SAHRA Strategic Plan

I. SAHRA's Mission Statement

The mission of SAHRA, the NSF Science and Technology Center for Sustainability of semi-Arid Hydrology and Riparian Areas, is ***to promote sustainable management of water resources by conducting water resources-related science, education, and knowledge transfer in the context of critical water management issues of semiarid and arid regions***. For our purposes, "sustainable" can be defined as the development and use of water resources in a manner that can be maintained in the long-term without causing unacceptable environmental, economic, or social consequences. SAHRA is university-centered and its research activities are strongly focused around the physical and behavioral sciences. However, the power to define unacceptable consequences and to improve sustainability of water resources properly rests with society through elected officials, resource managers, and stakeholders at local, state, and national levels. What is required is an effective mechanism for synthesis, integration, education, and outreach, in support of better informed decision-making. SAHRA's purpose is therefore to inform and support such water professionals by conducting stakeholder-relevant research, education, and knowledge transfer activities. Consequently, SAHRA's mission to promote sustainable management implies two actions:

1) to research, in partnership with stakeholders and in a multidisciplinary context, critical hydrologic knowledge gaps (as currently defined by the three integrating questions) and identify unresolved uncertainties that limit our ability to assess and achieve "sustainable management" practices; and
2) to continually transfer advances in understanding to the decision makers and the public so they can evaluate the "sustainability" tradeoffs involved in any decision.

SAHRA's challenge is, therefore, to bring about a high level of coordination and integration across a broad range of scientific disciplines as well as among scientists, policy and decision makers, and the general public. SAHRA's approach is to (a) anticipate the future need for critical hydrological understanding in arid and semiarid regions by defining stakeholder-relevant questions that cannot be addressed by individual-investigator research; then, (b) bring together appropriate multidisciplinary teams of researchers to address these questions effectively; and (c) simultaneously build partnerships with a relevant spectrum of stakeholders (public agencies and private organizations) so that this new understanding will be effectively applied to the efficient and equitable management of water resources and to the rational implementation of public policy.

II. SAHRA's Institutional Environment

Changing the way water resources-related science is conducted and used in semiarid and arid regions requires phased long-term planning of Center activity. For the purpose of strategic planning, ***SAHRA's development is envisioned as occurring in four main phases***, as follows:

Phase 1 (Years 1-4):	Building the Center
Phase 2 (Years 5-8):	Building the Center Legacy
Phase 3 (Years 9-10):	Securing the Center Legacy
Phase 4 (Years 11+):	Propagating the Center Approach

At this writing, ***SAHRA has successfully completed Phase 1 and in the midst of Phase 2***. Consequently, this document primarily describes strategic plans for activity during Phase 2 and its relationship to Phase 3. However, strategic planning reflects past progress and may be influenced by longer-term considerations. Below we summarize relevant outcomes from Phase 1 and, to the extent they are currently known, potential opportunities during Phases 3 and 4.

Relevant Outputs from Phase 1

The key accomplishments of Phase 1 are summarized in Table 1. Much of the infrastructure that was developed during Year 1 persists, albeit with some significant modifications, and it will continue to provide the underlying basis for our activities during Phase 2. The foundations for communication, trust, and leadership within the Center that are critical for collaborative multidisciplinary and multi-institutional research planned for Phase 2 were also laid in the first year of Center operation. Major outcomes from Years 2 and 3 relevant to future planning include substantial progress towards the integration of scientific research within the Center, the rapid expansion and improvement of SAHRA's educational programs and outreach activities, and progress towards strengthening SAHRA's relationships with stakeholders and integrating the Center's research, education, and outreach activity. Past progress in these areas provides the basis for the increased attention that they receive during Phase 2. During Year 4, renewal funding for Years 6-10 of Center activity was secured and there was a significant management restructuring to enhance administrative efficiency and financial oversight. The revised management structure (described in detail in Section IIID) and the funding profile for Years 6-10 (Figure 1) are significant constraints on SAHRA's strategic planning for Phase 2 and beyond.

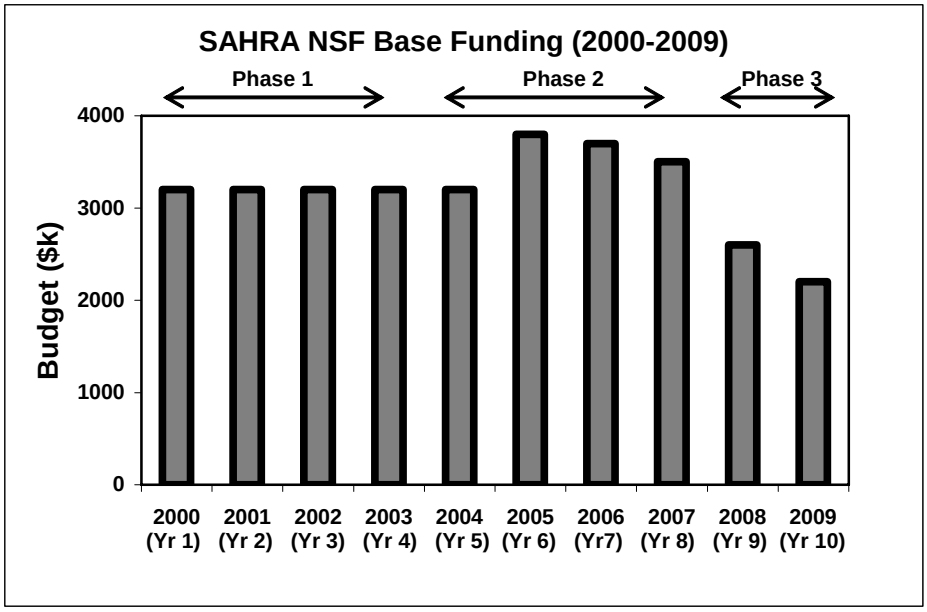
Table 1. Key accomplishments during Phase 1

Year	Activity	Accomplishments
1 (2000)	Establishing SAHRA	• Establish Executive Committee and External Advisory Board • Recruit professional and technical staff • Establish administrative and financial management structure
2 and 3 (2001 – 2)	Growth and Evaluation	• Strengthen, review and better define SAHRA's mission • Develop multidisciplinary teams • Recruit and integrate students and postdoctoral researchers • Integrate SAHRA's research, education, and knowledge transfer activities • Strengthen relationships with stakeholders
4 (2003)	Renewal and Transition	• Write renewal proposal and secure funding for Years 6-10 • Review the Center's budget, administrative and financial structures, and reporting procedures • Define SAHRA's scientific, stakeholder, knowledge transfer, and education activity through strategic planning • Transition toward a revised management structure with the departure of the founding Director in August 2003 and the Associate Director in January 2005

Projections for Phases 3 and 4

Detailed ***strategic planning of SAHRA activities during Phase 2 must occur with recognition of the opportunities for the long-term sustainability of SAHRA's activities during Phases 3 and 4.*** The NSF base-funding profile for SAHRA for the second five-year period includes a rapid decline in the final two years after Phase 2 (Figure 1). With this in mind, and to maximize the potential for propagating the SAHRA approach by demonstrating its success, strategic planning during Years 5-8 is strongly focused around activities that can realistically be completed and outputs that can realistically be provided by Year 8 (2007). NSF-funded activity during Phase 3 (Years 9-10) will contract dramatically and the likely consequences include significant changes in the relative balance with which the available NSF funding is deployed and some appropriate simplification of the management and financial structure of SAHRA.

Figure 1. SAHRA's NSF funding profile for the Period 2000-2009



SAHRA is committed to ensuring the lasting legacy of the Center beyond the 10 years of NSF funding and already is engaged in several pending and ongoing long-term funding opportunities (Table 2). However, due to the "public good" nature of water, it appears unlikely that funding for sustaining the SAHRA approach will be available from a single source. SAHRA's activities are more likely to be sustained through several proposals and initiatives focused on specific questions, activities and/or locations within the Southwest. In anticipation of this, strategic planning during Phase 2 includes identifying collaborative, multidisciplinary/multi-institutional research and outreach activities addressing specific research questions in specific river basins. The strategic plan also includes the intent that, in each case, there will be aggressive pursuit of additional leveraged funding to supplement or replace NSF funding for such activities as NSF funding progressively declines each year. In order to secure this funding, some redirection of SAHRA activity during Phases 3 and 4 in response to "market forces" ultimately seems inevitable.

Table 2. Long-term funding opportunities for SAHRA activities

Program	Funding Source	Activities to be funded	Status
Water Sustainability Program[1]	State of Arizona	Supports UA research focused on Arizona water issues through five funding sources: research grants, joint education and outreach, graduate student fellowships, center-directed initiatives and the recruitment and retention initiative.	Provides some current support of SAHRA activities in Arizona; funding fixed at $3.2 million for next 5 years
Focused Excellence - Earth and Environmental Programs / ESPRI[2]	University of Arizona	Potential support for faculty and research related to sustainability in the southwestern United States in general, and Arizona in particular, at University of Arizona	Program developing over the next decade; may include new building on campus and USGS partnership
Arizona Water Institute	Arizona Board of Regents	AWI is a consortium of the state's three universities, and focuses their faculty and researchers on issues related to sustaining water resources into the future in collaboration with state agencies and Arizona communities	AWI is in its first year of existence. Executive Director, Executive Committee and campus coordinators have been named. AWI currently does not fund projects.
CUAHSI[3]	NSF	Hydrologic observatories: potential to sustain some of SAHRA's field infrastructure; joint knowledge transfer activities; links between SGD and HIS	Rio Grande is a potential observatory – program status unknown; joint HIS activities started; KT activities being discussed
NEON[4]	NSF	Ecologic observatories: potential to sustain some of SAHRA's field infrastructure	Funding is possible within 2-3 years although status is unknown; semiarid observatory to be proposed
Sustainable Systems Industry[5]	Public and private entities in Arizona	Activities focused on water sustainability that build on "what is arguably the world's biggest and best water resource portfolio"	Proposed in Batelle report to the Governor of Arizona; currently unfunded
Salt Cedar and Russian Olive Control Demonstration Act	USDI or USDA	River restoration and invasive species removal; evaluation of restoration efforts	Legislation introduced in U.S. House and Senate, $20 million per year funding; implementation plans are being developed
National Water Technology Program – a.k.a the "Dominici Bill"	DOE National Labs	Basic and applied research and development in water supply technologies; national water supply law and policy institute to be located at UNM.	Bill introduced in Senate; $200 million per year funding requested; no action taken since then. Another bill related to water and energy efficiency also pending in Congress.

[1] http://www.uawater.arizona.edu/
[2] http://www.espri.arizona.edu/
[3] http://www.cuahsi.org/
[4] http://www.neoninc.org
[5] http://www.azcommerce.com/doclib/PROP/SSExecSum.pdf

III. SAHRA's Strategic Goals

A. Strategic Goals

During Phase 2 (Years 5-8), SAHRA is committed to building a lasting legacy in the field of integrated semiarid hydrology that will benefit future researchers, water agencies, and the private sector. Achieving this requires specification of appropriate long-term strategic goals, each related to a specific form of SAHRA's legacy, as follows:

1. **SCIENCE: New and improved understanding of semiarid hydrology**

   Create new and improved understanding of the complexities in, and impacts of, the interactions between physical, biological, economic, and human factors in semiarid hydrology, based in part on their accurate representation within an integrated modeling framework.

2. **STAKEHOLDER: Stakeholder/scientist dialog and mechanisms to support stakeholders in their decision-making**

   a) Initiate, sustain, and engage stakeholders and scientists in a dialog to stimulate and direct stakeholder-relevant research, by building confidence and mutual trust.

   b) With relevant stakeholders, jointly plan, develop, and implement tools such as models, management guidelines, and policy frameworks, in support of stakeholder decision-making.

3. **KNOWLEDGE TRANSFER: Dissemination and transfer of SAHRA-relevant knowledge to scientists, water professionals, elected officials and the public**

   a) Disseminate knowledge to the community of water professionals, elected officials, and scientists, to help them make more scientifically informed decisions on water policy and management.

   b) Widely disseminate knowledge about water and water-related issues so as to enhance general hydrologic literacy, leading to more scientifically informed choices by the public.

4. **EDUCATION: Enhanced multidisciplinary hydrologic literacy within the educational system**

   a) Develop the hydrologic literacy of K-16 students throughout the Southwest, leading to action and decision-making based on multidisciplinary knowledge of regional water issues.

   b) Produce a new and diverse generation of professionals, students, and faculty who are adept at approaching water issues from a multidisciplinary and basin-scale perspective and are able to communicate this perspective effectively to others.

5. **DIVERSITY: A center that reflects the Southwest United States**

   Create a demographic mix among SAHRA students, researchers, staff, and administration that more closely reflects the ethnic and gender mix of the population in the region within which SAHRA's primary activities occur, i.e., the southwestern United States and the U.S.-Mexico border region.

6. **MANAGEMENT: A management structure that adapts and responds to SAHRA's evolution**

   Implement a management structure that 1) delegates responsibility, where appropriate, to SAHRA middle management in order to enhance motivation, 2) facilitates efficient year-round monitoring of center activity and budgets, and 3) adapts in response to changing understanding, opportunities, and personnel.

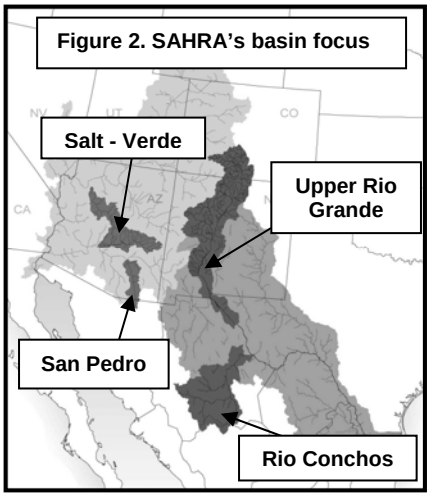
7. **INSTITUTION: An institution that will continue to deal objectively with the problems of water resources in semiarid regions**

   Develop an institution, with perceived value by state and federal agencies and the private sector, that will allow the stakeholder-responsive multidisciplinary science, knowledge transfer, and education activities that have been developed under NSF funding to continue into the future.

B. Science and Stakeholder Goals: Scope of Planned Activities

The ***strategic planning of science activities during Phase 2 is defined with respect to SAHRA's Science and Stakeholder Strategic Goals*** (Section IIIA) which seek to provide new and improved understandings of semiarid hydrology, ongoing stakeholder/scientist dialog and mechanisms to support stakeholders in their decision-making. Additional focus is necessary to ensure that the planned activities related to these goals are relevant to SAHRA's broader mission. This focus is provided by defining integrating research questions applied to specific river basins in the region. The integrating questions and basins both serve to focus the scope of research activities and relevant stakeholder engagement activities.

Three stakeholder-relevant integrating questions (Table 3) are used to focus SAHRA scientific research during Phase 2. These questions were defined by an evolutionary process during the first four years of SAHRA activity and were selected to reflect not only important and well-recognized stakeholder concerns, but also the capabilities of the scientists involved in SAHRA and to provide a research agenda sufficiently challenging to merit the attention of an NSF Science and Technology Center. The questions address issues related to riparian restoration and preservation, water markets, and the hydrologic impacts of land cover change, because it was recognized that these issues will soon become critical for the wise management of water resources in semiarid and arid regions and so engender stakeholder interest and involvement. Furthermore, all of these issues are currently not well studied and they crosscut many related topics of inquiry that can be addressed only by researchers operating in center mode through the consistent deployment of integrated, multidisciplinary science. Finally, these three broad-based questions touch on scenarios that are of prime interest in this region: agricultural land and water use changes, population growth, and climate variability. SAHRA understands the importance of all of these forces for change and also recognizes that some relevant aspects have well studied by others. Accordingly, we focus on critical knowledge gaps relevant to these three questions and will seek to incorporate existing understanding of climate variability, population and demographic changes and agricultural land and water use into our integrated models and potential scenarios. For example, SAHRA will not directly study issues related to agricultural water demand because this is well studied relative to other aspect of water demand and there is a large USDA research effort focused on agricultural water use along the Rio Grande[1]. However, SAHRA researchers do plan to incorporate this understanding into our catchment water balance estimates and our integrated assessment of water markets and banks.



