APPENDIX IE-5 – Summary of Research Implemented to Address Research Needs Identified in TRPA (1986) Monitoring and Evaluation Sub-element.

– Tiffany van Huysen, Science Coordinator, Pacific Southwest Research Station

The Environmental Improvement Program (EIP) and the Lake Tahoe Restoration Act (LTRA) identified Lake Tahoe and the surrounding Basin as a unique natural resource that requires protection, preservation, and restoration. The EIP and LTRA also highlighted the need for scientific research to inform management goals and actions, and to identify uncertainties and knowledge gaps as they relate to the overall objectives of conserving and restoring the Lake Tahoe Basin. The Southern Nevada Public Land Management Act (SNPLMA), enacted in 1998, specifically allowed funding from the sale of public lands by the Bureau of Land Management (BLM) to be set aside in support of LTRA projects. This funding has supported both capital projects and agency-sponsored research projects.

In 2006, the USDA Forest Service-Pacific Southwest Research Station (PSW) became the sole federal agency sponsor and assumed responsibility of administering the SNPLMA funding as it related to research projects in the Lake Tahoe Basin. This resulted in the creation of the Tahoe Science Program, which strives to promote applied, timely, and relevant research that addresses natural resource management needs in the Basin. Through a competitive grant award program, the Tahoe Science Program identifies and facilitates funding of research projects high in technical merit and relevant to land management and regulatory agencies working in the Tahoe Basin. As part of the grant award program, the Tahoe Science Consortium (TSC) coordinates a competitive review process. The TSC and PSW work closely with one another throughout the review process to ensure that the review process is fair, and that the research projects recommended for funding represent high quality science while addressing priority issues indentified by agencies. In addition, PSW and the TSC work to promote outreach, synthesis, and integration activities to ensure that research supported by the Tahoe Science Program addresses key management questions, includes input from agencies, produces tools that are useful and accessible, fosters collaboration and communication, builds on previous research, and ultimately addresses the science needs identified in the EIP.

Numerous projects funded through SNPLMA align with TRPA's Goals and Policies for monitoring and evaluation. These projects were selected based on their technical merit and agency relevancy, and demonstrate the depth and breadth of investment in support of science needs in the Lake Tahoe Basin. Summaries of funded projects are highlighted below to the extent that they address some of TRPA's Goals and Policies identified in TRPA (1986) Implementation Element, Monitoring, and Evaluation Subelement.

1. Evaluate and refine estimates of nitrogen loading to Lake Tahoe from runoff and atmospheric deposition.

The Lake Tahoe Total Maximum Daily Load (TMDL) was a project sponsored by the U.S. Environmental Protection Agency and represents an all-encompassing effort to assess sediment and nutrient loading to Lake Tahoe, and ultimately addresses the decline in deepwater clarity of the lake. Nitrogen was identified as one of the primary pollutants of concern with respect to clarity loss. The Lake Tahoe TMDL Report identifies atmospheric deposition as the primary source of dissolved inorganic nitrogen and total nitrogen in the annual nutrient load to the lake (55 percent), although uplands (both urban [16 percent] and non-urban [15.5 percent]) also contribute to lake nitrogen loading. The report was prepared by the California Regional Water Quality Control Board – Lahontan Region, and the Nevada Division of Environmental Protection.

2. Develop information on the exact sources of sediments and nutrients within individual watersheds.
Multiple projects implemented within the Tahoe Basin have investigated the sources of sediments and nutrients within watersheds and have evaluated the impacts of these sources on water quality. For example, the results of a study evaluating the effects of wildfire and prescribed fire on nutrient transport in runoff suggest that management practices that reduce litter biomass will potentially reduce nitrogen and phosphorus in surface runoff. Another study developed a Tahoe-specific Water Erosion Prediction Project (WEPP) model to predict the impact of disturbances on fine sediment loading from single hillslopes. Other on-going studies are addressing nutrient and sediment loading from slash pile burning, the relationships between fuels treatments and soil erosion potential, the effects of pile burning on soil and water quality, and the development of decision support tools to assist managers and planners in assessing sediment and nutrient loads from upland management practices.

3. Evaluate the effectiveness of best management practices in mitigating the water quality impacts from the watershed, and recommend revisions to the handbook of best management practices as appropriate.
The design and effectiveness of best management practices to mitigate water quality impacts from stormwater runoff has been evaluated by a number of projects, and continues to be a research area of importance to managers and planners in the Basin. The Tahoe Stormwater and Best Management Practices (BMP) Database was developed in support of the Tahoe Regional Stormwater Monitoring Program and the TMDL, to provide a source of stormwater data and allow tracking of BMP implementation, monitoring, and maintenance. Additional studies are evaluating the potential of floodplains and wetlands to serve as BMPs, novel filtration media for BMPs, alternative traction abrasives for roads, and the effectiveness of vegetated BMP treatment basins.

