1.0 Background and Goals

Non-point source pollution refers to a variety of difficult-to-trace pollutants, including those found in urban storm water runoff. By their nature, these pollutants can be extremely difficult to capture and treat. Acting as a conduit for pollution, urban runoff transports sediment, nutrients, metals, and various hydrocarbons to waterways. If not controlled, urban runoff can impair water quality, in some cases causing algal blooms, increased turbidity, decreased dissolved oxygen, and aquatic habitat degradation.

Lake Tahoe, famous for its extraordinary clarity, suffers many negative impacts attributable to urban storm water. Rapid development and increased tourism continue to threaten the integrity of sensitive Lake Tahoe watersheds. Recent research indicates urbanized areas and roadways contribute a significant amount of sediment and nutrients responsible for water quality impairment at Lake Tahoe (Lake Tahoe Watershed Assessment, 2000). To minimize the environmental impacts associated with storm water runoff, several agencies in the Tahoe Basin are working to effectively control non-point source pollution by implementing Best Management Practices (BMPs).

By definition, a storm water BMP is a technique, measure, or structural control used to manage the quantity and improve the quality of storm water runoff in the most cost-effective and efficient manner. Storm water BMPs are usually constructed systems ("structural BMPs") such as detention basins, infiltration trenches, revegetation efforts, and constructed wetlands. Other "non structural BMPs" aim to reduce the amount of pollutants found in urban runoff through education, source control (prevention), and maintenance practices. Unfortunately, no single BMP can address all storm water problems. Every BMP has limitations based on cost and pollutant removal efficiency as well as site-specific restrictions including available land, slope, soil type, and depth to groundwater. These issues must be considered when selecting the appropriate BMP or group of BMPs to treat storm water at a particular location.

Many unique conditions in the Lake Tahoe Basin further complicate BMP selection and performance. At over 6000 feet in elevation, snowfall dominates winter precipitation. As such, much of the urban runoff comes with spring snowmelt. Freezing temperatures associated with the alpine setting can hinder the effectiveness of settling basins and conveyance systems, limit infiltration capacities, and complicate routine maintenance. Winter sanding and snow removal activities increase sediment loads, placing greater demands on pretreatment devices. Steep slopes, erodible soils, and a short growing season further add to the complexities of controlling non-point source pollution in the Tahoe Basin.

Along with difficult climatic and environmental conditions, storm water BMPs at Lake Tahoe must also attempt to meet stringent water quality standards. In order to reverse trends of declining water quality and loss of transparency, major reductions in contaminants reaching Lake Tahoe are necessary. In 1980, the California Regional Water Quality Control Board – Lahontan Region (Regional Board) adopted numerical storm water effluent limitations (Table 1) to address the problem of pollutant-laden runoff on the California side of the Lake Tahoe Basin. These effluent limitations are based on measured concentrations from undisturbed, forested watersheds.

Table 1: *Regional Board's maximum allowable concentration of storm water constituents*

Constituent	Surface Waters	Infiltration Systems
Total Nitrogen as N	0.5 mg/L	5 mg/L
Total Phosphate as P	0.1 mg/L	1 mg/L
Total Iron	0.5 mg/L	4 mg/L
Turbidity	20 NTU	200 NTU
Grease and Oil	2 mg/L	40 mg/L

The Tahoe Regional Planning Agency (TRPA) adopted similar effluent limitations as part of the Water Quality Management Plan for the Lake Tahoe Region, (also called the 208 Plan) (Table 2). It is important to note that the limitations outlined in the 208 Plan are strictly for *dissolved* nutrients, while Lahontan regulations apply to *total* nutrient concentrations. For discharges to surface water, the TRPA limits substitute a 250 mg/L suspended sediment concentration for the turbidity requirement. The Nevada Department of Environmental Protection follows TRPAs effluent limits.

Table 2: TRPA'*s Maximum allowable concentration of storm water constituents*

Constituent	Surface Waters	Infiltration Systems
Dissolved Nitrogen as N	0.5 mg/L	5 mg/L
Dissolved Phosphate as P	0.1 mg/L	1 mg/L
Dissolved Iron	0.5 mg/L	4 mg/L
Suspended Sediment	250 mg/L	--
Grease and Oil	2 mg/L	40 mg/L

In some circumstances, the stringent effluent limits adopted by TRPA and the Regional Board have proven difficult to meet. In the past, the inability to comply with storm water effluent limitations has discouraged road and highway department from constructing treatment facilities in areas where site-specific conditions limit treatment options. Consequently, these areas often receive little or no treatment.

Clearly, discouraging implementation of storm water treatment practices was not the intent of resource agencies when they adopted storm water effluent limitations. Water quality improvement has always been (and continues to be) the primary goal of storm water regulations. To meet this goal, resource managers not only encourage, but also *require* the maximum possible storm water treatment.

To better correlate regulatory goals with actual nutrient and sediment reductions needed to reverse the trend of declining clarity, storm water regulations may shift from effluent limits to load based allocations. By 2007, numeric targets and load allocations to meet Total Maximum

Daily Load (TMDL) requirements for nutrients and sediment may offer road and highway departments the opportunity to compensate for poorly treated areas with enhanced treatment at more favorable locations.