SAHRA further frames its science and stakeholder activities in a river basin context. Basin-focused science yields a synergy of activities that helps to drive science integration and, because stakeholder issues are tied to river basins, also helps to drive the application of research results. SAHRA's primary geographical focus is on two river basins (Figure 2), the Rio Grande/Rio Bravo and the Upper San Pedro, although we maintain interest and some activity in

[1] http://riogrande.tamu.edu/

the Salt-Verde and Rio Conchos basins. Table 4 details SAHRA's science and stakeholder legacy products and illustrates their relationship to the three integrating science questions and the selected river basins.

Table 3. SAHRA's three integrating research questions.

RIPARIAN QUESTION: What are the costs and benefits of riparian restoration and preservation?
In the semiarid Southwest, most human settlements, irrigated agriculture, and regional biodiversity are located in riparian corridors. These riparian systems integrate the hydrologic and biogeochemical processes that occur within a basin. Consequently, water resource management decisions may impact river systems not only through changes in streamflow, but also through changes in water quality, the socioeconomic value of the river system, and the structure and diversity of the riparian ecosystem. A complete evaluation of the costs and benefits of important management decisions regarding riparian preservation and restoration therefore requires an integrated, multidisciplinary understanding. SAHRA research consequently focuses on developing fundamental, process-level understanding in three areas: 1) determining the water balance of riparian systems, 2) evaluating ecosystem dynamics and values, and 3) understanding nutrient and solute sources and cycling. The resulting understanding will further the development of integrated river system models that stakeholders can use to evaluate costs and benefits of potential restoration or preservation efforts.

WATER MARKETS QUESTION: Under what conditions are water markets and water banking feasible?
In the Southwest, water markets and water banking are increasingly viewed as potentially effective mechanisms for allocating water resources, providing economic benefits and avoiding potential conflicts associated with water scarcity. For these mechanisms to be truly effective, detailed knowledge of the available water supply and the factors that affect water demand is critical. To this end, SAHRA is developing products to better estimate precipitation rates and snow-pack volumes at the basin scale. SAHRA is also improving understanding of the factors that determine residential and industrial demand for water, using approaches such as experimental economics and water use micro-logging to disaggregate demand. These products and knowledge will then be integrated into a model that allows water resource managers to consider the trading of water rights and third party impacts in evaluating the potential of market-based mechanisms to allocate water resources effectively.

VEGETATION QUESTION*: *What are the impacts of vegetation change on the basin-scale water balance?
Vegetation change is a common feature of the Southwestern landscape. Over the last several decades this has occurred in the form of shrub invasion of grasslands, expansion of pinyon-juniper and mesquite, thickening of ponderosa pine forests, and anthropogenic land-use changes. More recently, drought-related fires and bark beetle infestations are resulting in large-scale vegetation change. While a widespread perception exists that such changes have reduced water resources available for human use, research that documents the actual changes on the basin-scale water balance is lacking. SAHRA seeks to understand the role of vegetation type and structure in the partitioning of rain and snow into evaporation/sublimation, runoff, and infiltration, and how moisture stored in the soil is shared between transpiration, recharge, and streamflow. SAHRA's approach involves: 1) intensive field measurements at selected plot- to hillslope-scale sites to investigate vegetation controls on partitioning and guide development of methods to model and scale these processes; 2) exploring the use of remotely sensed data to determine key hydrologic variables across basins; and 3) integrated modeling to evaluate the effects of vegetation change.

Because SAHRA's mission is to conduct multidisciplinary research that addresses stakeholder-relevant knowledge gaps while also contributing to improved water management and policy, stakeholders must be involved in SAHRA's science program. Stakeholders can provide guidance on the needs for and expected products of scientific activity. Engaging in dialogs with stakeholders also means that scientific results can be communicated more effectively and have more immediate impact. In general, SAHRA's stakeholders are those who can use the information generated by SAHRA. This can include a wide range of individuals and agencies, from land managers and water utilities, to local, state and federal government decision-makers, to scientists within and outside of SAHRA who use the outputs from one project as inputs to their own, to funding entities that have specific needs and expectations. All of these stakeholders have legitimate needs and, at some level, SAHRA seeks to serve them all through its knowledge transfer and education activity (Section IIIC). The focus that SAHRA has introduced into its strategic

planning to define Science legacies during Phase 2 has a parallel in the intended Stakeholder legacies. Defining geographical areas where research is concentrated and addressing specific research questions means there is a subgroup of stakeholders to whom the research has most direct relevance. During Phase 2, SAHRA intends to better define this subgroup of stakeholders and to strengthen the level and effectiveness of the dialog between them and the scientists engaged in SAHRA research activity.

Table 4. Relation of SAHRA's science and stakeholder legacies to the three integrating questions and the two primary river basins

		SAHRA Legacy	
		Science Legacy	Stakeholder Legacy
Q1-Riparian	San Pedro	• Non-market valuation of riparian habitat and benefit transfer functions and methodology • Riparian vegetation change as a function of changing hydrologic conditions • Riparian ET coupling with regional GW/SW model with depth-varying ET across multiple riparian vegetation species • Coupled modeling of feedbacks within the biogeochemical-hydrologic-ecologic system	• A science-based DSS to evaluate science-driven options for preserving and managing the San Pedro riparian management area. DSS will link regional groundwater model, riparian ET and streamflow with ecological feedbacks and non-market valuation • Bilingual hydrology primer for the San Pedro • Geochemical database for surface and ground waters in the San Pedro Basin
	Rio Grande	• Coupling and feedbacks between water quality and quantity • Non-market valuation of riparian restoration	• Decision Support System-type model of Rio Grande capable of evaluating third-party impacts of riparian restoration, water banking and the maintenance of water quality • Geochemical database for the Rio Grande as part of larger database effort
Q2-Water Markets	Rio Grande	• Disaggregation of urban and rural demand • Effect of scale on model representation of behavioral processes (coarse and medium) • Coupled physical and behavioral models with institutional structures	• Develop specifications and constraints for feasible water marketing and banking institutions
Q3-Vegatation	San Pedro	• Transect infrastructure and datasets on ET flux and biogeochemistry • Effect of climate- and fire-induced vegetation change on runoff and recharge • Water, energy, and nutrient cycling changes as a result of shrub invasion of both riparian and upland grasslands	
	Rio Grande	• Ecohydrologic feedbacks on groundwater and surface water resources • Transect infrastructure • Database of distributed and transect datasets • Fine-resolution distributed hydrologic model • Effect of scale on model representation of physical processes	• Basin-scale scenario analysis of vegetation change impacts

C. Knowledge Transfer, Education and Stakeholder Engagement Goals: Scope of Planned Activities

SAHRA's Knowledge Transfer and Education activities are intended to build hydrologic understanding among a diverse range of stakeholders and enhance multidisciplinary hydrologic literacy. Activities are organized around types of programs and targeted stakeholder groups.

SAHRA's Knowledge Transfer legacy (Table 5) will include effective two-way communication between scientists and key stakeholder groups, the capability to rapidly and effectively share useful science results and modeling capabilities, and an improved level of hydrologic literacy among policy makers and the general public. SAHRA's efforts to build an international legacy include sharing SAHRA science results with water professionals and policy makers throughout the arid and semiarid world and participating in international projects that result in shared expertise and unique opportunities for our students and faculty.

Building SAHRA's twofold education legacy of improving hydrologic literacy through educational activities and producing highly skilled water professionals and scientists will involve creating and supporting appropriate curricula, resources, and experiences. The audiences for these efforts are broadly defined as K-16 students and their teachers, undergraduate non-majors, and SAHRA undergraduate and graduate students. Most of our work with these groups is accomplished by providing educational resources, opportunities for professional development, research experiences, and extended learning (Table 6).

SAHRA's Knowledge Transfer, International, Education, and Stakeholder Engagement programs underwent an external review in September 2004. A background document was prepared for this review, *SAHRA Knowledge Transfer, Education and Stakeholder Engagement Activity Internal Review Report***,** which consisted of program descriptions and an internal assessment of the programs based on an anonymous survey. Several of the suggestions offered in the resulting report have been or are being adopted (Table 7). These include a review of the entire KT/INT and Education activities in light of SAHRA's mission and declining base funding. Two workshops were held in January 2005 to address long-term planning issues in light of declining base funding, identify criteria for prioritizing current efforts and proposed projects, and discuss project management issues. Quarterly KT/Ed meetings focus on developing and applying criteria for identifying and assessing long-term partnerships and leveraging opportunities with other organizations.

Table 5. Knowledge transfer legacy products
(Columns represent target audiences whereas rows represent the media)

Knowledge Transfer Legacy Matrix				
	SAHRA and Partners	Water Professionals	Regional Public and Policy Makers	National and International Public and Policy Makers
Web-based Services and Resources	Intranet, project mgmt to support, expand multidisciplinary work	Hydroarchive, isotopes, remote sensing information, arizonawater.org	Basin-specific data, documents, models, and decision-support tools	Global Water News Watch & News Tracker services, G-WADI
Informal and Experiential Education		Mobile display and kiosks for professional meetings	Displays, exhibits & kiosks that raise hydrologic literacy Hands-on, on-site learning centers	Displays, exhibits & kiosks that raise hydrologic literacy Interactive, Web-based displays
Skills Development	Workshops and seminars that nurture multi-disciplinary work	Short courses and M.Eng. program for mid-career water professionals	Short courses on key regional water resource management issues	
Publications, Conferences & Broadcasts	Internal bimonthly newsletter Annual Meeting	*SW Hydrology* trade publication to rapidly disseminate new understandings	State-of-the-art summary publications, media briefings, and special sessions	Continued involvement with International Transboundary Waters Symposium

Table 6. Relation between education activities and legacy

Education Legacy Matrix				
	Graduate Students	Undergraduates	Teachers	K-12 Students
Curricula	Curricula (SAHRA science-based courses, M.Eng.)	Resources & issues-based course for undergraduate non-science majors (Arizona Water Issues)	Resources for K-12 water education (WATER Kits, SPLASH) Science Olympiad / Envirothon	
Professional Growth	Interdisciplinary skills (seminars, symposia, exchange programs, M.Eng.)		High-quality teaching of K-12 Water Education (IWI, SPLASH, CATTS)	Science research skills development among K-12 students (GLOBE, high school interns)
Research Experiences	Research skills (GAs, REUs)			
Extended Learning	Interdisciplinary & community outreach skills (seminars, symposia, exchange programs, M.Eng., outreach opportunities)		Resources to promote hydrologic literacy in informal settings (summer camps, WATER kits)	

Table 7. Recommendations from KT/Ed and stakeholder engagement review and subsequent actions taken

Recommendation	Action
Focus on achieving SAHRA's mission, i.e., supporting water management decision making; use budgeting as a tool for prioritization	SAHRA staff report/workshops to further define mission and relationship to project priorities.
Identify specific high-priority audiences, document impacts; establish clear guidelines for successful interactions with users	Working with individual PIs to identify appropriate audiences and design individualized engagement activities; guidelines are established in the Strategic Plan
Establish intermediaries who can do needs assessment, translate/connect science to users	Through the stakeholder engagement initiative, hired staff and consultants to assist with this effort; expanding responsibilities of KT staff to bridge the science-stakeholder gap (see below)
Increase working linkages with other water centers on campus and with other Arizona campuses	Actively working to broaden the scope of water activities on campus through the Water Sustainability Program; with ASU and NAU through the Virtual Water University and other independent meetings
Integrate the international program into other macrothemes	No action at this time. Need to further define goals of international program.
Add the function of integration/liaison to the KT mix of staff skills and knowledge; encourage team-building and improved communication between science and KT; differentiate KT (focused on specific users) from ED	Introduced a Stakeholder Engagement Initiative focused on integration and liaison; engaged KT/ED staff significantly in this new initiative; distinguished "stakeholder engagement" from the broader KT activities.

An important development of 2005 was increased focus on stakeholder engagement activities. During 2005 SAHRA developed a comprehensive, center-wide, stakeholder engagement plan. Currently this effort is focused on the following tasks. Develop direct connections with water managers in Arizona through workshop on drought planning jointly sponsored with CLIMAS. Help SAHRA PI's identify target audiences and strategies for engagement. Perform a stakeholder needs assessment and design project management metrics that maximize the probability of meeting stakeholder expectations. Support water banking activities in New Mexico by evaluating the Jicarilla Apache water transfer success story, perform broad evaluation of impediments to water banking in New Mexico, design engagement activities for acequia managers and pueblos, and actively engage the State Engineers Office. Finally, in the Upper San Pedro basin the focused is on developing user-friendly versions of the decision support system (DSS) developed by SAHRA researchers and providing associated workshops, documentation, and science summaries for use by the Upper San Pedro Partnership (USPP). The timing and interrelationship of the planed stakeholder engagement activities are described in detail in Appendix 1.

D. Management Goals

As of January 2005 several facets of SAHRA's Management goal for Phase 2 have already been achieved; a description follows.

Revised Responsibilities and Line Management Structure

During Phase 1, most of the responsibility for planning, reporting, budget management, and line management supervision in SAHRA had rested with Hoshin Gupta, the Associate Director. In January 2005, he stepped down. Recognizing this, ***there was a phased transition in management responsibility within the Center***. Table 8 summarizes the way the Associate Director's

responsibilities have been reassigned. The fact that the current SAHRA Director allocates a substantially greater proportion (70%) of time to management of the Center than the previous Director is significant in this respect.

Table 8. Reallocation of Associate Director's responsibility

Former Associate Director's Responsibility	Reassigned Responsibility (Date reassigned)
Center-wide strategic planning	SAHRA Senior Staff with leadership from Assistant Director for Science (Jan. 2004)
Macro-theme strategic planning	Macro-theme co-leaders (Jan. 2004)
Cross-center science integration	Assistant Director for Science (Jan. 2004)
Budget allocation to macro-themes	SAHRA Director (Jan. 2004)
Budget allocation within macro-themes	Macro-theme co-leaders (Jan. 2004)
Student funding	Associate Director for Education (Jan. 2004)
Managing preparation of Annual Report to NSF	Associate Director for Knowledge Transfer (Jan. 2004)
Planning/running Executive Committee meetings	SAHRA Director and Administrative Associate (Jan. 2005)
Planning/running SAHRA Annual Meeting	SAHRA Director and Administrative Associate (Jan. 2005)
Weekly SAHRA staff meetings	Most senior staff member available (Jan. 2005)
Management of Administrative, Business Office, and Technical Support staff	Intermediate Senior Administrators (Jan. 2005)

Consistent with the above-described reallocation of responsibilities, ***SAHRA has implemented a new line management structure shown in Figure 3***. Steps in the transition are as follows:

a) In January 2004, James Hogan was appointed Staff Scientist with responsibility for fostering cross-center science integration and center strategic planning. In January 2006, title changed to Assistant Director for Science while maintaining these responsibilities.
b) In June 2004, Bert Sanchez was hired as Senior Business Manager with line management responsibility for the business offices of both SAHRA and the UA Dept. of Hydrology and Water Resources. He retired in 2005 and was replaced by Tomas Alvarez.
c) In September 2004, Kathy Jacobs became Deputy Director of SAHRA and took leadership of fostering cross-center interaction with stakeholders, with near-term management responsibilities that include making a center-wide survey to determine current stakeholder interfaces and managing a center-wide, external review of SAHRA's knowledge transfer, education, and stakeholder interaction functions.
d) In January 2005, Jim Washburne became Associate Director (rather than Assistant Director) of Education and Gary Woodard became Associate Director (rather than Assistant Director) of Knowledge Transfer in recognition of their increased responsibilities (see Table 8 and Figure 3).
e) In January 2005, Rannie Fox became Administrative Associate, with line management responsibility for SAHRA's Administration staff and increased responsibility for Center administration. She is supported by a new Administrative Secretary.

