City of South Lake Tahoe

Pollutant Load Reduction Strategy

November 2012

Prepared for:

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LIST OF ACRONYMS

BMP	Best management practices, e.g. stormwater control measures
CICU	Commercial/institutional/communications/utilities
CRC	Characteristic Runoff Concentration
CSLT	City of South Lake Tahoe
DCIA	Directly connected impervious area
DN	Dissolved nitrogen
DP	Dissolved phosphorus
FSP	Fine sediment particles
GIS	Geographic information system
HSC	Hydrologic source control
ICIA	Indirectly connected impervious area
Lahontan	Lahontan Region Water Quality Control Board
MFR	Multi-family residential
NDEP	Nevada Division of Environmental Protection
NRCS	Natural Resources Conservation Service
PSC	Pollutant source control
SEZ	Stream environment zone
SFR	Single family residential
SWT	Storm water treatment
TMDL	Total maximum daily load
TN	Total nitrogen
TP	Total phosphorus
TRPA	Tahoe Regional Planning Agency
TSS	Total suspended sediment
UPC	Urban planning catchment
USFS	United States Forest Service
WQIP	Water quality improvement project

EXECUTIVE SUMMARY

On December 6, 2011, the California Regional Water Quality Control Board-Lahontan Region (Lahontan) incorporated the first Lake Tahoe Total Maximum Daily Load (TMDL) pollutant load reduction targets into the updated Tahoe Municipal National Pollutant Discharge Elimination System (NPDES) Permit. As subsequently amended on October 10, 2012, this permit – Board Order R6T-2011-101A1 – regulates stormwater discharges from each California municipalities' stormwater management infrastructure. This municipal separate storm sewer system (MS4) infrastructure consists of collection, conveyance, and treatment facilities. Federal rules require operators of these MS4 systems to implement programs to control polluted runoff. California regulates these MS4s through municipal NPDES permits, and for this document, Lahontan Board Order R6T-2011-101A1 is referred to as the MS4 permit.

The MS4 permit stipulated a September 30, 2016 deadline to reduce estimated 2004 baseline jurisdictional pollutant loads of fine sediment particles (FSP) by 10%, total nitrogen (TN) by 8%, and total phosphorus (TP) by 7%. The MS4 permit requires the City of South Lake Tahoe (City) to prepare a Pollutant Load Reduction Plan by March 15, 2013 detailing the City's approach for meeting pollutant load reduction targets. The MS4 permit allows the City to take credit for load reductions resulting from water quality improvement projects or other actions implemented since the 2004 baseline period. These load reduction requirements also apply to Caltrans, as well as the two other California MS4 permitees in the Tahoe Basin (i.e. Placer County and El Dorado County).

The City authorized the Pollutant Load Reduction Strategy Report (Strategy Report) to assess potential approaches for reducing pollutant loading to Lake Tahoe from urban stormwater runoff within the City's jurisdiction. The Strategy Report is intended to guide the City's load reduction planning process by identifying feasible and cost effective actions to meet load reduction targets. The findings and recommended approaches in the Strategy Report will be used to draft the Pollutant Load Reduction Plan.

The Strategy Report categorizes and analyzes water quality improvement actions into three primary load reduction methodologies:

1. Improvements to road maintenance operations for water quality;
2. Public water quality improvement projects (WQIPs); and
3. Private parcel BMPs implemented through retrofit or redevelopment.

Using this general framework, an existing condition assessment identified load reductions the City could register from completed actions. Following the existing conditions assessment, each methodology was assessed under various assumptions, which included varying levels of implementation. The results produced estimates of potential load reductions and costs required to achieve load reduction targets.

Existing Conditions Assessment

Water quality improvement actions completed through 2012 include:

- Road Operations:
    - On average, the City applies 550 tons of road traction abrasives per year with a total cost of $10,500 for abrasive material.
    - Street sweeping is performed citywide one to two times during the year in the summer and fall months, and more frequently on specific roads during the winter to recover road abrasives applied during snow events. The City spends $270,000 on street sweeping per year, which includes cost recovery for sweeper purchases.