4. Improve understanding of the cause-effect relationships affecting visual range in the basin.
Studies related to air quality and its impacts on visual range in the Basin have evaluated and identified multiple sources of air pollutants in the Tahoe Basin and the management implications associated with those sources. A study evaluating nutrient emissions from prescribed fire suggested that implementing prescribed fire treatments when fuel moisture is low would likely maximize fuel consumption, while minimizing air quality impacts. Another study measured seasonal and spatial changes in fugitive dust emissions from paved roads in the Basin and recommended the use of particulate matter-compliant sweepers, anti-icing pre-treatment, and avoidance of loose gravel for road surfaces to minimize dust emissions. An air pollutant emissions inventory identified mobile sources and residential fuel combustion as major contributors to ambient air pollution for multiple pollutants, and also identified road dust re-suspension and biogenic sources as contributors. A source attribution study found that re-suspended paved road dust a major source of particulate matter (PM) in the Basin, followed by wood smoke and mobile sources. Two other studies addressed the relationship between visibility and air quality specifically. One study evaluated visibility measurements for tracking haze in the Basin. The final report recommends establishing measurements to estimate the chemical light extinction coefficient at a South Lake Tahoe site to: 1) allow regional and sub-regional visibility monitoring to be based on the same methods; 2) maintain reasonable continuity for tracking long-term trends; 3) relate receptor concentrations to source emissions; and 4) evaluate PM concentrations related to the National Ambient Air Quality Standards (NAAQS). The other study analyzed long-term, chemically-speciated PM aerosol data for Bliss State Park and South Lake Tahoe. Key results include: 1) seasonal differences in light extinction for the two sites (South Lake Tahoe and Bliss State Park Site) due to wildfires in the summer impacting Bliss State Park site, and residential

wood combustion and traffic impacting South Lake Tahoe in the winter, 2) clean days becoming cleaner and hazy days becoming hazier at Bliss State Park site based on the Regional Haze Rule, 3) biomass burning was the dominant source of PM, and 4) road dust and traffic emissions were higher for South Lake Tahoe.

5. Improve the understanding of the cause-effect relationships between piers and buoys and fish habitats and fish behavior in Lake Tahoe.

A number of studies were completed by UC Davis – Tahoe Environmental Research Center from the late 1980s through the 1990s to address questions associated with the effect of piers and buoys. These studies were widely cited in environmental documents leading up to the 2008 TRPA Shorezone Ordinances. More recently, the Nearshore Indicators for Clarity, Habitat, and Ecological Sustainability (NICHES) project synthesized information to determine the status of the nearshore native and non-native fish community if there are quantifiable indicators and methodologies that can be created to determine the condition of the nearshore fishery. The researchers also conducted experiments to determine if ultraviolet radiation (UV) can be used to link nearshore and non-native fish ecology to the physical environment. Key findings include: 1) nearshore fish densities have undergone a general decrease between 1988-89 and 2009; 2) UV transparency of nearshore sites significantly impacts the survival of warmwater fish larvae and influences whether these potentially invasive fish species are able to establish in nearshore Lake Tahoe; and 3) measurements of UV transparency showed that more than half of the sites sampled were in non-attainment of the UV attainment threshold as identified in the study. These results suggest that the health of Lake Tahoe's nearshore native fishery is deteriorating and that a long-term nearshore monitoring and warmwater fish prevention program is necessary to further understanding of Lake Tahoe's nearshore native fishery. Additional studies are examining the linkages between physical and biological components in the nearshore zone of Lake Tahoe and the factors controlling the spread of non-native fish species.

6. Establish instream flow standards for each of the Basin's tributaries.

Rost and Tracy's (2003) study found that only Trout Creek and Upper Truckee River support 'optimal flows' consistent with life history requirements of salmonids. They found that stream flow is primarily regulated by annual precipitation and any adopted minimum flow standards would need to account for annual variation in precipitation and address minimum flow needs for different aquatic species' life histories.

7. Evaluate the feasibility and effectiveness of ponding facilities along stream corridors as a strategy for removing instream loads of sediment and nutrients.

Multiple projects have evaluated, or are currently evaluating, the potential effectiveness of floodplains and stream environment zones (SEZs) to capture fine sediment and nutrients. A completed study found that stream reaches on the Upper Truckee River may reduce fine sediment loads during overbank flow events. Studies nearing completion are quantifying stream restoration effectiveness with respect to sediment load reductions, quantifying urban stormwater load reductions from SEZ restoration, and developing modeling tools to simulate channel erosion and meandering to inform stream management.

8. TRPA shall conduct a survey to identify areas where existing excess coverage is causing environmental damage.

Two projects have characterized land cover in the Basin. A capital project sponsored by the U.S. Geological Survey mapped the current and historical state of the land surface in the Tahoe Basin, analyzed patterns, rates, and trends in urbanization and land-use change, and assessed the causes and possible environmental consequences of land-use change. The U.S. Geological Survey, in collaboration

with TRPA, sponsored an additional capital project to obtain High-resolution Light Detection and Ranging (LiDAR) and multispectral imagery covering the entire Lake Tahoe Basin. Applications for this data include fuel treatment planning, fire behavior modeling, habitat restoration planning and evaluation, hydrologic modeling, terrain visualization, landform extraction, surface feature extraction, watershed and water quality evaluations, community planning, engineering surveys and planning, natural resource monitoring and evaluation, and accurate mapping of vegetation height, density, size, distribution, and heterogeneity. An interpretation and estimate of hard and soft coverage derived from LiDAR and Multispectral datasets is expected to be completed in December 2012. Mapping resulting from this work will provide details on the location of excess coverage at the parcel scale for the entire Lake Tahoe Region.

In addition to supporting the Tahoe Science Program through the agency relevancy review of proposals, agency representatives provide additional support by serving on Technical Advisory Committees for funded projects, serving on Working Groups which help guide project implementation, and by representing their respective agencies as part of the Science and Management Integration Team (SMIT). SMIT is composed of agency representatives and members of the TSC, and works to identify, prioritize, recommend, and communicate research and monitoring activities. As part of this effort, SMIT developed fact sheets addressing forest health, aquatic invasive species, air quality, lake clarity, and stream and meadow restoration for the 2011 Lake Tahoe Summit.