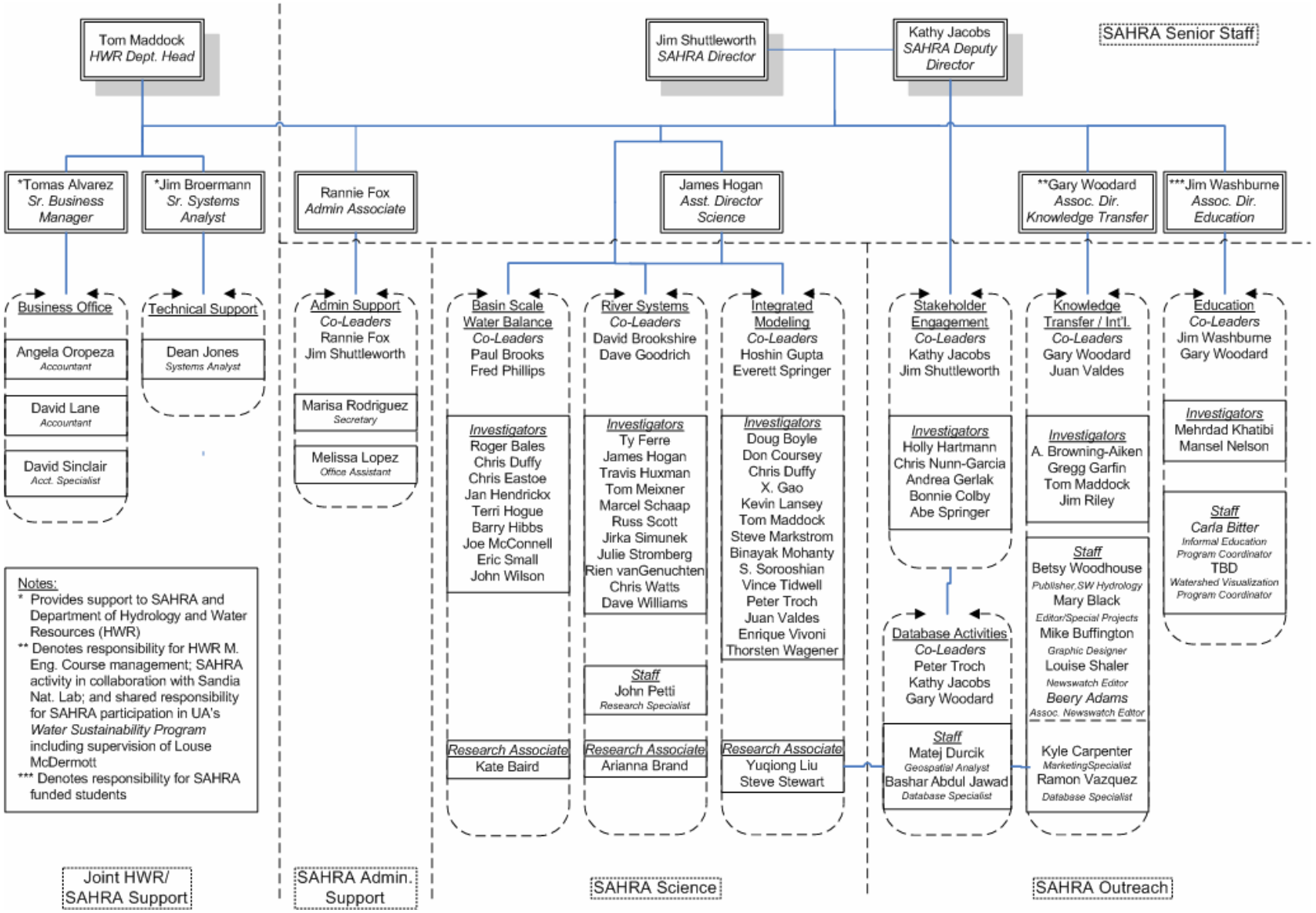


Figure 3. SAHRA's line management structure as of January 2006.

Macro-Theme Management and Reporting Procedures

To improve the level of integration between activities and to ensure that efficient direction of activities and budget oversight occurs at an appropriate level, ***SAHRA's activities are now grouped into five macro-theme management areas plus an administrative core, each requiring resources of approximately $0.5-1.0M per year*** (Figure 3). Each macro-theme has two Co-Leaders (appointed by the Director) who are responsible for managing the macro-theme. At least one has academic allegiance to the University of Arizona and can provide year-round budget oversight within the University of Arizona financial system. In addition, SAHRA recognizes two cross-center focus areas: Stakeholder Engagement, which maintains its own budget for activities housed in the KT and Science macro-themes; and Database Activities, which includes activities budgeted and housed in KT, Stakeholder Engagement, and Integrated Modeling

The leaders of the five SAHRA macro-themes, the Director and Deputy Director of SAHRA, the past Director of SAHRA, and the Head of the UA Department of Hydrology and Water Resources (HWR) form the SAHRA Executive Committee. In addition, the Director may invite ex-officio members of the Executive Committee to attend meetings and give advice, as required. The Executive Committee's function is more focused than in the past and is to ensure effective and coordinated execution of macro-theme proposals defined during the SAHRA annual reporting cycle and to resolve any associated management, budgetary, and staff-related issues.

To allow directed evolution of SAHRA activities in response to new understanding and opportunities and to enable multi-year planning of proposed SAHRA activity at the macro-theme level, an annual review cycle was instituted January 1, 2004 (Table 9). Co-Leaders of each macro-theme have responsibility for proposing how resources will be deployed in support of activities. Proposed activities and allocations are subject to internal review of activities, projects, and budgets by the SAHRA Executive Committee as well as external review by the SAHRA Advisory Board and additional select members of the scientific community. The timing of this review complements the NSF reporting cycle so as to facilitate efficient preparation of the Annual Report and proposed budget due to NSF each August. The format of the annual report and proposal document prepared by the Executive Committee in February (see Table 9) is designed to allow easy editing into the form required in the annual report to NSF. Similarly, the annual review cycle provides a final version of the proposed budget for the Center for the coming year by early June.

Project Evaluation Criteria

As SAHRA proceeds during Phase 2, it is critical that funded projects help achieve SAHRA's strategic goals and enhance the long-term sustainability of the Center. In recognition of this the following criteria are used to evaluate the relative merits of individual projects. Note that all criteria may not be applicable to some projects.

1. To what extent is this project an innovative way to achieve one of **SAHRA's strategic goals**?
2. To what extent does this project directly relate to stakeholder/water management needs relevant to one of **SAHRA's three integrating questions**?
3. To what extent does this project aid (directly or indirectly) the **long-term sustainability of SAHRA**? This includes building institutional relationships and increasing SAHRA exposure.
4. To what extent does this project represent a **good investment of resources** through the efficient use of personnel, infrastructure, and materials to achieve a high quality, timely outcome?

Table 9. Approximate timing for the SAHRA annual review cycle

	Month	Review and Proposal Cycle Tasks	Responsibility
Data Gathering and Planning	October	SAHRA Annual Meeting and NSF Site Visit At Annual Meeting distribute printouts for PIs to update lists of participants and participating institutions	Ad. Assc. & Director KT Staff
	November	1st Week: New participants added to OMS; all contacted to fill in personal data 1st week: PIs emailed to update project goals, outcomes, and plans via OMS During month: Discuss future plans with SAHRA participants	KT Staff KT Staff MT Leaders
	December	1st week: Project updates due 1st week: Follow up w/PIs who have not updated OMS and participants who have not updated personal information 3rd week (or earlier): budgets released for each macro-theme	Project PIs SAHRA Director SAHRA Director
	January	During month: OMS data evaluated for quantitative indicators	KT Staff
Evaluation and Adjustment	February	During month: Prepare macro-theme proposals; see guidance below During month: Update relevant portions of strategic plan 1st week: OMS data evaluated for quantitative indicators sent to MT leaders	MT Leaders SAHRA Senior Staff KT Staff
	March	1st week: MT proposal due, including qualitative indicator analysis 1st week: Update of Strategic Plan due 2nd week: 2-day Executive Committee retreat to approve macro-theme proposals, ensure consistency between reports, and discuss changes to Strategic Plan	MT Leaders SAHRA Senior Staff Executive Com.
	April	2nd week: Report and planning document edited, finalized and sent to EAB	SAHRA Director, Admin. Associate KT Staff
	May	1st week: Joint meeting ExCom/EAB 2rd week: Budgets released to SAHRA participants 2rd week: Request for subcontract budget information and financial reports 4th week: Initial editing of report text and information gathering for additional text for Annual Report to NSF begins	ExCom and EAB Business Office Business Office SAHRA Editor
Reporting and Budgeting	June	1st week: Final budgets for subcontracts submitted to SAHRA Business Office	Subcontract Leaders
	July	1st week: Directors' review of text for Annual Report begins 2nd week: Target date for final text of Annual Report 1st week: Preparation of financial section of Annual Report begins 3rd week: Final financial reports for subcontracts due in SAHRA Business Office	SAHRA Directors SAHRA Editor Business Office Subcontract Leaders
	August	1st of month: Target date for financial info for Annual Report 1st of month: NSF deadline for submission of Annual Report	Assoc. Director KT
	September		

Each report/planning document will document past activity (specifically through the analysis of quantitative and qualitative indicators), outline activities for the coming year (specifically by updating the timeline of activities) and propose a budget for the following year. The document should be structured according to the NSF reporting guidelines as follows:

Science MT leaders summarize: 1) changes in objectives (if any); 2) problems encountered and plans for addressing them; 3) research partnerships; 4) goals, activities, and outcomes/impacts if changed; 5) plans for next year w/ anticipated changes in direction or level of activity; 6) anticipated budget for following year.

ED leaders summarize: 1) changes in objectives (if any); 2) problems encountered and plans for addressing them; 3) internal educational activities (goals, outputs, outcomes/impacts); 4) professional development activities; 5) external educational activities (goals, outputs, outcomes/impacts); 6) integration of research and education; 7) plans for next year and any changes in direction or level of activity; and 8) anticipated budget for following year.

KT/Int leaders summarize: 1) changes in objectives (if any); 2) problems encountered and plans for addressing them; 3) KT activities (goals, outputs, outcomes/impacts); 4) other impacts of KT activities; 5) plans for next year and any changes in direction or level of activity; and 6) anticipated budget for following year.

Diversity leaders summarize: 1) changes in objectives (if any); 2) problems encountered and plans for addressing them; 3) activities contributing to HR development; 4) impacts of programs on enhancing diversity; 5) plans for next year and any changes in direction or level of activity (if any); and 6) anticipated budget for following year.

Management leaders summarize: 1) changes in organizational strategy (if any); 2) problems encountered and plans for addressing them; 3) any changes to the strategic plan; and 4) anticipated budget for following year.

E. Diversity Goals

SAHRA understands that ***Center-wide participation and representation of Hispanics, Native Americans, and women is essential if we are to achieve our mission*** of working with stakeholders to better understand the challenges of water resource management in the semi-arid Southwest and to rapidly bring the results of SAHRA research to bear on these challenges. Each of these groups plays an important role in managing water resources in the southwestern U.S. and along the Mexican border region where SAHRA's efforts are concentrated. Although women are no longer underrepresented among college undergraduates and in many graduate programs, they are still underrepresented in engineering and the physical sciences and among university faculty nationally. Hispanics and Native Americans are underrepresented at every level of academia. SAHRA considers the increased participation of these groups in our activities to be essential for us to facilitate stakeholder interactions critical for two-way communication and to build the mutual trust necessary for sustainable water resource management.

Consequently, the long-term diversity goal of SAHRA (see Section IIIA) is to create a demographic mix among SAHRA students, staff, and faculty that better reflects the ethnicity and gender of the population in the region within which SAHRA's primary activities occur, i.e. the southwestern U.S. and the U.S.-Mexico border region. In the short term, our goal is to match or exceed university-wide levels of diversity. SAHRA uses the ethnic and gender mix for the states of Arizona, Colorado, New Mexico, and Utah as documented in the 2000 U.S. census (www.census.gov/main/www/cen2000.html, Table 10) as a numerical measure against which to judge our progress towards these goals. Consequently, SAHRA's primary long-term diversity goals are to achieve Center-wide diversity that is statistically consistent with 50% participation by women, and 22% and 4% participation by Hispanics and Native Americans, respectively.

Table 10. Gender and Ethnic Diversity of the Southwestern United States

State or Region	Female	White (non-Hispanic)	Hispanic	Native American
Arizona	50.1%	63.8%	25.3%	5.0%
Colorado	49.6%	74.5%	17.1%	1.0%
New Mexico	50.8%	44.7%	42.1%	9.5%
Utah	49.9%	85.3%	9.0%	1.3%
Average	50%	68.2%	22.3%	3.7%

Achieving improved diversity in SAHRA is a Center-wide responsibility. The current ethnic and gender mix of SAHRA staff and students is a result of the application of preexisting institutional hiring and recruiting policies during the first four years of activity, with some bias associated with the nature of the Center and its areas of study. The resulting ethnic and gender mix is not yet consistent with SAHRA's general diversity goal (Table 11). SAHRA's efforts to improve diversity at all levels are focused in three areas:

a) developing career pathways;

b) recruiting more diverse pools of applicants; and

c) retaining minority students and staff by improving support and mentoring.

These efforts span a range of SAHRA participants, from K-12 to college, from undergraduate

and graduate students to postdoctoral and professional staff, support staff, and principal investigators. We anticipate that the next generation of Hispanic graduate students will be recruited through our K-16 outreach activities, by giving appropriate attention to diverse applicants and by building new relationships with regional community college programs. A similar strategy is appropriate for engaging Native Americans' participation in SAHRA. For both of our targeted minorities, more effort will be devoted to their retention through stronger mentoring and developing a better understanding of their unique family, economic, and cultural needs.

Table 11. Gender and Ethnic Diversity of SAHRA in January 2006

SAHRA Participant	Female	Hispanic	Native American
Faculty	16.7%	11.1%	0%
Staff	56.5%	21.7%	0%
PDRA's	30.8%	0%	0%
Graduate Students	43.8%	12.4%	2.2%
Undergrads	50.0%	25.0%	6.3%
Other Participants	38.6%	6.8%	0%

Enhancing the diversity of the faculty engaged in SAHRA is a particularly difficult challenge because faculty recruitment is largely outside SAHRA's control, and tenure considerations restrict the rate at which change can occur. Nonetheless, all faculty active in SAHRA can work to ensure that, within their own institutions, the pool of candidates from which new faculty are selected is appropriately diverse. In addition, macro-theme leaders should consider issues of diversity along with the expertise and experience of potential new participants when considering additions and changes to the research programs and projects within their macro-themes.

SAHRA's Management and Education macro-themes are providing leadership, coordination and support for meeting our diversity goals, but achieving them requires active commitment and participation throughout SAHRA. To encourage progress toward center-wide diversity goals at SAHRA's major participating institutions and to effectively monitor such progress, each year SAHRA's management will seek a statement from each partner institution documenting the current gender and ethnic diversity of the institution's SAHRA participants and reporting any significant successes or failures in progress towards the Center's diversity goals as an integral part of the subcontract renewal process.

IV. Timing and Interrelationship of SAHRA's Activities

An integrated science program requires coordination between the participants to ensure a successful outcome. For example, if SAHRA's integrating science questions are to be addressed effectively, specific inputs are required from multiple projects within specified time frames. These science questions are relevant to decision makers, so it is also important to define and engage relevant stakeholders to identify how the science investigation being undertaken relates to their concerns, what the time frame is for their decision processes, and what types of information, data, or models are most useful to them. Conversely, stakeholders who are engaged in this pursuit of knowledge will develop realistic assumptions about the types of information they can expect from the scientists. Such expectations can then be built into the management and budgeting scheme to increase the likelihood that useful products will result in a timely way.

The integration schematics and timelines in Appendix 1, which are organized by research question and river basin, illustrate the planned timing and interrelationship between activities

that seek to provide legacy products associated with SAHRA's science and stakeholder strategic goals (Table 4). The timelines given in these appendices identify the parties responsible for particular projects, inputs needed from contributing projects, the intended audience for the outputs, and a date when project tasks are expected to be completed. The intent of this planning exercise is to enhance the potential productivity of the scientific research undertaken, while building support for the SAHRA approach among external stakeholders. Both are considered critical if SAHRA is to be viewed as an important contributor to integrated hydrologic science and water management in semiarid regions, this in turn being critical to the ongoing application of the SAHRA approach during Phase 4. ***Timelines in Appendix 2 illustrate the timing of SAHRA Knowledge Transfer and Education activities***, with emphasis on the timing of transfer of support from NSF to alternate funding sources. The timelines that describe our center-wide activities in pursuit of our diversity goal are also included in Appendix 2.

