will be addressed in the adaptation phase.
F	Will the LSCR Basin Study assess adaptation for land management infrastructure and address impacts on transportation, flood control levees and public health?	These impacts on facilities of concern to land managers can be evaluated in the risk analysis step of the study. Changes in land management that would reduce per-capita water use or otherwise affect water resources can be analyzed as part of the adaptation phase. The impacts of higher temperatures on water supply and demand also need to be incorporated into the scenarios to ensure these effects do not surprise water providers.
G	What assumptions about shortages to Central Arizona Project water are included in the CAP Service Area Model?	The CAP Service Area Model includes assumptions shortages to Central Arizona Project water supplies under future climate conditions over the study period (through 2060). In the case of less severe conditions, CAP shortages could be moderate and periodic. Under more severe conditions, they could be frequent and deep. While the time-series' of CAP shortages were not generated through mathematical models, they represent an expert opinion of a range of plausible shortage scenarios. This is the best information currently available.
H	How is recycled water considered in the CAP Service Area Model?	Recycled water is included in the model's calculation of demand if it is currently being delivered in a reclaimed system. The remaining recycled water is discharged, mostly to the Santa Cruz River, where it supports riparian habitat and replenishes groundwater. Some of the recycled water

Questions and Comments Received at Stakeholder Meeting		Discussion
		accrues long-term storage credits, the amount depends on the type of facility. In some cases, the CAP:SAM model projects that these long-term storage credits will be used by water providers to meet future Assured Water Supply rule requirements. Some recycled water could potentially be used for adaptation.
I	Does the CAP Service Area Model include all cities and towns?	The Service Area Model does not include city and towns boundaries, but includes all water providers in the three county CAP service area (Pima, Pinal and Maricopa Counties). Therefore, it covers the water providers serving cities, towns and unincorporated Pima County. The Service Area Model also includes known planned annexation areas.
J	How relevant is comparing the impacts of emissions scenarios (Worse Case / Higher Emissions vs. Best Case / Lower Emissions)?	The contrast between these two emission scenarios will help define the range of risk to infrastructure and the environment and inform the development of adaption measures.
K	Baseline growth is misplaced on the chart. It should be between the Slow Outward Growth and Rapid Outward Growth columns.	Baseline growth will be relocated on the chart between Slow Outward Growth and Rapid Outward Growth and referred to in the future as Official Projections.
L	The chart has no scenario for rapid compact growth.	The Tucson area has observed a slow, somewhat outward growth pattern without a lot of infill, per Ken Seasholes' presentation. Growth patterns in Pima County have also been trending toward lower density. Given current trends, rapid compact growth is not representative of expected growth patterns and therefore was not included.
M	Were environmental risks considered in these demand scenarios and where would they fit in?	Outward growth would result in increased groundwater pumping in outlying areas (compared to compact growth) that may exacerbate impacts to riparian areas.
N	Should the Slow Outward Growth and Rapid Outward Growth with mine replenishment in Green Valley demand scenarios be eliminated to simplify the matrix?	There was consensus that Rapid Outward Growth with mine pumping replenishment in Green Valley should be eliminated because (a) it is very similar to the Rapid Outward Growth without mining pumping replenishment and (b) it would straightforward to consider mine pumping replenishment as an adaptation measure. It was suggested that the Slow Outward Growth demand scenario be eliminated because the information it would provide can be approximated by looking at the results of Rapid Outward Growth in the early portion of the

	Questions and Comments Received at Stakeholder Meeting	Discussion
		study period. The Stakeholder Advisors suggest the following six supply/demand scenario combinations (see Figure 2): A. Official Projections - Current PAG projections, reflecting medium growth rate, mixed-density growth pattern and Current climate, conforming to ADWR's assumptions. B. Slow Compact Growth and Best-Case climate C. Rapid Outward Growth - No Replenishment of Future Mine Pumping in Green Valley and Best-Case climate D. Slow Compact Growth and Worse-Case climate E. Official Growth and Worse-Case climate F. Rapid Outward Growth - No Replenishment of Future Mine Pumping in Green Valley and Worse-Case climate Note – while Scenario E was not explicitly recommended, it was discussed positively by those remaining at the end of the meeting.