- WQIP Construction: Seven WQIPs have been completed from 2004-2012 with a total project delivery cost of $31 million for planning, environmental documentation, permitting, design, property acquisition, and construction.

- BMP Certification: The level of TRPA BMP certification for developed parcels within the City (14 percent) is less than the California average (26 percent), and significantly less than the Nevada average (54 percent).

Pollutant load reduction estimates developed using the Pollutant Load Reduction Model (PLRM) indicate that 1) completed WQIPs provide a 4.3 percent FSP load reduction, and 2) private property BMP certification provides roughly a 1 percent FSP load reduction relative to the City's baseline load. In total, completed actions have reduced the City's baseline pollutant load of FSP by nearly 5 percent relative to the required 10 percent target. Currently available data for sanding and sweeping operations was too coarse to reasonably inform PLRM estimation of pollutant load reductions.

2016 Pollutant Load Reduction Plan Recommendations

The City anticipates construction of at least three WQIPs (Bijou Commercial Core, Harrison Avenue, and Sierra Tract Phase 3&4) by the first pollutant load reduction deadline (September 2016). These three active WQIPs have an estimated project delivery cost of roughly $17 million and target construction of improvements in dense urban areas of the City that discharge stormwater directly to Lake Tahoe. These WQIPs highlight a new City strategy to incorporate stormwater treatment of runoff from dense commercial land uses into each project where feasible. Consequently, the active WQIPs provide a significant load reduction benefit, which preliminary PLRM models estimate will provide a 5.7 percent FSP load reduction.

The Strategy Report recommends the City register completed and active WQIPs. PLRM performance estimates indicate these WQIPs might provide up to a 10 percent reduction in baseline FSP loading. However, this overall load reduction estimate is relatively uncertain as a number of individual WQIP performance estimates are based preliminary PLRM models, which in some cases reflect the preferred alternative for project design. Therefore, a more diversified strategy is recommended to ensure the required 10 percent FSP reduction is met through optimization of road operations for water quality by a combination of the following actions:

1) minimizing the amount of road abrasives applied while maintaining traffic safety; and
2) maximizing the recovery of FSP on targeted roads with frequent street sweeping.

The recommended actions are estimated to cost $48 million to reach the 2016 load reduction target. Of this amount, approximately $34 million has already been expended on completed WQIPs and the planning and design of active WQIPs. The cost estimate includes annual operation and maintenance and Lake Tahoe TMDL reporting costs from 2012-2016, which average roughly $200,000 per year during that time period.

Achievement of Future Load Reduction Targets

Lahontan has indicated that the MS4 Permit will be updated every five years to include additional load reduction targets. Upcoming targets are anticipated for 2021 and 2026. Attainment of the 2026 target, termed the Clarity Challenge, is estimated to return Lake Tahoe to an average annual transparency of about 80 feet (Lahontan 2010).

Given current uncertainties associated with public grant funding, which has typically been used to construct WQIPs, the recommended strategy to achieve future load reduction targets proposes to shift away from a heavy reliance on WQIPs to a more balanced program that includes a greater emphasis on improvements in road operations for water quality and targeted implementation of private property BMPs. The recommended strategy provides flexibility by identifying three separate water quality improvement actions for combination in various proportions and timeframes. The recommended strategy for the City to meet future load reduction targets blends the following:

1) continuation of WQIPs in catchments with notable and cost effective opportunities for load reduction;
2) further optimization of road operations, including more frequent and targeted street sweeping; and
3) support and/or enforcement of private property BMP Certification with a near-term focus on roughly 290 acres of commercial land use discharging stormwater directly to Lake Tahoe.