V. Performance Indicators

A strategic planning document merely represents one phase in a continuous circular process of program evaluation, adjustments, and reporting as SAHRA works toward achieving its strategic goals. ***Essential to the strategic planning process is the development and measurement of performance indicators.*** It must be recognized that SAHRA's performance indicators serve two distinct purposes. First, performance indicators measure our progress toward achieving the seven strategic goals related to science, stakeholders, knowledge transfer, education, diversity, management and the institution. Second, as part of the cooperative agreement, SAHRA is required to develop and maintain a set of management and performance indicators. NSF requires indicators in the following areas: science, knowledge transfer, education, diversity, management and partnerships. Table 12 lists the performance indicators SAHRA has selected to monitor its performance towards meeting its strategic goals during Phase 2 and for reporting to NSF. As noted in Table 12, these performance indicators do not map perfectly onto either of the stated purposes.

For each strategic goal, two related indicators are evaluated, one quantitative and one qualitative. The quantitative indicators are selected measures that provide an adequate evaluation of progress without imposing onerous information-gathering demands on SAHRA participants, SAHRA staff, and Macro-Theme Leaders. These quantitative indicators allow analysis of SAHRA's current status related to its strategic goals. Furthermore, evaluating the trend in these indicators in succeeding years provides a measure of SAHRA's progress and evolution. However, these quantitative indicators and their trends over time are not by themselves adequate monitors of performance; an interpretation of their intrinsic importance and relevance to SAHRA's mission is also needed. Consequently, interpretive text provides the context and value of the selected quantitative performance indicators. In most cases, guidance on the expected nature of the interpretation is provided (Table 13). The guidance allows qualitative evaluation of the quantitative indicators in a full spectrum, from planning and initiating activities to obtaining mature results and achievement of SAHRA's strategic goals.

Performance indicators are evaluated each January in the context of the annual review cycle (Table 9). Quantitative indicator data and analysis is provided by SAHRA staff, mainly using data generated from the Online Management System (OMS). The qualitative assessment of these indicators is then undertaken by the responsible individuals detailed in Table 12. This information is posted on the SAHRA website (http://www.sahra.arizona.edu/about/advisory/indicators/) and included in the Annual Report to the NSF.

Table 12. SAHRA performance indicators

STRATEGIC GOAL	ANNUAL PERFORMANCE INDICATORS		RESPONSIBLE INDIVIDUALS
	QUANTITATIVE INDICATOR	**QUALITY OR CONTEXT OF INDICATOR**	
Science	Number and list of scientific papers for the reporting year in refereed and non-refereed journals, including percent multi-institutional and percent multidisciplinary List of impact factors for journals where SAHRA has published for the reporting year Number of citations for previous SAHRA publications, change from pervious year and top 10 cited articles Number and list of presentations including percent invited, percent multi-institutional and percent multi-disciplinary Number and description of novel scientific products (e.g. models, DSS, databases, patents, etc.)	Description of primary scientific findings, with emphasis on their contribution towards achieving SAHRA's science and stakeholder legacy products, as well as their relevance to SAHRA's mission, the three integrating questions and their contribution to building multi-disciplinary knowledge Organization of sessions and workshops at national and international scientific meetings on SAHRA legacy products Description of the potential and/or actual application of each legacy product with emphasis on its adaptability, scalability and transferability	**For Basin:** P. Brooks F. Phillips **For River Systems:** D. Goodrich D. Brookshire **For Integrated Modeling:** H. Gupta E. Springer
Stakeholder*	Number and list of events that involved direct and significant interaction between SAHRA scientists and stakeholders (e.g. meetings, workshops, presentations, etc.)	Description of the quality and effectiveness of the interactions and their relevance to SAHRA's mission	K. Jacobs H. Hartmann
Knowledge Transfer	Quantitative impact measure knowledge transfer products (e.g. publications with number of subscriptions, web products with number of hits, etc.)	Description of quality and effectiveness of novel Knowledge Transfer products and their relevance to SAHRA's mission	G. Woodard J. Valdes
Education	List of novel education products, (e.g. curricula, workshops, websites) and audiences reached Number of SAHRA students who are enrolled or who were enrolled at each level during the last year, including percent multi-institutional and percent multi-disciplinary Placement of SAHRA graduates in the hydrology field after graduation	Description of quality, impact, and effectiveness of the Educational products and programs and their relevance to SAHRA's mission and macrotheme goals. Description of the relevance student research topics to SAHRA's strategic mission and integrating questions and their contribution to building multi-disciplinary understanding	J. Washburne Gary Woodard
Partnerships**	Number of SAHRA partnerships and any changes over the last year	Description of the nature of existing and new partnerships and their relevance to SAHRA's mission	J. Hogan J. Shuttleworth
Diversity	Racial, ethnic and gender diversity of SAHRA investigators, staff, and students	Description of diversity in the regional context, relevance of diversity to mission of SAHRA, and of any noteworthy successes and/or failures in progress towards meeting the diversity goal	J. Shuttleworth J. Washburne
Management	Percent of staff provided with written performance evaluations and expectations for the next year Number of meetings held (staff, senior staff, advisory board and executive committee meetings) Annual meeting attendance, including SAHRA participants (researchers, students and staff and stakeholders). Number of oral and poster presentations.	Description of ways in which management supports innovation, interdisciplinary activities, timeliness of staff products, prioritization of activities Description of improvements in administrative processes that promote communication and efficiency Description of budgeting, data monitoring and archiving improvements Description of management activities and progress relative to long-term funding	J. Shuttleworth R. Fox T. Alvarez

* Not required for NSF reporting; these indicators will be reported under the knowledge transfer section

** Partnerships are not a SAHRA strategic goal, but evaluation of partnerships is required for NSF reporting.

Table 13a. Guidance for Evaluating the Quality and Context of SAHRA's Science and Stakeholder Performance Indicators

STRATEGIC GOAL	GUIDANCE
Science: Publications and Presentations	**A. Quality of science activity results can be judged relative to the following indicators as a measure of increasing quality (not all apply to all projects)** Undertaking of disciplinary research focused on SAHRA's mission Publication of disciplinary research which contributes toward a legacy product Development of multidisciplinary teams to address SAHRA's integrating questions Undertaking of multidisciplinary research activities Researchers publishing in journals or presenting at conferences outside of their traditional disciplines Publications integrating SAHRA research with other research which contributes toward a legacy product Publications integrating several multidisciplinary SAHRA research activities which results in the completion of a SAHRA legacy product
Science: Products	**B. Quality of science activity results can be judged relative to the following indicators as a measure of increasing quality (not all apply to all projects).** Development of disciplinary products relevant to SAHRA's mission Distribution of disciplinary products Development of multidisciplinary products Products have been widely distributed to stakeholders Products have been widely used Products impact other science activities or water management decisions
Stakeholder	**C. Quality of stakeholder engagement can be judged relative to the following indicators as a measure of increasing quality of engagement (not all apply to all projects).** **Stakeholder Indicators:** Key stakeholders have been identified through a deliberate and documented process Contact has been initiated with individuals or organizations representing major stakeholders Potential stakeholders have been briefed about opportunities to help define research questions, share data, identify stakeholder-relevant data gaps, receive outputs, etc. Distribution materials about the project are accessible and stakeholder-relevant Stakeholders attend SAHRA sponsored workshops, presentations Attendance includes a broad spectrum of interested parties, as appropriate Comments from key stakeholders on intermediate products and results have been documented and responded to Interactions are frequent, e.g. more than twice per year; varied, e.g. not always in the same context; rich, e.g. substantive, involving two-way communication Project milestones are shared and regular updates provided Stakeholders call or contact project participants to request additional information Stakeholders lend political support to projects, including calls or letters to support proposals or grants Stakeholders provide substantive, iterative feedback regarding progress and products Stakeholders provide in-kind contributions or invite on-site research activities Stakeholders fund projects or parts of projects Stakeholders participate in project review SAHRA products, tools or data are used as a regular, integrated component of water management decision making

Table 13b. Guidance for evaluating the quality and context of SAHRA's Knowledge Transfer and Education performance indicators

STRATEGIC GOAL	GUIDANCE
Knowledge Transfer	**D. Quality of knowledge transfer can be judged relative to the following indicators to gauge quality of engagement (not all apply to all projects).** **Planning Indicators** Target audiences have been identified, relevant to SAHRA mission Options for reaching target audiences are identified and analyzed relative to resources Priorities and desired outcomes are identified Methods and resources for maintaining and updating are in place early Mechanisms for documenting and quantifying impact are in place Feedback regarding effectiveness is used to improve the product Criteria for review of product in place from the start **Product Evaluation Indicators** Quantitative indicators of demand for KT products and services are a key indicator of quality and effectiveness. Virtually all KT projects incorporate methods for quantifying use Citations in literature Unsolicited media requests Multimedia presentations, e.g. multiple avenues to reach the same target audience, evidence that the material is used In-kind contributions from users Funding provided by outside interests and users Products transferable to other applications
Education: Products and Programs	**E. Quality of education programs and products can be judged relative to the following indicators (not all apply to all projects).** **Education Indicators** Target groups and education objectives are identified, relevant to SAHRA mission and science foci Options for reaching target audiences are identified and analyzed relative to resources Priorities and desired outcomes are identified Criteria and mechanisms for documenting effectiveness are in place Feedback regarding effectiveness is used to improve the curriculum and program Number and diversity of students taught/supported in each category are identified Integration of science and education is articulated Transferability is built in Support for future implementation, interactions and feedback is identified
Education: Graduate Students	**F. Quality of graduate student education can be judged relative to the following indicators.** Identify recruitment targets and goals Evaluate recruiting effectiveness Communicate SAHRA expectations to students early Encourage broad participation in campus and professional activities Degree completed in timely fashion Identify degrees completed, publications, continuing studies in field of supported students Identify interdisciplinary components to course work and research

Table 13c. Guidance for evaluating the quality and context of SAHRA's diversity, partnership, and management indicators

STRATEGIC GOAL	GUIDANCE
Diversity	**G. Quality of diversity can be judged relative to the following indicators.** Ensure that SAHRA programs and support reach underrepresented K-12 students and teachers. Ensure all SAHRA job openings are advertised widely and attract a diverse applicant pool. Strengthen ties with local/university organizations supporting academic success among under-represented students. Attend meetings and recruit from venues that target underrepresented students. Establish supportive faculty and peer-mentoring networks. Facilitate the communication of SAHRA findings and understandings to regional populations through multilingual and multimedia presentation formats. Provide support as required to ensure the broadest possible representation at SAHRA events. Strengthen research and recruiting ties with regional minority serving institutions and organizations. Increase the number and proportion of under-represented students.
Partnerships	**H. Quality of partnerships can be judged relative to the following indicators (not all apply to all partnerships).** Contact has been initiated with individuals or organizations representing potential partners Potential partners have been briefed about opportunities to help define research questions, share data, identify stakeholder-relevant data gaps, receive outputs, etc. Distribution materials about the project are accessible and relevant Partners attend SAHRA sponsored workshops, presentations Interactions are frequent, varied and rich Partners lend verbal support to projects, including calls or letters to support proposals or grants Partners provide substantive, iterative feedback regarding progress and products Partners provide in-kind contributions or invite on-site research activities Partners fund projects or parts of projects
Management	**I. Quality of management can be judged relative to the following indicators (does not apply to all projects).** Foster innovation and problem solving Encourage interdisciplinary activity by identifying and removing barriers Ensure clear expectations about quality and timeliness of work products Incentives for high productivity and motivation, including positive feedback for good performance Swift and equitable resolution of personnel issues with appropriate documentation Written annual staff evaluations Clear and easily accessible monitoring system for documenting activities Clear and regular communication of relevant information to all staff and macro-theme leaders Expectation of improvements in administrative efficiency Establishment of leveraging goals and gauge of success Accurate budgets with clear explanations, focus on avoiding negative consequences and misunderstandings

Appendix 1

The following diagrams describe the contribution of and interrelationship between the several SAHRA projects that relate to each of the three integrating questions SAHRA will use to give focus to its activities that seek provide its Science and Stakeholder legacies, together with the Macro-Theme and individuals responsible for each and the inputs they need and outputs they will provide.

(a) THE RIPARIAN QUESTION (Rio Grande Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Coupling and feedbacks between water quality and water quantity	Rio Grande solute balance: Conservative solute dynamic simulation model (R04)	Phillips, Hogan	Geochemical / Hydrologic Data	DSS model of Cl for RG							
			Groundwater and surface water salinization in the El Paso / Juarez region (B11)	Hibbs, Eastoe, Hogan **Glue**	Well sampling by EPWU	Basin GW-SW exchanges, isotopic and geochemcial data on groundwater							
			Rio Grande solute balance: Nutrient sources and cycling (R12)	Brooks, Hogan	Chemical data from the Rio Grande	DSS for reactive solutes (nutrients, trace metals)							
			Rio Grande solute balance: Reactive solute dynamic simulation model (R04)	Phillips, Hogan	DSS model for conservative solutes; source/sink understanding of reactive soutes	DSS for reactive solutes (nutrients, trace metals)							
			Rio Grande solute balance: Scenario analysis (R04)	Phillips, Brooks, Hogan	DSS model	Impact of salinity management options of river system							
		Non-market valuation of riparian restoration	Stormwater trading experiments (R27)	Stewart, Carpenter **EPA**		Benefits and costs of stormwater detention							
			Economic valuation of riparian flyways: ecosystem services (M21)	Brookshire **EPA**	Component of EPA grant	Valuation of riparian habitat along the Rio Grande							
			Valuation of Rio Grande Bosque restoration (R39)	Stewart **Sandia, USACE**	Wildlife and vegetation change response to restoration	Non-market valuation of restoration attributes to be used by USACE for benefit transfer and as part of Sandia model							
			Seek leverage funding (see below)	Stewart, Hogan	Restoration Team, conceptual model	Funding to undertake non-market valuation of restoration							

(b) THE RIPARIAN QUESTION (Rio Grande Basin: Stakeholder Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Stakeholder	DDS for evaluating river restoration projects	Dynamic simulation model of the Upper Rio Grande Basin (M14)	Tidwell **Sandia**		General dynamic simulation model of the RG							
			Dynamic simulation model of a generic southwest basin (M11)	Lansey / Stewart **TRIF**		Non-market benefits of in-stream flows							
			Develop conceptual model	Restoration Team	Restoration Team	Conceptual model of river system wrt restoration							
			Stakeholder engagement (K38)	Restoration Team (+ Hartmann)	Meet with basin stakeholders interested in restoration	Stakeholder input on evaluating restoration							
			Scenario development (M30)	Stewart, Hartmann	Stakeholder inputs	Restoration scenarios for evaluation							
			Seek external funding	Restoration Team	Restoration Team and conceptual model	Proposal unsuccessful in 2005 / plans for 2006							
			Integrated DSS for evaluating restoration scenarios	Restoration Team **Pending leverage**	Funding, ecologic understanding (Dahm et al.), water quality DSS	DSS linking ecological and hydrologic understanding with economic valuation							
			Restoration scenario analysis	Restoration Team	Linked DSS	Evaluation of restoration scenarios							
		Geochemical database	Rio Grande geochemical database (part of R04)	Hogan	Geochemical data from R04, B11 and other projects	Database of SW and GW geochemical data for use in DSM							