	Comments Received by Email	Responses
O	Will the study consider impacts of surface water use at Rancho del Lago golf course?	The surface water model will make projections about flows in Cienega Creek so that future risks can be evaluated and adaptation strategies can be developed
P	Golf courses on the periphery of the basin might become straws in the aquifer if the price of reclaimed water is raised. (The next round of rates from Tucson Water is proposing to raise their rates 5%, which isn't much after being frozen for 5+ years, but this is a big cost to courses hanging on by their nails... Just saying, if they choose to go back to pumping to avoid bankruptcy. Note: TW is promising to research the proper value of reclaimed water, so the proposed increases may be reversed eventually, but I wouldn't bet on that.	Thank you for your thoughtful comments on the effect of prices on water demand. The CAP:SAM model does not explicitly incorporate water pricing, but it may be possible to explore changes in water prices and associated demand responses as an adaptation measure. We will keep this in mind for later phases of the study.

	Comments Received by Email	Responses
	As a water economist, having intensively studied Tucson residential demand which is highly price sensitive (with some recent indications to confirm), it was a shock to learn Ken (*Seasholes*) puts little or no confidence in any price response. So, I know his black box does not, nor ever will, include any water price assumptions. He would only modify GPCD, if persuaded. We could discuss that further, if you wish. So, I bring a few economic factors to your attention which seem as though they might directly affect groundwater, as opposed to Tucson Water's residential demand, which is on the increase for at least the past year (~5%), I believe due to economic factors of the recovery from the Great Recession. My concerns about basin groundwater are wells going dry in outlying areas, which you are certainly aware of as PAG has studied them. Secondarily, I'm concerned about golf industry potential responses to reclaimed water costs, as mentioned, and farmers faced with CAP shortages, who would likely go back to well water. I assume that further development, or tree farm startups, if not controlled, could mine local aquifers even if there was compensatory water banking elsewhere. Not clear on how this might work in our basin. I trust you have a handle on mining-related issues. Generally, considering the low turnout at the second stakeholders meeting, I suspect you have a process perceived as highly technical, and that some stakeholders may feel they have little chance of affecting what goes into the process (or Ken's black box...). Perhaps some will take more interest in discussions about the outcomes and adaptations when those are considered.	

	Comments Received by Email	Responses
	At a recent CWAC meeting, I heard from and spoke with someone representing the golfing industry, concerning proposed increases in the reclaimed water rates. (I will say that I'm opposed to increasing them because every acre foot saved that way reduces future groundwater needs, and the prospect of paying a fortune for new water sources.) He said that his golf courses could be switched to groundwater, if he were to purchase water rights from another entity that he mentioned. So, that's an example of how water prices can drive demand down, or sideways in this case. Presumably, you should speak with him about the risks in that area. This is an area that begs for economic research; ie: the economic value of the golf industry in Tucson. (Note: he said that he wouldn't do it because it would conflict with political correctness, and create image problems...) I've already spoken with Ken, as I mentioned above, and discovered that his belief is that prices don't affect demand, but the reverse. On the practical side, establishing future pricing possibilities would be difficult, but I think some assumptions could be made that might benefit his model(s). Research on agricultural demand and pricing is not necessarily available, but considering farmers were unwilling to buy CAP water at its original price suggests there definitely is elasticity based on the price of water, in agriculture, which is the bigger player in most of the state, although perhaps not in the Tucson basin. (I'm told that there are at least preliminary data revealing price sensitivity for ag water in exchanges in Colorado.) I think the “black box” is Ken's models, not your part of the process, but that's a huge part of the process. I might be interested in hashing over some of them critically, but I doubt many others would, and it’s a given that no major adjustment would be supported by your grant, etc. But I will just say that ignoring the price of water is much like ignoring gravity. Just	

	Comments Received by Email	Responses
	because water's been seen flowing uphill to money doesn't mean there's no gravity. We've all grown accustomed to massive subsidies, but I hardly think the cost of water will be so low in the future. In any case, the CRB (*Colorado River Basin*) study is suspect since it included no price/demand piece (and, hopefully, that may only affect how to construct scenarios, not meaning the range of scenarios is insufficient to reflect probable outcomes). Putting scenario construction aside, unrecognized economic forces could greatly affect mitigation/response to some scenarios. (Note: The 'gravity' of price pressure on water demand is commonly distorted by subsidies which deflect the actual cost of delivery. Political considerations have long affected the price facing consumers, and have consequently modified their use substantially; the CAP 'postage stamp' rate is a key example of this. Others include how utilities price water served to their customers; some penalize larger users with higher prices, while others charge extremely high fixed charges to cover their costs. Reliance on volume-based charges usually has a considerable dampening influence on demand, while fixed charges can greatly reduce the incentive to conserve. Also, utility managers are often reluctant to recognize, or research, price and income effects on demand.)	

Appendix 1

Lower Santa Cruz River Basin Study
Demand Scenarios

These scenarios have been formulated to envision a range of conditions in the LSCR Basin (Tucson Active Management Area) given a set of driving forces.
The scenarios are being developed to provide specific input to:
CAP's Service Area Model (CAP-SAM), the surface hydrologic model (Sacramento-Soil Moisture Accounting Model) and the groundwater model (Tucson AMA Modflow Model).