In addition to the effluent limitations discussed above, storm water regulations currently designate a 20-year 1-hour “design storm” for storm water control facilities in the Lake Tahoe Basin. Containment of a storm this size, however, does not necessarily ensure compliance with effluent limitations or receiving water standards.

As with effluent limits, the inability to contain the design storm in some areas has caused some storm water to go untreated. Furthermore, the 20-year 1-hour storm requirement has often limited the size treatment structures where larger, more effective facilities could have been constructed. It is important to realize the regulation requires containment ***or*** treatment of the design storm. Treatment does not necessarily require containment; other options should be considered when containment is not feasible or when better treatment is available by other means.

As part of the pending shift to pollutant load based regulations, dischargers are encouraged to construct storm water treatment facilities to provide the greatest possible water quality benefit. In some instances this may involve treating a volume greater than that generated by a 20-year 1-hour storm event. Regulatory agencies realize extra treatment may come at additional costs, but such commitment is needed if management efforts are to effectively reverse transparency loss at Lake Tahoe.

Scientific research continues to improve our understanding of the causes of transparency loss. Such research helps guide regulatory agencies and project proponents in directing treatment efforts on the specific constituents responsible for clarity decline. Free floating algae, stimulated by bioavailable phosphorus, and fine sediment particles (silts and clays) are now considered the primary threats to the transparency of the Lake (Lake Tahoe Watershed Assessment, 2000).

The loss of vital wetlands capable of filtering fine sediments and dissolved nutrients from Lake Tahoe tributaries further contributes to the problem. Considering this new information, many existing practices meant to protect Lake Tahoe may be less effective than expected. While erosion control and sediment reduction remain important goals, new and retrofitted BMPs must focus on the removal of bioavailable nutrients and fine particulates (silts and clays) if these efforts are to improve the clarity of Lake Tahoe (Lake Tahoe Watershed Assessment).

Unfortunately, definitive research regarding the most effective means to accomplish these goals is limited. Much of the BMP effectiveness research discussed in scientific literature has been conducted on the East Coast of the United States, particularly in Florida and Maryland. In addition to the differing environmental conditions, many of these studies focus on the removal of other constituents (such as heavy metals, bacteria, and coarse sediment) rather than the treatment of fine particles and dissolved nutrients.

Fine sediments and bioavailable nutrients have proven extremely difficult to eliminate from storm water flows. Many BMP reference manuals and research reports have been written that address the variables associated with implementing effective storm water treatment projects in the Tahoe Basin. Of particular interest is a study submitted to TRPA by HydroScience, entitled *Bioavailable Nutrient Loading Into Lake Tahoe and Control Opportunities With an Emphasis on Utilizing Stream Environment Zones (SEZs) to Treat Urban Runoff* (March 20, 2000).

Along with a thorough discussion of bioavailable nutrient sources and the feasibility of using SEZs for storm water treatment, the HydroScience report offers a comprehensive review of local monitoring efforts and BMP-related research. Based on this review and other studies conducted outside of the Basin, the report suggests that few conventional BMPs are effective for treating bioavailable nutrients and fine sediment. Only two types of BMPs have shown the ability to filter these constituents from urban runoff: on-site infiltration and shallow dispersion across dense vegetation (i.e. SEZ treatment). Infiltration is particularly efficient for phosphorus removal, while SEZs can permanently remove bioavailable nitrogen and phosphorus. Other conventional BMPs, including settling basins and storm water drop inlets have proven inadequate for the task.

Ideally, all storm water BMPs in the Tahoe Basin would incorporate both infiltration *and* SEZ treatment. Unfortunately, many of the SEZs in the Basin have been adversely impacted through filling, excavation, and channelization of associated waterways. Furthermore, a large portion of the urbanized areas of the Basin (including most of the west and north shores) do not drain to an SEZ. Those SEZs that do receive urban runoff (such as those in the south shore area) are often incapable of treating the high pollutant loads found in urban runoff. Consequently, infiltration currently remains the primary method for removing fine sediment and bioavailable phosphorus from urban storm water.

Since infiltration practices must face the brunt of the treatment challenge, it is important that other BMPs such as source control measures, conveyance structures, pretreatment devices, and maintenance practices effectively help reduce pollutant loads. If sediment and nutrient concentrations can be reduced before final treatment, infiltration and SEZ treatment systems will function more efficiently and with greater success.

To meet this objective, it is important to limit the volume of storm water that must be treated. Evaluation of source control opportunities such as revegetation should be the first step in BMP implementation, followed by assessing the potential to treat small volumes of runoff near the source. Conveyance methods should only be employed when necessary clean runoff should be separated from contaminated runoff when ever possible. These simple practices can help ease the burden on downstream BMPs.

The effectiveness of many BMPs used in the Tahoe Basin has not been fully evaluated. Although recent monitoring efforts have begun to shed light on those BMPs that work and those that do not, many questions remain. Careful BMP selection, design, and implementation is essential for achieving the highest possible pollutant reduction. Monitoring of BMP projects will provide better understanding of how to improve storm water treatment in the Lake Tahoe Basin.