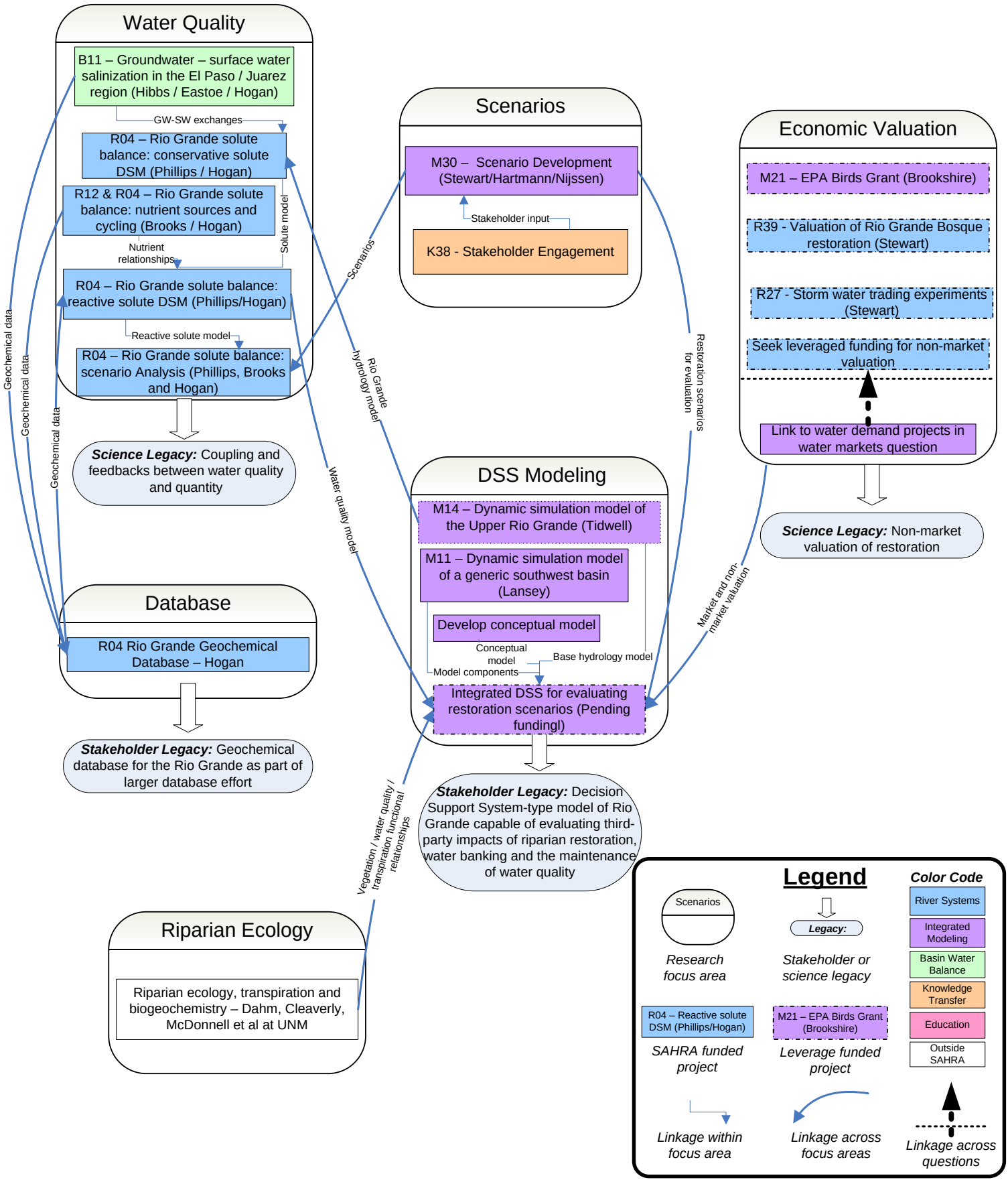


Figure A1. Integration diagram for SAHRA funded and leveraged research activities focused on riparian restoration along the Rio Grande.

(c) THE RIPARIAN QUESTION (San Pedro Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
San Pedro	Science	Riparian ET coupling with regional GW / SW model	Riparian ET tool w/ GIS-based vegetation management (R29)	Scott, Goodrich	BLM vegetation and burn management plans and 2004 riparian vegetation map	An ARC View GIS tool delivered to BLM in 2005 with training that will allow them to estimate changes in GW use with changes in riparian Veg.							
			Evaluate water use change due to riparian veg. change (R30)	Scott, Huxman	Flux measurements across a range of riparian vegetation types	Simultaneous seasonal riparian water use for a range of vegetation types							
			Medium-resolution MODFLOW model of the middle and lower San Pedro (R17)	Maddock		Model completed and scenarios being evaluated by The Nature Conservancy for conservation easements							
			Riparian ET package for hydrological and ecological changes in riparian zones (R22)	Maddock, Shuttleworth Huxman **WSP**	Results from projects R08 and R31	Updated GW model that will predict hydrologic riparian change and subsequent changes in vegetation							
			Geochemical identification of riparian water sources (R01)	Hogan, Ekwurzel **Part WSP**	GW samples, geochemical data from past SAHRA studies	Quantification of % of baseflow from regional GW versus monsoon recharge							
			Medium-resolution integrated LSM (was part of M05)	Bastidas		Medium resolution LSM for the San Pedro River basin							
			Coupling of GW, SW and ET models (R13)	Goodrich, Scott, Maddock	Results from project R30 - Restructured KINEROS2 SW model GW model from project R22	Coupled model and documentation to be submitted to USGS for inclusion in MODFLOW family of models							
		Non-market valuation of riparian habitat	Economic valuation of riparian flyways: ecosystem services (M21)	Brookshire **EPA**	Changes in riparian habitat and riparian bird characteristics as a function of changes in riparian hydrolgy	Non-market valuation of a range of riparian habitat and bird characteristic (from dry to wet-perrenial							

(c) THE RIPARIAN QUESTION (San Pedro Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
San Pedro	Science	Riparian vegetation change as a function of hydrologic condition	Riparian vegetation dynamics (R08)	Stromberg, Dixon	Observed Hydro and Vegetation Conditions over a range of condition classes	Hydrologic metric required to maintain 3 classes of riparian functional condition classes, publication expected in 2007							
			Riparian vegetation change w/ variable hydrology (R31)	Huxman, Scott	Results from project R08 and multi-year observations/analysis of riparian ET tower transect	Space for time model of riparian vegetation change with changing hydrology, fina publication in review 2006							
			Hydrologic thresholds for biodiversity in arid and semiarid riparian ecosystems: importance of climate change and variability (R40)	Meixner, Baird, Dixon, Hogan, Stromberg **EPA**	Results from project R01, R08 and R13 and multi-year observations/analysis of riparian vegeation, isotopic composition and water levels.	Linkages between climate, hydrologic variability, vegetation structure, and ecosystem services in riparian ecosystems and a transferable coupled model of hydrologic-vegetation processes in riparian ecosystems							
			Vegetation - bird relationships (part of EPA Bird Grant M21)	Brand **(part SAHRA funding)**		Relationships between vegetation and bird diversity							
		Coupled modeling of feedbacks within the biogeochemical-hydrologic-ecologic system	Influence of episodic flow events on nutrient and sediment loads (R9)	Conklin		Combined with R24							
			Coupling nutrients and surface water (R14)	Meixner, Conklin		Combined with R25							
			Nutrient loading from ephemeral channels (R24)	Brooks, Conklin	Required observations and data analysis completed	Relationships between land cover and nutrient loading of ephemeral lateral channels in the San Pedro, finish w/ final publication pending							
			Coupling BGC and hydrology: simple mixing and DSM (R25)	Meixner, Rien, Brooks, Conklin	Results from projects R9, R24, R14, and R25 with targeted additional data collection	Simple mixing/mass balance model of major BGC constituents with GW/SW fluxes							
			More complex coupling BGC to hydrology: Daycent and Hydrus (R25)	Meixner, van Genuchten, Brooks, Conklin, Simunek, Hendrickx	Results from R25, sediment quantity and quality, fluxes of carbon and water from vegetation to the atmosphere within the basin, aqueous fluxes of carbon and nitrogen	Coupled HYDRUS-Century Model and Powersim model							

(d) THE RIPARIAN QUESTION (San Pedro Basin: Stakeholder Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
San Pedro	Stakeholder	DSS for evaluating science-driven management with bilingual hydrology primer	Dynamic simulation model of a generic southwest basin (M11)	Lansey **WSP**	Costs and water savings for management decisions not found in the San Pedro	Generalization of model from project M13 to cover cases not found in the San Pedro							
			DSS for San Pedro managers: Phase 1 non-spatially explicit (M13)	Lansey **USPP/ SAHRA**	Conservation and augmentation strategies and associated costs from the USPP	Windows-based model with basin, county, and municipality level treatment and evaluation of alternative scenarios specific to the San Pedro							
			DSS for San Pedro managers: Phase II Spatially Explicit (M13)	Lansey + USGS	Next generation San Pedro GW model from USGS and spatial locations of pumping centers, riparian areas, etc. from USPP for response function development - Also results from project R08	DSS model with spatial scenario options and display capabilities							
			DSS for San Pedro managers: Phase III Bilingual DSS (M13)	Goodrich, Lansey + Woodard	Results from project M13, Phases 1 and 2, a Mexican based example scenario, explanatory graphics and glossary in English	Bilingual version of Phase 2 (Project M13 DSS) with Mexico specific examples for education and knowledge transfer							
			Institutional analysis and social assessment of the Upper San Pedro Basin (was K03 now part of M13)	Browning, Varady		Inputs to DSS for San Pedro managers							
		Geochemical database for surface and ground waters	Pedotransfer functions and land surface parameters for modeling (R03)	van Genuchten, Schaap	Soil samples for laboratory analysis (completed)	GIS-based map of hydraulic properties of the San Pedro Riparian Corridor							
			Geochemical database for the San Pedro (Part of R25)	Hogan (with Brooks, Meixner)	Geochemical data from past SAHRA studies	Datasets for BGC modeling							
		KT Legacy	Science fact sheets (K39)	Jacobs **SAHRA SE**	Science results from the San Pedro	Fact sheets for public							

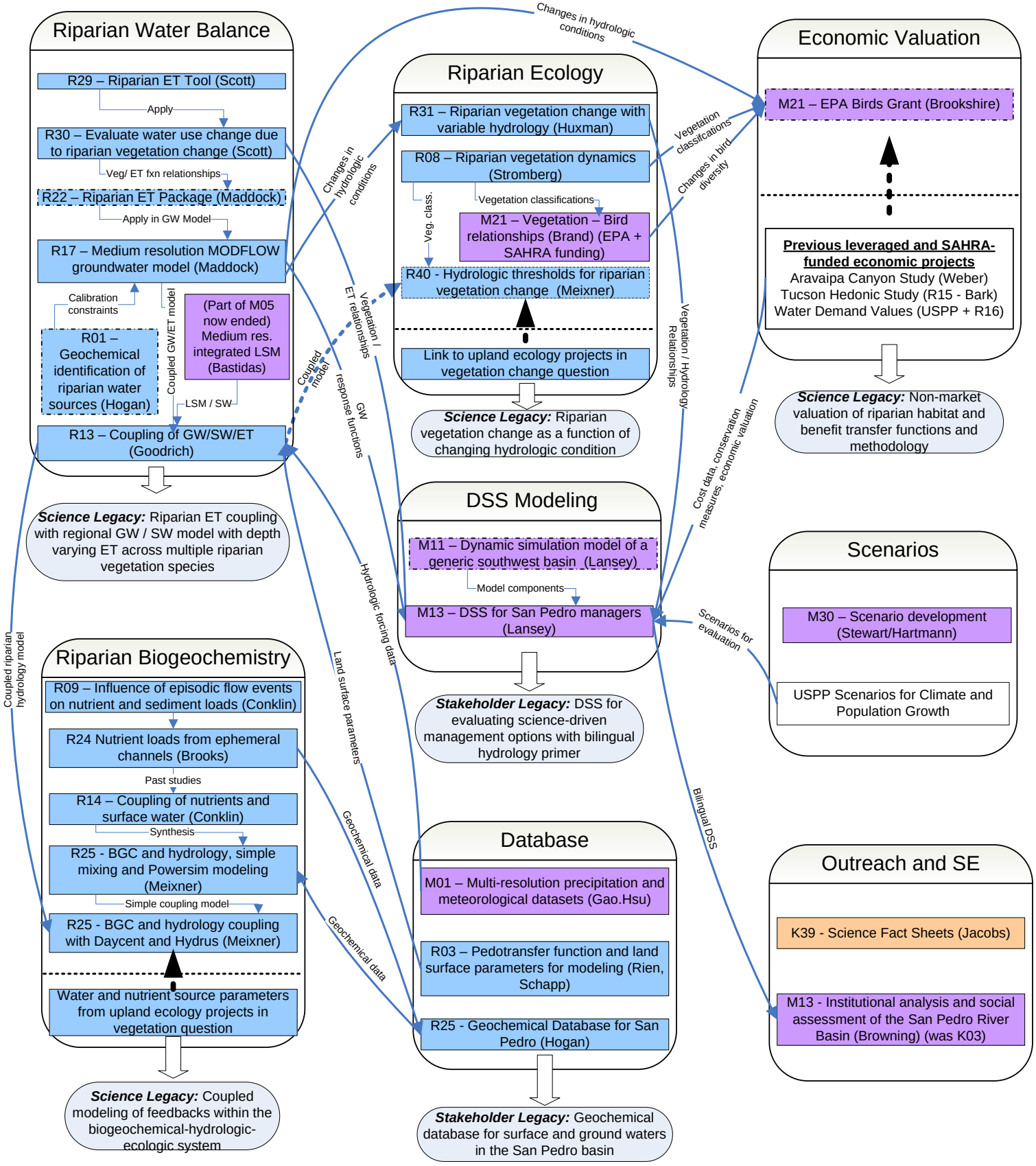


Figure A2. Integration diagram for SAHRA funded and leveraged research activities focused on riparian preservation in the San Pedro basin. Specific research or stakeholder will be developed in the following areas: 1) scenario development and social needs, 2) riparian water balance, 3) riparian ecologic condition and 4) riparian economic value. This knowledge will be developed in to a DSS which will intelligently relate the above systems. The DSS will allow the evaluation of approriate scenarios and the propogation of their effects thru the riparian system to the social and economic value.

(e) THE WATER MARKETS QUESTION (Rio Grande Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Disaggregation of urban and rural demand	Domestic and institutional water demand: Phase II and III (R16)	Krause, Stewart, Chermak, Brookshire	Demand experiments where participants allocate water								
			Disaggregating domestic demand: phase 1 (M19)	Woodard		Evaluation of trends in assessor databases							
			Disaggregating domestic demand: phase 2 (M19)	Woodard	phase 1 outputs	Link monthly water demand to assessor data							
			Low-cost, high-resolution water meter loggers: phase 1 (M20)	Woodard		Prototype water logger development and production							
			Low-cost, high-resolution water meter loggers: phase 2 (M20)		phase 1 outputs	Addition of remote wireless data retrieval							
			Sociodemographic and water demand databases (K48)	Woodard, Gober (DCDC)	Database support person, leveraged funding	Extend domestic water demand database to Albuquerque							
			Integration of behavioral components with Rio Grande coarse resolution modeling (M27)	Chermak, Tidwell, Brookshire, Grimsrud, Mathews, Thatcher	Results from demand experiments, develop values relationship beyond crop basis	Linking of behavioral aspects with the overall integrated DSS modeling frameworks							
		Coupled physical and behavior models with institutional structures	Rio Grande dynamic simulation model (M14)	Tidwell **Sandia**		General dynamic simulation model of the RG							
			Assessment and modeling of institutional structures for demand-side management: V1.0 (M18)	Brookshire, Tidwell	Simplified Riverware model, MRG GW model, URG/MRG watershed model (M14); programming (KT staff)	CRM 1.0							
			Assessment and modeling of institutional structures for demand-side management: V2.0 (M18)	Brookshire, Tidwell, Boyle, Gupta	CRM1.0 (M18); farm & profit model (M08); improved physical structure (M5); conceptual site model (M23); uncertainty & stakeholder analyses (M22)	CRM2.0							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Coupled physical and behavior models with institutional structures	Assessment and modeling of institutional structures for demand-side management: V3.0 (M18)	Brookshire, Tidwell, Gupta, Boyle, Liu	CRM2.0 (M18); refined physical structure (M5); conceptual physical model for coarse resolution (M23); improved uncertainty & stakeholder analyses (M22); search algorithms for feasible alternatives	CRM3.0							
			Water markets physical system model development: Medium-res. LSM V1.0 (M5)	Boyle, Brookshire, Gupta	Riverware; USGS GW model;URG&MRG PRMS model (M05);	MRM1.0							
			Water markets physical system model development: Medium-res. LSM V2.0 (M5)	Boyle, Brookshire, Gupta	MRM1.0 (M5); farm & profit model (M08); improved institutional structure and third party effects (M5); conceptual site model (M23); uncertainty & stakeholder analysis (M22)	MRM2.0							
			Water markets physical system model development: Medium-res. LSM V3.0 (M5)	Boyle, Brookshire, Gupta	MRM1.0 (M5); refined institutional structure (M18); conceptual physical model for medium resolution (M23); improved uncertainty & stakeholder analysis (M22); search algorithms for feasible alternatives;	MRM3.0							
			Water markets model testing and integration: with CRM and MRM V1.0 (M28)	Gupta, Boyle, Coursey, Brookshire, Tidwell	CRM1.0 & MRM1.0 (M5&M18); initial water markets scenarios (M30); climate and basin data (M24)	Comparison of CRM1.0 & MRM1.0							
			Water markets model testing and integration: with CRM and MRM V2.0 (M28)	Gupta, Boyle, Coursey, Brookshire, Tidwell	CRM2.0&MRM2.0 (M5&M18); improved water markets scenarios (M30); climate and basin data, farm & ag data (M24); conceptual site model (M23); uncertainty & stakeholder analysis (M22)	Comparison of CRM2.0 &MRM2.0							
			Water markets model testing and integration: with CRM and MRM V3.0 (M28)	Gupta, Boyle, Coursey, Brookshire, Tidwell, Liu	CRM3.0&MRM3.0 (M5&M18); refined water markets scenarios (M30); climate and basin data, farm & ag data (M24); conceptual site and physical models (M23); uncertainty analysis (M22)	Comparison of CRM3.0 and MRM3.0							