The Strategy Report demonstrated with the specific blend of recommended actions that achievement of load reduction targets through the Clarity Challenge is technically feasible. The total cost to implement the recommended actions through achievement of the Clarity Challenge is estimated to be $58.6 million. Of this amount, roughly $34 million has already been expended on completed WQIPs and the planning and design of active WQIPs. Additionally, roughly $7.25 million is estimated to be contributed by the private sector for targeted commercial BMP implementation. The cost estimate includes annual operation and maintenance cost, and annual Lake Tahoe TMDL reporting and tracking costs. After full implementation, the costs are estimated at approximately $800,000 per year. Of this amount, roughly $325,000 per year is estimated to be contributed from the private sector for BMP maintenance of commercial properties.

Given present uncertainties in available funding, a refinement of the recommended actions will likely be needed as part of the updated Pollutant Load Reduction Plan submitted in June 2016 to Lahontan. Future load reduction actions implemented by the City will be dependent upon: 1) resolution of institutional or policy changes required to accelerate private property BMP implementation; 2) available funding; and 3) the results of monitoring and lessons learned from implementation of the 2016 Load Reduction Plan.

1.0 BACKGROUND AND APPROACH

On December 6, 2011, the California Regional Water Quality Control Board-Lahontan Region (Lahontan) incorporated the first Lake Tahoe Total Maximum Daily Load (TMDL) pollutant load reduction targets into the updated Tahoe Municipal National Pollutant Discharge Elimination System (NPDES) Permit. As subsequently amended on October 10, 2012, this permit – Board Order R6T-2011-101A1 – regulates stormwater discharges from each California municipalities' stormwater management infrastructure. This municipal separate storm sewer system (MS4) infrastructure consists of collection, conveyance, and treatment facilities. Federal rules require operators of these MS4 systems to implement programs to control polluted runoff. California regulates these MS4s through municipal NPDES permits, and for this document, Lahontan Board Order R6T-2011-101A1 is referred to as the MS4 permit. The MS4 permit requires the City of South Lake Tahoe (City) to prepare a Pollutant Load Reduction Plan by March 15, 2013 detailing the City's approach for meeting pollutant load reduction targets.

The City authorized this Pollutant Load Reduction Strategy Report (Strategy Report) to assess potential approaches for reducing pollutant loading to Lake Tahoe from urban stormwater runoff within the City's jurisdiction. The intention of the Strategy Report is to inform the City's pollutant load reduction planning process by identifying feasible and cost effective solutions to meet the Lake Tahoe TMDL load reduction targets. The findings and recommended approaches from this Strategy Report will be used to draft the Pollutant Load Reduction Plan.

Section 1 of this Strategy Report summarizes: the City's 2011 baseline pollutant load estimate; load reduction planning milestones and load reduction targets specified in the MS4 permit and the Lake Tahoe TMDL; and key findings from previous Lake Tahoe Basin studies that have shaped the analysis for this report..

1.1 BASELINE LOAD ESTIMATE

In 2011, Lahontan issued an *Order to Submit Technical Reports in Accordance with California Water Code – Lake Tahoe Urban Stormwater Implementation* (13267 Order) to the City and the other Tahoe Basin MS4 permitees (El Dorado County and Placer County). The 13267 Order required that the City estimate a baseline pollutant load discharged to Lake Tahoe for fine sediment particles (FSP), total phosphorus (TP), and total nitrogen (TN). The period of time from October 1, 2003 to May 1, 2004 is defined by the 13267 Order as the baseline condition (Lahontan 2011b) and is the point of reference for estimating baseline pollutant loading.

The Pollutant Load Reduction Model (PLRM) was used to estimate the City's baseline pollutant load. The PLRM is a publicly available long-term continuous simulation model used to evaluate and compare alternatives for storm water quality improvement projects in the Tahoe Basin. The PLRM links urban stormwater hydrology and site specific land use conditions to estimate average annual pollutant loading from urban drainage catchments under varying scenarios (NHC 2009). The PLRM was developed to estimate pollutant loading from individual water quality improvement projects (WQIPs). Consequently, many individual PLRM models would be necessary to estimate pollutant loads for the entire urban area of the City. To conserve resources, roughly 50% of the City's urban area was modeled using PLRM by selecting urban planning catchments (UPCs) within

the City that represent a range of stormwater conditions. The results from detailed PLRM modeling were extrapolated by developing regression equations, and these were used to estimate pollutant loading in UPCs not explicitly modeled. For UPCs that discharge stormwater to meadows or marshes within the City, a connectivity methodology was developed to estimate the proportion of stormwater and associated pollutant load that reaches Lake Tahoe.