	Low Risk				High Risk	
Driving Forces	**Slow Compact Growth**	**Slow Outward Growth**	**Official Projections (Medium, Mixed Density Growth)**	**Rapid Outward Growth**	**Rapid Outward Growth, No Replenishment of GW used by mines**	**Comments**
Demand Scenario Summary	Low growth series: condensed growth pattern, no additional mines, no overdraft in Green Valley	Medium growth series: outward growth pattern, new mine development, replenish Green Valley	Medium growth series	High growth series: outward growth pattern, new mine development, replenish Green Valley	High growth series: outward growth pattern, mining growth, no replenishment in Green Valley	Growth series from Arizona Department of Administration and growth pattern from PAG. Standard CAP-SAM assumptions
Municipal Demand: Population Growth Rate	Low Series	Medium Series	Medium	High Series	High Series	Arizona Department of Administration Population Series Projections https://population.az.gov/population-projections
Municipal Demand: Infill vs. Outward Growth	In-Fill/Redevelopment	Slow Outward	Baseline	Rapid Outward	Rapid Outward	Assumes outward growth will be dependent on groundwater needing replenishment outside area of hydrologic impact; and in-fill growth will use renewable water sources served directly
Municipal Demand: Gallons Per Household Unit Per Day	Decline faster than expected	Decline as expected	Decline as expected	No change in current GPHUD	No change in current GPHUD	Reflects current water conservation trends expressed in gallons per housing unit (GPHU) demand
Municipal Demand: Additional recharge	Year 2020	Year 2030	per current CAP-SAM assumptions	Year 2030	Never	Plan is to recharge 4,758 AFY CAP water at Project Renews site in Green Valley area, funded by Rosemont Mine owner. Therefore, linked to date of Rosemont Mine operation
Municipal Demand: Develop Ag Land or Undeveloped Land	Low GPHUD development tends to replace high water use ag land.	CAP-SAM Baseline	Baseline	Higher GPHUD development occurs on undeveloped land before replacing agriculture	Higher GPHUD development occurs on undeveloped land before replacing agriculture	CAP-SAM allows adjustment of preference for development on ag or undeveloped land; model will use current FICO build-out estimates
Agricultural Demand: Consumptive Use (CU) Crop	Some ag areas convert to low CU crops	No change in CU crops	Baseline	Some ag areas convert to higher CU crops	Some ag areas convert to higher CU crops	Ag Sub-team reports that current level of farming will continue with acreage approximately constant unless replaced by development.
Agricultural Demand: Groundwater Savings Projects	Highest savings start 2018	Highest savings start in 2018	per current CAP-SAM assumptions	Half of highest savings start in 2025	No savings	Phases I & II permitted for 11,000 AFY each; Interacts with urbanization of FICO land. (Urbanization of FICO land will displace Groundwater Savings Facility.) Tied to year of putting CAP agricultural pool water to use, provided it is available.
Industrial Demand: Manufacturing	Slow economic growth and/or greatly improved water use efficiency	Moderate economic growth within existing water service areas, expected improvements in efficiency	Baseline	Rapid economic growth that depends on groundwater, minimal improvements in efficiency	Rapid economic growth that depends on groundwater, minimal improvements in efficiency	Assumes outward growth will be dependent on groundwater replenished outside area of hydrologic impact; in-fill growth will use renewable water sources. Manufacturing assumed to grow in proportion to population in each service area.
Industrial Demand: Mining	No new mines	New mine in 2020-2030	Baseline	New mine in 2020-2030, Existing mines expand	New mine in 2020, Existing mines expand	Upper Santa Cruz Providers and Users Group, subject to impacts to shortages of Tohono O'odham CAP water allocation leased to ASARCO. 2013 Freeport NIA allocation application. Rosemont EIS, life of mine is 24.5 to 30 years. Start year as defined in application to ADWR for CAP Non-Indian Agricultural Water Allocation. Includes 30% expansion in two highest risk scenarios: Sierrita mine expansion plan may mean additional groundwater pumping, potential for increased intensity at existing mines.
Environment's Demand: Riparian Evapotranspiration	Changes with climate and availability of surface water and shallow groundwater	Changes with climate and availability of surface water and shallow groundwater	Baseline	Changes with climate and availability of surface water and shallow groundwater	Changes with climate and availability of surface water and shallow groundwater	8,000 AFY estimate from ADWR Tucson Active Management Area Model Report #24, page 14. Will be adjusted according to selected climate scenarios.