(f) THE WATER MARKETS QUESTION (Rio Grande Basin: Stakeholder Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Stakeholder	Feasible water market and banking institutions	Stakeholder engagement (K38)	Hartmann **SAHRA SE**	Meet with basin stakeholders interested in water markets	Stakeholder input regarding water markets							
			Support for Water Banking and Stakeholder Interactions in New Mexico (K43)	Garcia, Jacobs **SAHRA SE**		Stakeholder needs / impediments to NM water banking/leasing							
			Farm Module for MODFLOW (M08)	Maddock, Schmidt **USGS**	SAHRA funds initially, last year+ leveraged funds for test locations in California and NM	Module with documentation completed, pending approval by USGS							
			Scenario development (M30)	Stewart, Hartmann	Stakeholder inputs	Water market scenarios for evaluation							
			Water markets scenario analysis (M29)	Brookshire, Boyle, Gupta, Liu	CRM 3.0 & MRM 3.0 (M5&M18); model input data for scenario period (M24); final water market scenarios (M30)								

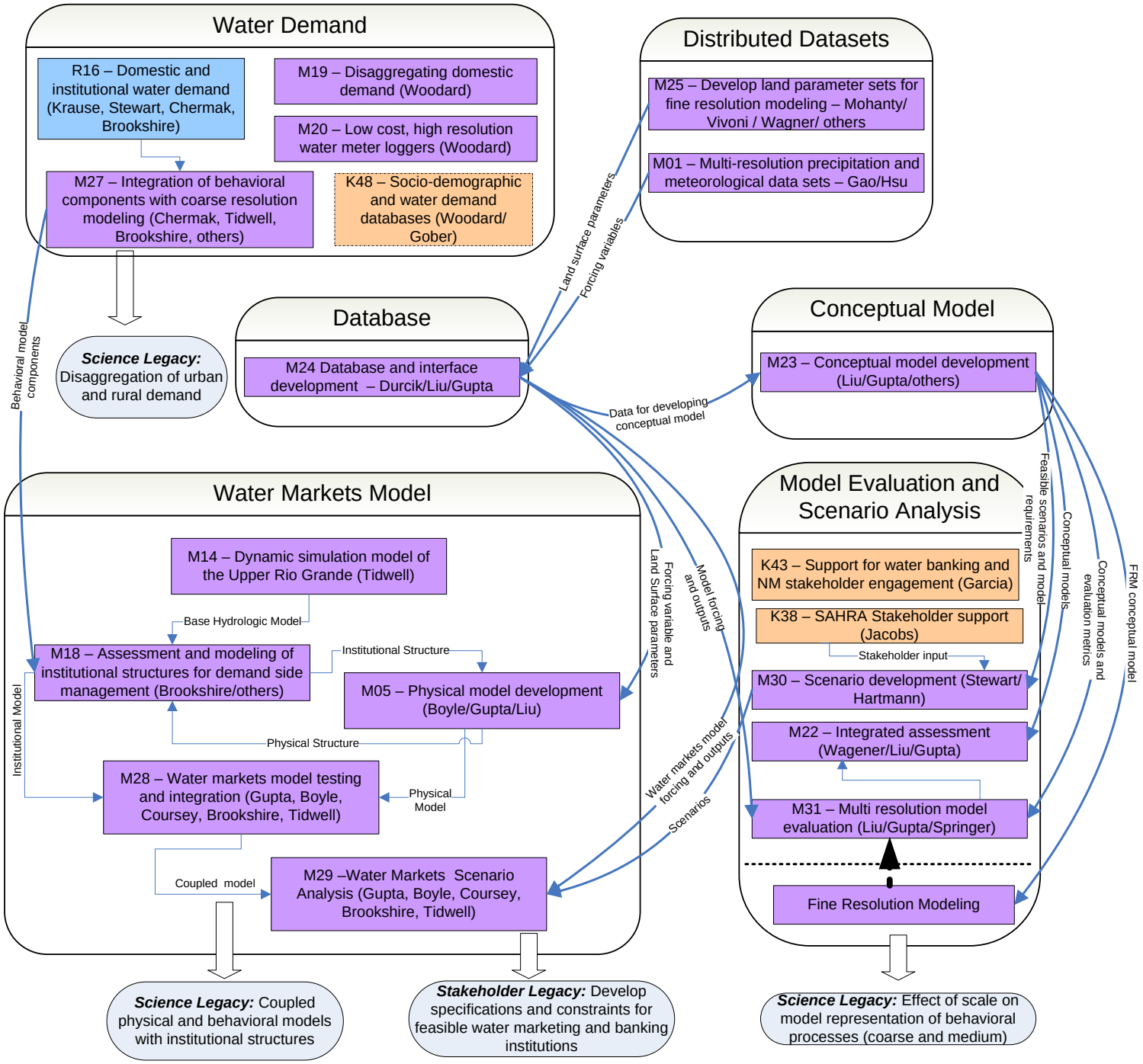


Figure A3. Integration diagram for SAHRA funded and leveraged research activities focused on feasibility of water markets or water banks in the Rio Grande banking.

(g) THE VEGETATION QUESTION (Rio Grande Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Ecohydrological feedbacks on surface water and groundwater resources and transect infrastructure	Sevilleta drought plots (B04)	Small **Part NSF**		Data and process knowledge to FRM							
			Transect Study: vegetation partitioning of infiltration/runoff (B18)	Small		Data and process knowledge to FRM							
			Transect Study: SWE distribution and snowmelt processes (B01)	Brooks, Molotch, Bales		Data and process knowledge to FRM							
			Transect Study: Vegetation water use from sap flux measurements (B19)	McConnell		Data and process knowledge to FRM							
			Transect study: ET flux towers (B25)	Brooks (Litvak)		Data and process knowledge to FRM							
			Transect study: biogeochemistry (B21)	Brooks	Water balance data from B1, B2, B18, B20	Data and process knowledge to FRM							
			Ecohydrological controls on desert vadose zone dynamics (B05)	Phillips	Data from vadose boreholes under various ecosystems	Sub-root zone flux to FRM							
			Modeling the mechanisms of mountain block recharge (B08)	Wilson, Duffy	Distributed datasets on precipitation and hydraulic properties	Estimates of spatially distributed recharge into FRM							
			Transect study: recharge/runoff partitioning from geochemical tracers (B20)	Phillips	Measurement of subsurface residence times and subsurface time-dependent solutes with stream flow distance	Subsurface flow path length and residence time to FRM							
			Basin recharge: ETR arrays (B10)	Duffy **NASA**		ETR arrays along Salado and Valle							
			Secure long-term funding	Phillips, Brooks	Results from existing studies	Long-term funding							

■ - River System Project, ■ - Integrated Modeling Project, ■ - Basin Project, ■ - KT / International, ■ - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Fine-resolution distributed hydrologic model	Develop fine-resolution integrated model of the Rio Grande Basin (M03)	Springer **DOE** Vivoni	1) Complete tRIBS model (M26) that includes snow processes completed by 2006. 2) Studies that support new conceptualizations or parameterizations of fine scale model including vadose zone (B05), snow hydrology (B01), hillslope/ mt front modeling (B08), partition precip into recharge and runoff (B10) by 2006. 3) Parallel version of tRIBS (M26) by 2005. 4) Integrate FEHM subsurface code by 2006.	Working code that has been verified and tested on selected subbasins in the Rio Grande that will be evaluated (M31) by 2007.	■	■	■				
			Incorporate tRIBS model of the regional Rio Grande watershed (M26)	Vivoni	1) Rio Grande hydrologic data base efforts. 2) Parameter-estimation (B14); Transect Field Data (B01, B02, B05, B10, B18, B19). 3) Remote sensing data (B06, Persiann).	Completed parallel tRIBS model with new modules for semiarid regions, including snow processes. Incorporate model into LANL framework with RAMS and FEHM.	■	■					
			Parameterize fine-resolution integrated model of the Rio Grande Basin (M03)	Springer **DOE**	Data from Basin Scale Water Balance studies used in developing parameters and testing fine resolution model. This includes: B01, B02 B03, B04, B05, B08, B10, B18, B19	Model that has been parameterized for the Rio Grande Basin that will be used in scenario analyses.		■	■	■	■		

- River System Project, - Integrated Modeling Project, - Basin Project, - KT & International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Effect of scale on model representation of physical processes	Basin recharge: low dimensional recharge/runoff models (B10)	Duffy **Part NASA**		Research paper and work focused on Rio Salado							
			Medium-resolution integrated land surface model (M5)	Boyle	For details, see Water Markets section (table e)								
			Additional projects listed: M22, M23 and M31		For details, see Integrated Assessment (table k)								
		Database of distributed datasets of PPT, ET, etc	Hydrologic modeling of snow water equivalent (SWE) and snowmelt runoff (B02)	Bales / Vivoni	Data from all transect process studies, remote sensing data	Streamflow models							
			SEBAL ET: Modify SEBAL for semiarid regions (B03)	Hendrickx	Landsat images	Working algorithm, testing against flux data							
			SEBAL ET: Calibrate/validate data (B03)	Hendrickx	ET flux data	ET datasets to be incorporated into M05							
			Additional projects listed: M01, M24 and M25		For details see Database section (table k)								

(h) THE VEGETATION QUESTION (Rio Grande Basin: Stakeholder Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Stakeholder	Basin-scale scenario analysis of vegetation change impacts	Stakeholder engagement (K38)	Hartmann w/ Phillips, Brooks									
			Scenario development (M30)	Stewart, Hartmann									
			Evaluate scenarios with fine-resolution integrated model of the Rio Grande Basin (M03)	Springer **DOE**	1) Fine resolution model code M03 that has been tested (M31) at the end of 2007. Completed scenario including time period and vegetation change parameters by 2007 (M30).	Scenario results from fine resolution model that will be placed in database and analyzed as a SAHRA product.							

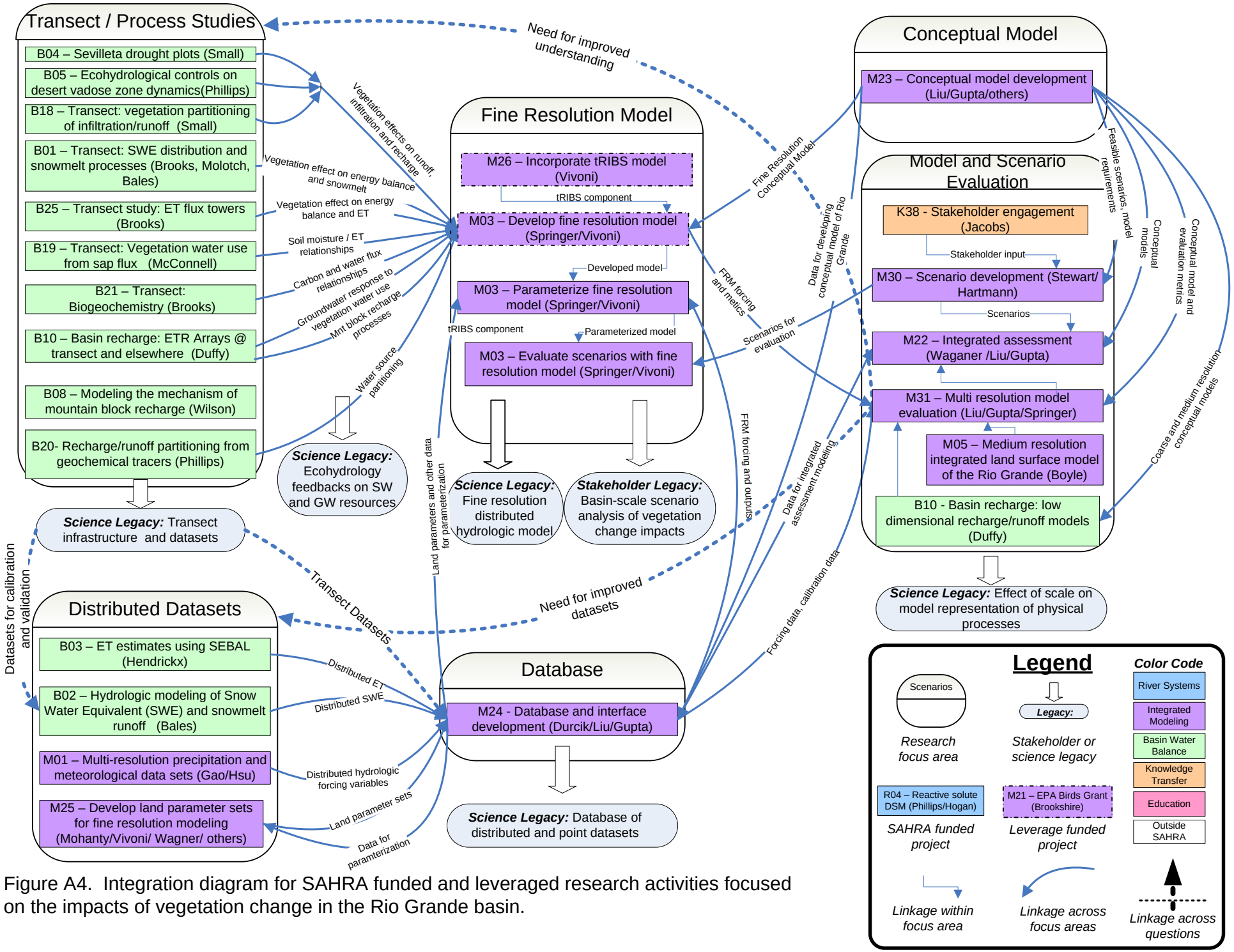


Figure A4. Integration diagram for SAHRA funded and leveraged research activities focused on the impacts of vegetation change in the Rio Grande basin.