The final *City of South Lake Tahoe – Lake Tahoe TMDL Baseline Pollutant Load Estimate Report (CSLT 2011)* was submitted to Lahontan in September of 2011. The baseline load estimate (Table 1.1) in the final report was subsequently reported in section IV.A of the MS4 Permit.

Table 1.1 – City Baseline Pollutant Load Estimate

Urban Area (acres)	Surface Runoff (acre-feet/year)	Pollutant Loading			
		Fine Sediment Particles (FSP)	Total Phosphorus (TP)	Total Nitrogen (TN)	Units
5,500	1,200	389,000	1,740	7,410	lb/year
		176.7	0.8	3.4	metric tons/year
		1.94E+19	n/a	n/a	number of particles/year[1]

[1] One kg FSP = 1.1×10^{14} particles FSP (Equation 0.3 - Lahontan and NDEP, 2011)

1.2 LAKE TAHOE TMDL TARGETS AND PLANNING MILESTONES

Through the Lake Tahoe TMDL, Lahontan established five-year load reduction targets to assess a jurisdiction's progress towards meeting overall load reduction goals. Load reduction targets for FSP, TP, and TN have been established based on attainment of California's Lake Tahoe transparency standard (roughly 97 feet) over an estimated 65-year implementation period. The first load reduction target is specified in the MS4 permit, which requires a 10 percent FSP reduction, 7 percent TP reduction, and an 8 percent TN reduction from baseline pollutant loading by September 30, 2016.

In addition to load reduction targets, the MS4 permit identifies a number of milestones for load reduction planning efforts, which include:

- Five Year Pollutant Load Reduction Plan – March 15, 2013
- Pollutant Load Reduction Progress Report – October 1, 2013
- Report of Waste Discharge and Updated Pollutant Load Reduction Plan – June 9, 2016

The Lake Tahoe TMDL sets a fifteen-year interim goal, termed the Clarity Challenge, to reduce total loading of FSP, TP, and TN by 34 percent, 14 percent, and 4 percent, respectively. Attainment of the Clarity Challenge is estimated to return Lake Tahoe to an average annual transparency of about 80 feet (Lahontan 2010).

The Lahontan has developed the Lake Clarity Crediting Program to support the Lake Tahoe TMDL, which specifies the process to link implementation of water quality improvement actions to estimated pollutant load reductions. Through this program, Lake Tahoe TMDL Credits have been

defined as a mechanism to provide flexibility for regulated jurisdictions to achieve required load reductions using a blend of operations and maintenance practices, capital improvement projects, BMP retrofits on developed public and private lands, and restoration efforts. Lahontan intends to use the Lake Clarity Crediting Program and an accounting system for Lake Tahoe TMDL Credits to track compliance with stormwater regulatory measures (Lahontan 2010). Table 1.2 displays anticipated City load reduction targets for FSP through attainment of the Clarity Challenge and associated Lake Tahoe TMDL Credits.

Table 1.2 – City FSP Load Reduction Targets

Load	% FSP Reduction	Time of Measure	FSP Loading (lb/year)	FSP Reduction (lb/year)	Lake Tahoe TMDL Credits
Baseline Pollutant Load Estimate	-	October 1, 2003 to May 1, 2004	389,000	-	-
First Load Reduction Milestone	10%	September 30, 2016	350,000	39,000	195
Second Load Reduction Milestone	21%	2021	307,000	82,000	410
Clarity Challenge Milestone	34%	2026	257,000	132,000	660

