In contrast to the simplistic analysis of CWEs from estimation of equivalent roaded areas (ERAs), we followed the suggestion of Merritt et al. (2003), that for the purposes of land management decisions based on load (sediment and nutrient) allocations in the Tahoe Basin, a semi-distributed watershed model (LSPC, Loading Simulation Program in C++) developed by the US EPA be employed (Tetra-Tech, 2005). This model was at the foundation for the establishment of the Tahoe Basin sediment loads used in the TMDL process and represents the "state-of-the-art" of watershed modeling capability in the Basin. The LSPC system components include an integrated system for GIS watershed data analysis, a watershed customizable interface for GIS-driven input configuration, a database for data storage and management, and a watershed model that can be rapidly configured and run. The core watershed model includes streamlined Hydrologic Simulation Program, Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality on land as well as a simplified stream transport model. By automatically linking upstream contributions to downstream segments, LSPC overcomes difficulties experienced with large-scale watershed simulation while allowing users to freely model sub-areas within a topdown framework. Importantly from a land-allocation of sediment and nutrient loading perspective, LSPC enables users to link in-stream water quality directly to point and non-point source loads. Through use of the Microsoft Access database to manage model data and weather text files that drive the simulations, comprehensive output files by sub-basin for all land-uses, reaches, and simulated modules can be expressed on hourly or daily intervals. Basic watershed information is readily available from digital elevation maps and GIS layers of land-uses and soil types across a catchment. Here, we "ground-truthed" the dirt roaded areas in the three watersheds and adjusted the original GIS land-use areas used in the TMDL modeling to better reflect "on-the-ground" conditions found in the watersheds. Water quantities (infiltration, interflow and runoff rates, soil moisture storage and deep percolation rates) and quality (erosion and sediment transport) are calculated for each land-use in the sub-basin. Water and sediment fluxes are then added to the stream and routed to the basin outlet. Basin inputs to the model include snowmelt, rainfall, evaporation, air and water temperatures, solar radiation, sediment grain-size distributions, point-source discharges, and water quality data. Possible outputs from the simulation are a temporal history of runoff, flowrates, sediment load and nutrient concentrations along with a time series of water quantity and quality at each desired outlet in the catchment. HSPF is one of the few conceptual models of watershed hydrology and water quality that explicitly integrates the simulation of land and soil contaminant runoff processes with in-stream hydraulic and sediment–chemical interactions. As with other hydrologic models, LSPC or HSPF have been shown to successfully predict catchment discharges for a variety of settings. HSPF modeling relies heavily on calibration for parameterization (Walton and Hunter, 1996); such an in-depth calibration process was completed for the Tahoe Basin LSPC model (Tetra-Tech, 2005).

The extensive LSPC/HSPF model calibration was conducted using both short and long-term stream monitoring data from 12 USGS and 10 LTIMP (Lake Tahoe Integrated Monitoring Program) sites for tributaries around the Tahoe Basin. These data were augmented with in-depth field studies by Simon et al. (2004). The model was calibrated using both historical stream monitoring data and locally observed stormwater runoff monitoring data. Model calibration followed a sequential, hierarchical process that began with hydrology followed by calibration of water quality related parameters. As inaccuracies in the hydrology simulation propagate into the water quality simulation, the accuracy of the hydrologic simulation has a significant impact on the accuracy of the water quality simulation. Calibration included a time-series comparison of daily, monthly, seasonal, and annual values, and individual storm events. Composite comparisons (e.g., average monthly streamflow values over the period of record) were also made. The majority of the streamflow and sediment loading data used in this calibration was from the Lake's west shore tributaries including Quail Creek and Blackwood Creek (located just to the north of Madden Creek). More recently collected streamflow and sediment discharge (April –June, 2009 & 2010) from Homewood Creek was also used to further verify the streamflow model predictions and recalibrate the sediment loadings for the three catchments considered here.

While the LSPC model is expected and appears to accurately predict streamflows in the three watersheds, there is little information available about the relative predictive capability with respect to sediment and nutrient loadings. As a result, we constrain our discussions here to comparisons of annualized sediment loads from the watersheds as determined from LSPC modeling. Such results are subject to errors associated with determination of the various land-use areas within each watershed. From the GIS based and ground-truthed information, we expect relative prediction errors <10% for the land-use areas of each alternative and baseline conditions. Unfortunately, for the determination of the "allowed coverage" areas, there were conflicting maps and overlays resulting in various interpretations of what exactly "allowed coverages" were; the best interpretations from different parties were assembled into one reasonably "coherent" set of areas that were then used in the LSPC modeling to estimate the ToC annualized sediment loads for comparison to the different alternatives. The error associated with this determination are unknown, but likely greater than the ~10% indicated above.

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