(i) THE VEGETATION QUESTION (San Pedro Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
San Pedro	Science	Water, energy and nutrient cycling changes as a result of shrub invasion	Evaluate impacts of brush invasion (R35)	Huxman. Scott, Williams **NSF**	Multi-year observations and experiments over a gradient of grass to brush cover	Improved basic understanding of the changes in water, energy, carbon, and nutrient fluxes with brush invasion							
			Upland mesquite savannah water and carbon exchanges (R36)	Scott **USDA-ARS**	Part of R35								
			Rainout experiments on the Santa Rita range (R37)	Huxman **NSF**	Part of R35								
			Water, energy and carbon cycling in a southwestern subalpine forest (R33)	Breshears, Scott	Multi-year observations and experiments of the alpine Bigelow tower site	Basic understanding of the energy, water and carbon cycling of this system, publications in 2006							
		Transect infrastructure ***and*** transect datasets	Additional non-SAHRA tower sites	Ameriflux, Walnut Gulch etc.	Tower sites	Datasets to database							
			Geospatial database development (M24)	Durcik	For details see Database section (table k)								

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
San Pedro	Science	Basin-scale runoff and recharge with focus on the effects of climate- and fire-induced vegetation change	Evaluation of paleohydrology of Arizona (R28)	Valdes **WSP**	Array of paleo-climate and tree-ring data	Evaluation of the ancient history of water in the region and its consequences for the future							
			Impact of fire on catchment hydrologic response : Sabinio Canyon (B22)	Ferre, Nijssen, Ekwurzel **WSP**	Post-fire Sabino Creek measurements and analysis	Determine impacts of fire on flood response, evaluate mitigation strategies and enhance public understanding							
			Hydrologic impacts of LA Basin Fires (R34)	Rademacher Hogue **Glue Grant**	Post-fire analysis of City Creek and Aspen fire watershed, chemistry and isotope data	Re-parameterize NWS models with soft data (chemistry, isotopes) for pre- and post fire watershed modeling							
			Isotopic Quantification Mountain Front Recharge (B13)	Hogan, Ekwurzel **WSP**		Geochemical constraints on mountain front and mountain block recharge rates and processes							
			Groundwater sources, flowpaths and residence times in the Middle Verde Watershed (B23)	Hogan, Meixner **WSP**	Groundwater and spring samples from the Middle Verde, geochemical analysis	Understanding of flowpaths and residence times in the basin for use with USGS modeling effort, data on springs to be used for drought indicators (R38)							
			Estimating Arizona's water reserves using space-borne gravity observations (B24)	Troch **WSP**	Gravity data from GRACE mission	Estimated change in water storage for Colorado River basin and state of Arizona							

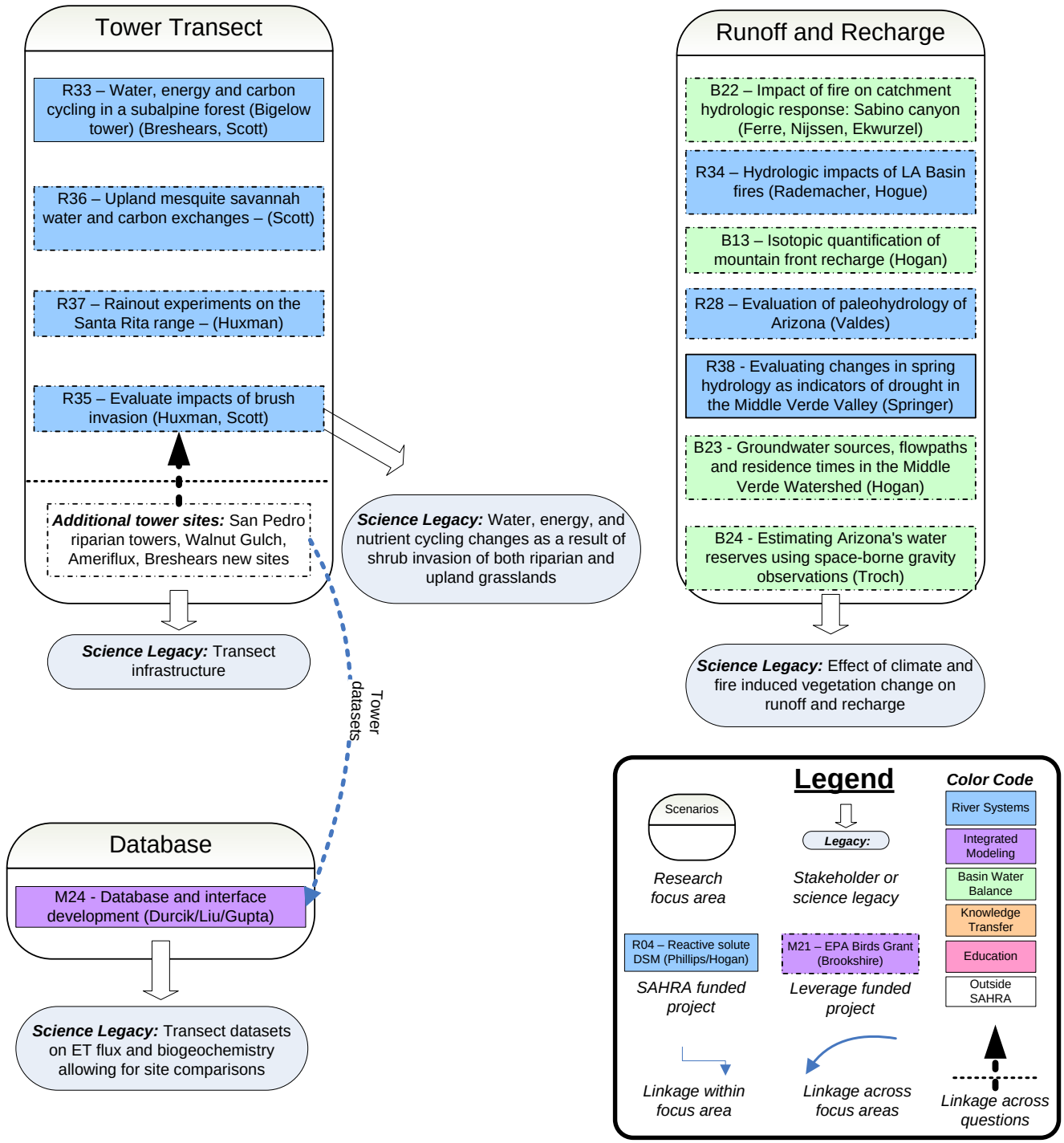


Figure A5. Integration diagram for SAHRA funded and leveraged research activities focused on vegetation change in the San Pedro basin and elsewhere in SE Arizona. Specific research is focused on the following areas: 1) a regional tower transect focused on addressing the ecohydrologic impacts of shrub invasion and other vegetation change in the region and 2) understanding the impacts of vegetation change, specifically as a result of fires, on runoff and recharge from mountainous regions. Note that most projects listed here are occurring through leveraged funding.

(j) INTEGRATED FRAMEWORK (Rio Grande Basin: Science Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science	Coupled physical and behavior models with institutional structures	Integrated assessment: internal modeling analysis (M22)	Wagener, Liu, Gupta	Discussion w/ modeling groups (M3,M5 and M18);	Initial uncertainty & stakeholder analysis							
			Integrated assessment: stakeholder analysis (M22)	Wagener, Liu, Gupta	Discussion w/ modeling groups and stakeholders (M3,M5 and M18);	Assessment strategy; Refined uncertainty & stakeholder analysis							
			Integrated Assessment: further analysis (M22)	Wagener, Liu, Gupta	Integrate assessment strategy (M22)	coordinated analysis of sensitivity & uncertainty							
			Conceptual model development: conceptual Site Model (CSM) (M23)	Liu, Gupta, Springer, Brookshire	Basin characteristics, climate (M01);	A common CSM for coarse, medium, and fine resolution modeling							
			Conceptual model development: conceptual Physical Models (CPM) (M23)	Liu, Gupta, Springer, Brookshire	inputs& feedback from modeling groups (M3,M5 and M18); scenarios design (M30); additional data (M24)	3 res-specific conceptual physical models (CPM)							
			Conceptual model development: Refine CSM and CPM (M23)	Liu, Gupta, Springer, Brookshire	inputs& feedback from modeling groups (M3,M5 and M18); scenarios design (M30); additional data (M24)	Final CSM and CPMs (can be used for model evaluation effort)							
			Multi-resolution model evaluation: framework development (M31)	Gupta, Liu	CSM and CPMs (M22); evaluation data(M01, M24); scenarios (M30); assessment criteria (M22)	Multi-resolution, multi-discipline, multi-model evaluation strategies;							
			Multi-resolution model evaluation: datasets for evaluation (M31)	Liu, Gupta	Evaluation framework (M31); Modeling outputs (M3,M5 and M18);;	Datasets and metrics for multi-res model evaluation (to database)							
			Multi-resolution model evaluation: Model evaluation (M31)	Gupta, Liu	Evaluation framework (M31); evaluation datasets (M24);	Multi-resolution model evaluation							

(k) DATABASE (Rio Grande Basin: Stakeholder Legacy)

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

River Basin	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Rio Grande	Science and Stakeholder	Database of distributed and point datasets	Multi-resolution precipitation and meteorological data sets: 5-year record (M01)	Gao, Hsu, Sorooshian	Satellite land cover data & imagery; evaluation data requirement (M31)	PERSIANN products, 5-yr atmo forcing data, surface fluxes, soil temp. & moisture for model testing							
			Multi-resolution precipitation and meteorological data sets: 20-year record (M01)	Gao, Hsu, Sorooshian	Satellite land cover data & imagery; scenario analysis data requirement (M30)	PERSIANN products, 20-yr atmo forcing data, surface fluxes, soil temp. & moisture for scenario analysis							
			Develop relational geospatial database of land parameters (M25)	Mohanty, Wagener	List of model parameters, governing equations, support scales from SAHRA models (M3, M5, M18)	Relational geospatial database of land parameters							
			Estimate "effective" distributed land parameter sets (M25)	Mohanty, Wagener	Feedback from modeling groups (M3, M5, M18)	Effective distributed land parameters of Rio Grande; look-up tables							
			Establish a preliminary database with general hydrological data and basin properties (M24)	Durcik, Gupta, Liu	Data formats, sources, & access interfaces measured & modeled data (M3, M5); basin and climate data (multiple agencies)	A preliminary hydrological database for Rio Grande							
			Build interfaces and load more data into the database (M24)	Durcik, Gupta, Liu	More feedback from modeling groups (M3, M5); additional data requirements (M23); model evaluation data (M01)	Enhanced geospatial database with model evaluation data							
			Complete database for model testing and scenario analysis (M24)	Durcik, Gupta, Liu	Further feedback from modeling (M3, M5); scenario analysis data (M24);	A centralized geospatial database and interface, Data piping							
			Database & interface maintenance (M24)	Durcik, Gupta	Any additional feedback from scenario analyses and model evaluation	Final SAHRA geospatial database							

Appendix 2 The following diagrams summarize the timing of SAHRA activities in the areas of Stakeholder Engagement, Knowledge Transfer and Education not related to fostering dialogue between specific stakeholders and SAHRA scientist and consequently not included in Appendix 1. Timelines for Knowledge Transfer and International Activities

Timelines for Stakeholder Engagement Activities

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Southwest	SAHRA Stakeholder	Stakeholder assessment and scenario development related to SAHRA research	SAHRA stakeholder support (K38)	Hartmann **SAHRA SE**	Macrotheme planning	Scenarios, SE engagement implementation							
			Scenario development (M30)	Stewart, Hartmann	Stakeholder inputs	Stakeholder relevant scenarios for evaluation							
			Support for water banking and stakeholder interactions in New Mexico (K43)	Garcia, Jacobs **SAHRA SE**		Stakeholder needs / impediments to NM water banking/leasing							
			Arizona tribal water settlements: implications for regional water management (K44)	Colby **SAHRA SE**		Economic and policy evaluation of Gila River settlement							
			Evaluation of DSS models in support of water management (K51)	Jacobs (Eden) **SAHRA SE**	Information on SAHRA's and others' DSS models in use	Summary of lessons learned with DSS models							
		Disseminate info on current topics to policymakers	Arizona Town Hall on water (K31)	Woodard, Jacobs	Wrote chapters, created maps	Inform policy-making process							
			Science fact sheets (K39)	Hartmann, Bitter, Jacobs	Scenario development	Fact sheets on SAHRA science for USPP and others							
			Short courses for water professionals and policy-makers (K14)	Woodard, Jacobs, McDermott	WSP partnership, KT staff	Hydrologic literacy, revenue							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
State of Arizona	AWI Stakeholder Engagement	Needs Assessment	Arizona Water Institute Needs Assessment (K40)	Gerlak, Jacobs **WSP CDI**	Survey data	Report of needs for Arizona Water Management							
		Arizona Water Database	Arizona Hydrologic Information System (K41)	Carpenter, Jacobs **WSP CDI, WSP RRI CUAHSI HIS/ESRI year one, AWI after**	Coordination with SAHRA database efforts, links with Arizona hydrologic datasets	Year 1 products include: metadata catalog of water data, design database architecture, evaluate existing water data systems							
			Making Arizona well databases web-accessible (K47)	Woodard **WSP CDI**	Data from GWSI, Wells55, ADEQ GW quality databases	Unified and web accessible / searchable database as part of arizonawater.org and AzHIS							
			Sociodemographic databases in support of municipal water demand research (part of M19)	Woodard, Gober (DCDC)	Database support person	Domestic water demand database for Phx and Tucson							
			Modeling outdoor residential water use (K50)	Colby **WSP**	Domestic water demand database for Phx and Tucson								
		Drought Management / Planning	Evaluating changes in spring hydrology as indicators of drought in the Middle Verde Valley (R38)	Springer **SAHRA SE**	Spring samples, geochemical analysis, field monitoring	Evaluate changes in spring hydrology to serve as drought severity indicators							
			Drought planning and implementation in Cochise and Santa Cruz Counties (K49)	Garfin **WSP CDI**		Local area impact monitoring evaluation and protocols; monitoring database							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
State of Arizona	WSP Program	WSP Program	WSP marketing and publicity (K29)	Carpenter **WSP**		WSP website, logo, brochures, etc.							
			WSP joint water education and outreach program (K37)	Woodard, Jacobs **WSP JEOP**	On-going outreach opportunities related to Az water issues	Water expo programs, websites, etc.							

Timelines for Knowledge Transfer and International Activities

(a) Southwest Hydrology

■ - Develop, ■ - Maintain, ■ - Partial Support, ■ - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Southwest	Knowledge Transfer	Trade publication to disseminate new understanding	Publish a high-quality trade journal, 6 issues per year (K09)	Woodhouse, Woodard	KT staff time, marketing reader feedback	Subscribers, advertisers, improved website							

(b) Global Water News Watch

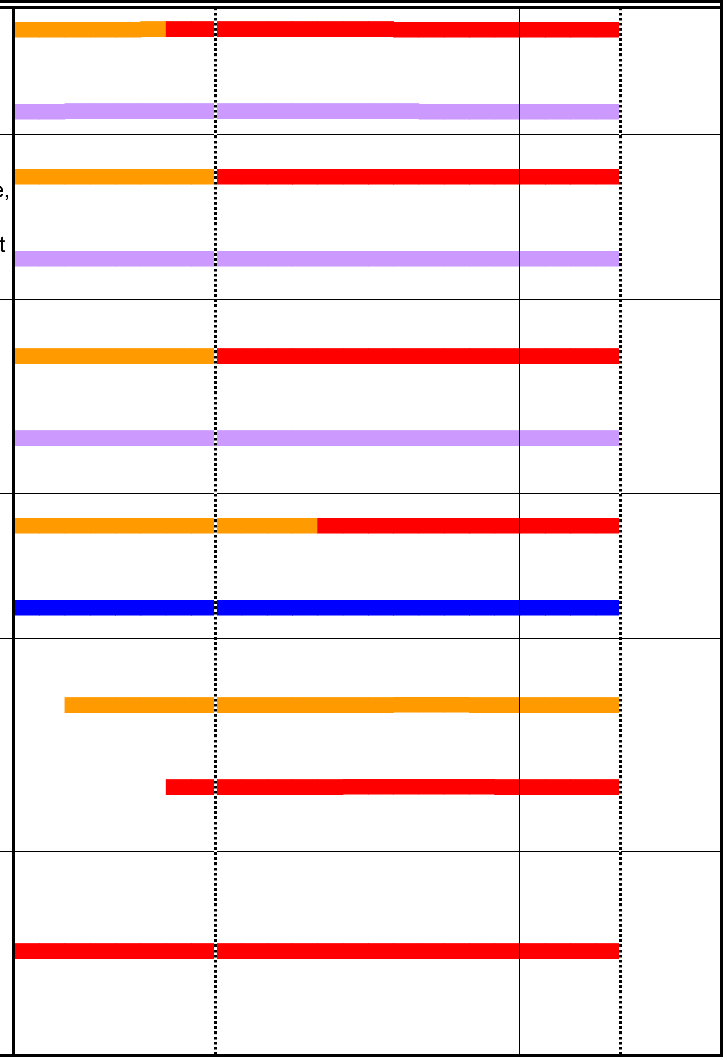
■ - Develop, ■ - Maintain, ■ - Partial Support, ■ - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Worldwide	Knowledge Transfer	Global Water News Watch & News Tracker services	Publish regular updates of water-related information on the web (K13)	Woodard, Shaler	KT staff, leveraged funding, Arabic language student	More page views, subscribers, translations							

(c1) Web-based Information Transfer (Worldwide)

■ - Develop, ■ - Maintain, ■ - Partial Support, ■ - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Worldwide	Knowledge Transfer	Archive of hydrologic software	Support a web-based software sharing facility (Hydroarchive) (K24)	Wagener, Vazquez	Sponsor, software contributors, new Web interface	Software downloads, email service subscribers							
		Self-supporting portal for international water centers	Support UNESCO G-WADI website (K16)	Woodard	UNESCO funding, modeling curriculum, isotopes content, revamped HyDIS tool	Enhanced website, more pageviews, flyer and pamphlet							
		Isotopes Web-based resource for hydrologists	Develop isotopes and hydrology database (K26)	Woodard, Hogan	UNESCO funding and content, KT staff	Enhanced Web tools, searchable labs database, more page views							
		Web-based resource on H20 conservation	Further develop water conservation house (K15)	Woodard, Carpenter, Buffington	Research results, graduate student	More page views, enhanced re-use section							
		Web-based DSMs: Information dissemination for water managers and policymakers	Make dynamic simulation models available on web (K04)	Woodard, Tidwell, Lansey, Vazquez	Integrated modeling results, new versions of PowerSim	K-12 use, univ. use, decision-maker use							
		Institutional legacy and general info dissemination on SAHRA	SAHRA Website (K25)	Carpenter, Buffington, Vazquez, Black	KT staff time, feedback, KT staff	More page views, synergies, opportunities, higher SAHRA profile							



(c2) Web-based Information Transfer (Local, including Border)

- Develop, - Maintain, - Partial Support, - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Regional SW	Knowledge Transfer	Share hydrologic information among educators	Support Outreach Connection Web resource for water educators (K10)	Vazquez, Woodard		Page views							
		Data sharing for research on Lower Rio Grande	Provide access to data on Lower R.G.. (Aguanet) (K21)	Valdes, Passell, Aparicio	Computer support	Searchable database							
		Accessible info on San Pedro	Include San Pedro News and Comment in NewsWatch (K28)	Shaler	Student support	Project discontinued							
		WaterWeb Expertise and Research Directory	ArizonaWater.org (K36)	Woodard, McDermott **WSP JEOP**	Faculty input	Developed water expertise database and set of web based tools for Az							
			Environmental science expertise and research directory for the Southwest (K36)	Woodard, McDermott, Hogan, Breshears **WSP RRI**	Faculty input, research sites and facilities	Developed water expertise and research database and set of web based tools for the SW region							
		Rainlog.org	Volunteer rainlog network (K45)	Woodard, Crimmins **WSP et al.**	Citizen data collection, website development	Arizona database of citizen-reported rainfall							
		On-line water quality resources	Homeowner guidance on in-home water treatment (K30)	Artiola, Woodard, Buffington **WSP**	KT staff	Web tool							
			Non-treatment options for arsenic in Arizona (K32)	Stewart, Hogan **WSP**	Research results, KT Staff	Web sections							

(d) U.S.-Mexico Collaborative Science Projects

- Develop, - Maintain, - Partial Support, - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Knowledge Transfer	Disseminate knowledge to water professionals and stakeholders	DSS for San Pedro Managers: Facilitate formation of binational watershed alliance (part of M13)	Browning-Aiken, Varady		Partnerships							
		Development of system dynamics model (sci legacy)	DSS for Lower Rio Grande/Rio Bravo (K20)	Valdes, Passell, Aparicio	Research results, IM results, KT staff	Partnerships, funding opportunities							
		Water markets in international situations	Dynamic simulation modeling and water banking for the Rio Conchos (K02)	Valdes, Stewart	Research results, KT staff	Partnerships, funding opportunities							
		Alternative Futures models in international situations	Alternative futures for changing landscapes models: international applications	Maddock, Baird **various funding**		Alternative Futures models for Mexican cities such as La Paz, Loreto and Oaxaca							

(e) International Activities

- Develop, - Maintain, - Partial Support, - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Worldwide	Knowledge Transfer	International Meetings Partly self-supporting activity	Transboundary Waters Management Symposium (K23)	Valdes, Woodard, Black	KT staff time	SAHRA profile raised, networking, revenue							

(f) Short-term and Opportunity-Related Knowledge Transfer Activities

■ - Develop, ■ - Maintain, ■ - Partial Support, ■ - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Knowledge Transfer	Increased hydrologic literacy of public	Media briefings on topical issues such as drought and climate change (K08)	Woodard, Garfin	Collaborations, media contacts and collaboration	Media coverage, partnerships, raised SAHRA profile							
		Disseminate info on current topics to water professionals	Participation in AHS meetings (K22)	Woodard	KT staff	Opportunities, exposure, water professionals exposed to latest research							

(g) Participate at Professional Conferences and Meetings

■ - Develop, ■ - Maintain, ■ - Partial Support, ■ - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Worldwide	Knowledge Transfer	Hydrologic synthesis activities and products	Hydrologic synthesis center proposal development (K52)	Troch **WSP RRI**		Proposal for synthesis activities to NSF							
		SAHRA institutional legacy, recruitment	Publicize SAHRA's mission and research	Woodard, Washburne	Mature research; staff support	Opportunities							

(h) Interactive and Public Displays

- Develop, - Maintain, - Partial Support, - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Worldwide	Knowledge Transfer	Disseminate hydrologic knowledge	Develop hydrologic displays for public areas (K05, K06, K07)	Woodard, Carpenter, Bitter	DamCam, federal firewall solution, KT staff	Sabino							
						Kartchner Caverns							
						Explora/Rio Nuevo							
					Outside funding, KT staff	Grand Canyon, Yosemite							
			Rainwater harvesting for desert environments (K42)	Woodard, Riley **WSP CDI**	Demonstration project	Rainwater harvesting exhibit/ demonstration, content for water conservation website, short course							
			Water exhibit collaboration with Utah Museum of Natural History (K46)	Bitter, Woodard **UMNH**	GW model and kiosk display technology	Display on Great Salt Lake hydrology for new museum							
			Phoenix Zoo: water education and discovery carts (E22)	Bitter, Washburne **PHX Zoo, WSP**	Funding	Water content for public programs and camps programs; "water station" kiosks							
			Water Planet (E21)	Bitter **NSF-Ed**	GW model and kiosk display technology	Display for traveling exhibit / water education							

(i) Internal (Center) KT

■ - Develop, ■ - Maintain, ■ - Partial Support, ■ - Full Support

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
Regional SW	Knowledge Transfer	Internal communication for SAHRA	Improve internal reporting system (OMS) (K12)	Carpenter, Vazquez	KT staff, feedback	Potential Virtual University opportunity, CUAHSI							
			Publish internal newsletter (K27)	Black, Carpenter	News items, SAHRA participants	6 newsletters per year							
			Prep. of Annual Report and Strategic Plan (K33)	Black, Hogan, Shuttleworth	KT staff, SAHRA participant cooperation	Annual report, Strategic Plan							
			HWR online student application (K34)	Woodard, Vazquez, Washburne	HWR cooperation, KT staff	Improved student recruitment, potential Virtual Univ. component							
			SAHRA alumni database (K35)	Black	KT staff	Student recruitment, placement							

Timelines and Activities for Achievement of Education Legacies

(a) Develop the hydrologic literacy of K-16 students throughout the southwest, leading to action and decision making based on multidisciplinary knowledge of regional water cycling and issues.

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Education	High-Quality Teaching of K-12 Water Education (IWI, SPLASH)	Summer workshops (E02, E03)	Bitter	Instructors and participants	Trained teachers							
			Integrate SPLASH into IWI (E02, E03)	Hancock	Planning	Increased marketing of SPLASH							
			Offer workshops throughout the region (E02,E03)	Bitter, Washburne, *Contacts outside Tucson*	Human resources and infrastructure throughout region	Trained teachers							
			Develop leveraged funding	Washburne, Bitter	Partners, funding opportunities	Trained teachers							
			Continue to provide support for teacher participation in UA HWR camps (E11)	Washburne	Continued collaboration	Teachers with hydrology research skills							
			Watershed visualizations prof. dev. (E20)	Washburne, Higgins **NSF GeoEd**	Planning and implementation	Intensive prof dev experience, Educational DVD							
			Identify & address gaps in offerings	Washburne	Planning	More complete set of programs, greater impact							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Education	Resources for K-12 Water Education (WATER Kits, SPLASH, CATTS, IM Tool)	Complete WATER Kit development, construction, and pilots (E09)	Wilson **WSP**	Content, planning	Kits							
			AZ watersheds visualizations kits (E20)	Washburne, Higgins **NSF GeoEd**	Existing GIS/DEM databases	Kits, Educational DVD							
			Finalize SPLASH curriculum (E02)	Hancock	Feedback	Completed curriculum							
			Provide kits and kit workshops throughout Arizona (E09)	Wilson, Bitter **WSP**	Human resources and infrastructure throughout AZ	Trained teachers, kit use							
			Provide classroom instructional support (E09, E13)	Higgins **CATTS**	Continued participation in CATTS	Supported classrooms							
			K-12 version of dynamic simulation models (E17)	Washburne Pending	USPP DSS, funding, collaboration with science, appropriate personnel	IM tool for K-12 classrooms							
			Develop leveraged funding	Washburne, Bitter	Partners, funding opportunities	Resources							
			Develop permanent resources (web, print, material, storage, maintenance) (E2,E9,E13, E17)	Washburne, Bitter	KT staff time, partners	Permanent resources							
			Identify & address gaps in offerings	Washburne	Planning	More complete set of programs, greater impact							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Education	Science Research Skills Development among K-12 Students (GLOBE, High School Interns, ECOSTART)	Identify regional issues/research questions for study via GLOBE (E18)	Washburne, Whitaker **grant pending**	Science partners	Need for networks							
			Develop partnerships and regional affiliates for GLOBE studies (E04, E18)	Washburne, Whitaker **grant pending**	Informal monitoring partners, leveraged funding	Infrastructure, research support							
			Develop and maintain regional school networks participating in GLOBE studies (E04)	Washburne, Whitaker **grant pending**	Schools, trained teachers, equipment	Data, completed research							
			Develop leveraged funding for GLOBE studies (E18)	Washburne, Whitaker **grant pending**	Partners, funding opportunities	Support for projects							
			Identify projects and recruit high school interns (E12)	Washburne	Positions, students	Assistance with research, skilled h.s. students							
			Continue support for ECOSTART Program (E10)	Washburne, Udall Center	Funding	Data collection skills and knowledge of water in Southern AZ border region							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Education	Resources to Promote Hydrologic Literacy in Non-formal Settings (Summer Camps, Summer Scholars, WATER Kits, CATTS)	Develop and implement Camp Wildfire (E05, E13)	Washburne, Hancock, Rubio Flandrau	Field and lab sites, staff	Student participation Done SU 04							
			Develop permanent camp curricula (Monsoon and Wildfire) (E05)	Washburne, Bitter, Colodner	Feedback	Permanent camp curricula							
			Redesign based on community needs and ideal scheduling (E05, E13)	Bitter, Washburne	Feedback, information	Attractive camp							
			Continue offering water-oriented camps at Science Centers (E05, E13, E22)	Bitter, Washburne, Phx Zoo	Leveraged funding	Permanent camp							
			Disseminate WATER Kits and camp curricula to regional science centers (E05, E09)	Bitter, Washburne	Partners	Water camps and use of WATER kits throughout region							
			Continue support for Summer Scholars and NAU K-12 tribal ed program (E07)	Washburne, Nelson NAU	Regular contact	Native American student participation							
			Education and outreach for the Valles Caldera (E23)	Bitter, Parmenter, Atherr **VCNP**	SAHRA related research on water, seeking NSF informal Ed funding	Water education materials and displays							
			Develop leveraged funding	Washburne	Partners, funding opportunities	Camps							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Education	Resources and Issues-based Course for Undergraduate Non-science Majors (Arizona Water Issues) (E01)	Develop permanent web-based content (E01)	Washburne	KT staff time	Permanent web-based content							
			Continue offering course every year at UA (E01)	Washburne HWR	Support of HWR	Permanent course							
			Develop & include IM tool (E01)	Washburne WSP	Funding, collaboration with science, appropriate personnel	IM tool for undergraduate non-majors							
			Encourage adoption throughout center (E01)	Washburne	Center-wide collaborators	Course on multiple campuses							
			Solar stills development (E19)	Washburne **EPA**		Development of solar stills activities for classroom + dissemination							

(b) Produce a new and diverse generation of professionals, students, and faculty who are adept at approaching water issues from a multidisciplinary and basin-scale perspective and are able to communicate this perspective effectively to others.

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
SAHRA Institutions	Education	Interdisciplinary & Community Outreach Skills (Seminars, Symposia, Exchange Programs, MSEng, Tribal Prof. Dev.)	Seminars (E14)	Washburne, Meixner	Topics, instructors, guests	Student learning							
			Symposia (E14)	Washburne	Topics, sites	Student learning & experience							
			Exchange Programs (E14)	Washburne, Browning	Sites, logistical support	Student learning & experience							
			Advising (E14)	Washburne	Standardized procedures	Successful students							
			Expand MEng program (E16)	Woodard, Davis	Recruit students	Trained water professionals							
			Develop NAU Tribal Professional Development Program (E15)	Washburne, Ramsey NAU	Develop infrastructure, recruit students	Trained tribal water professionals							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
SAHRA Institutions	Education	Research Skills (GAs, REUs)	Identify projects and recruit REU students (E06)	Washburne **NSF STC REU Grant**	Positions & mentors, applicant pool	Student learning & experience							
			Continue to provide graduate fellowships (E14)	Washburne	Positions, funding	Student learning & experience							
			Develop leveraged funding	Washburne	Partners (IGERT), funding opportunities	Research opportunities							
		Curricula (SAHRA Science-based Courses, MSEng)	Evaluate SAHRA relevant courses throughout center (E14)	Washburne	Course descriptions	Documentation of SAHRA-related education							
			Create web links (E14)	Washburne, Bitter	KT Staff time	Permanent web presence and network							
			Implement best practices (E14)	Washburne, Bitter	Identified practices, training	Knowledgeable, skilled students							

- River System Project, - Integrated Modeling Project, - Basin Project, - KT / International, - Education, - All

Domain	Legacy Type	Legacy Product	Task	Responsible PI	Inputs Needed	Outputs	Year 5 (2004)	Year 6 (2005)	Year 7 (2006)	Year 8 (2007)	Year 9 (2008)	Year 10 (2009)	Year11+ (2010)
All of the Semiarid Southwest	Diversity	Improved diversity among SAHRA researchers and staff	Expand staff recruitment pools	All	Job description; wider advertising	More diverse staff							
			Collaborate w/ new researchers & alumni who can strengthen our diversity efforts	All	ID targets of opportunity Funding	More diverse researchers							
		Improved diversity among SAHRA students	Expand recruiting efforts to diverse venues	Washburne	SAHRA opportunities	Larger pool							
			Work more closely w/ Univ. minority progs.	All	Assess synergies	Improved recruitment & support							
			Develop collaborative relationships with minority-serving institutions	All	Contacts Funding	Larger pool							
			Increase under-rep. grad. students	All	Diverse pool	More diverse students							
			Improve student mentoring	All	Faculty/Peer mentors Training	Student retention							
		Career Pathways - Improved access to hydrologic sciences	High school Teacher Training HS interns	Washburne	Products	Literate and motivated							
			Middle school summer camps, NAU outreach, GLOBE	Washburne Nelson NAU	Programs	Literate & interested							
			Expand programs to other locations	All	Locations / collaborators								
		Social & Regional relevancy	Reach a diverse public audience	Woodard, Bitter	Bilingual venues	Public engagement							