As noted in the text above, the MS4 Permit and the Lake Tahoe TMDL specify load reduction targets for TP and TN in addition to FSP. To simplify the presentation and discussion of results, this report focuses on interpretation of FSP pollutant loading based on modeled water quality improvement actions. With the exception of alterations to vegetated turf management practices, PLRM water quality data is based on the premise that a proportional relationship exists between FSP, TP, and TN loading changes caused by specific water quality improvement actions or changes in land use condition (Lahontan and NDEP 2008b). Therefore, the interpretation of PLRM modeling results for FSP are assumed to apply to TP and TN. Lahontan plans to accept the risk associated with modeling uncertainties and will honor baseline load estimates and load reduction estimates produced from PLRM simulations through at least the duration of the current permit term (Larsen, pers. comm. 21 April 2011). In the future, should a jurisdiction demonstrate achievement of an FSP target, but TP and TN load reductions fail to meet corresponding targets, the Lake Tahoe TMDL Program will revisit the assumption that if FSP load reductions are met TN and TP load reductions will follow.

1.3 KEY FINDINGS FROM PREVIOUS STUDIES

The primary reference guiding development of the City's Strategy Report is the recently completed *Placer County Stormwater TMDL Strategy 2011* (Placer Strategy). Load reduction estimates from a multitude of PLRM runs made during the Placer Strategy work were used to identify effective and site-specific load reduction actions within the City. The following Placer Strategy approaches and findings influenced the analyses in the City Strategy Report (Placer County 2011):

> Primary Concepts for Load Reduction: Water quality improvement actions that reduce pollutant loading from stormwater runoff in the Tahoe Basin can be grouped into three primary concepts:

1. Improvements to road maintenance operations for water quality;
2. Public water quality improvement projects (WQIPs); and
3. Private parcel BMPs implemented through retrofit or redevelopment.

Load Reduction Achieved from Primary Concepts: No single concept achieved load reductions that would satisfy the Lake Tahoe TMDL Clarity Challenge with a high degree of confidence. Therefore, the Placer Strategy recommended the integrated use of all three concepts when developing a strategy to meet Lake Tahoe TMDL load reduction targets.

Cost Effectiveness of Concepts: In the near-term, the most cost-effective concept for reducing pollutant loads appears to be improved operations and maintenance actions to reduce the availability of FSP on roads where stormwater runoff discharges directly to Lake Tahoe or streams flowing to Lake Tahoe.

Cost to Meet Load Reduction Targets and Associated Funding Uncertainty: Achievement of load reduction targets will require significant resources. Presently, the outlook for sustained allocation of grant funding to continue water quality improvement actions in the Tahoe Basin is uncertain. Furthermore, some of the proposed actions for load reduction are not currently eligible for grant funding (e.g., increased water quality maintenance activities).

Targeting Significant Load Reduction Opportunities: Land use conditions influence the volume of stormwater runoff and the quantity of pollutant loads generated. The poorest land use conditions generating the highest pollutant loads on a unit area basis are:

1. Heavily trafficked roads; and
2. Commercial land uses.

In addition to the Placer Strategy, the City's recently completed *Lake Tahoe TMDL Baseline Pollutant Load Estimate Report (CSLT 2011)* provides useful information to help prioritize water quality improvement actions within the City. The City's *Baseline Pollutant Load Estimate Report* separately identifies UPCs that drain directly to Lake Tahoe and UPCs that drain to a meadow or other natural filtration systems prior to reaching Lake Tahoe. The term *catchment connectivity* is used to specify this distinction, which classifies the portion of surface runoff and associated pollutant load discharged from a discrete UPC that reaches Lake Tahoe. Catchment connectivity is expressed as a percentage and termed a *connectivity factor*, where a connectivity factor of 100 percent denotes a directly connected UPC that discharges stormwater directly to Lake Tahoe or a stream flowing to Lake Tahoe. Distinguishing between UPCs based on drainage patterns is particularly important to the City because much of the City's urban drainage area discharges to meadows prior to reaching Lake Tahoe. For these UPCs, only a fraction of the total pollutant load generated by the urban land uses within the City reaches Lake Tahoe.

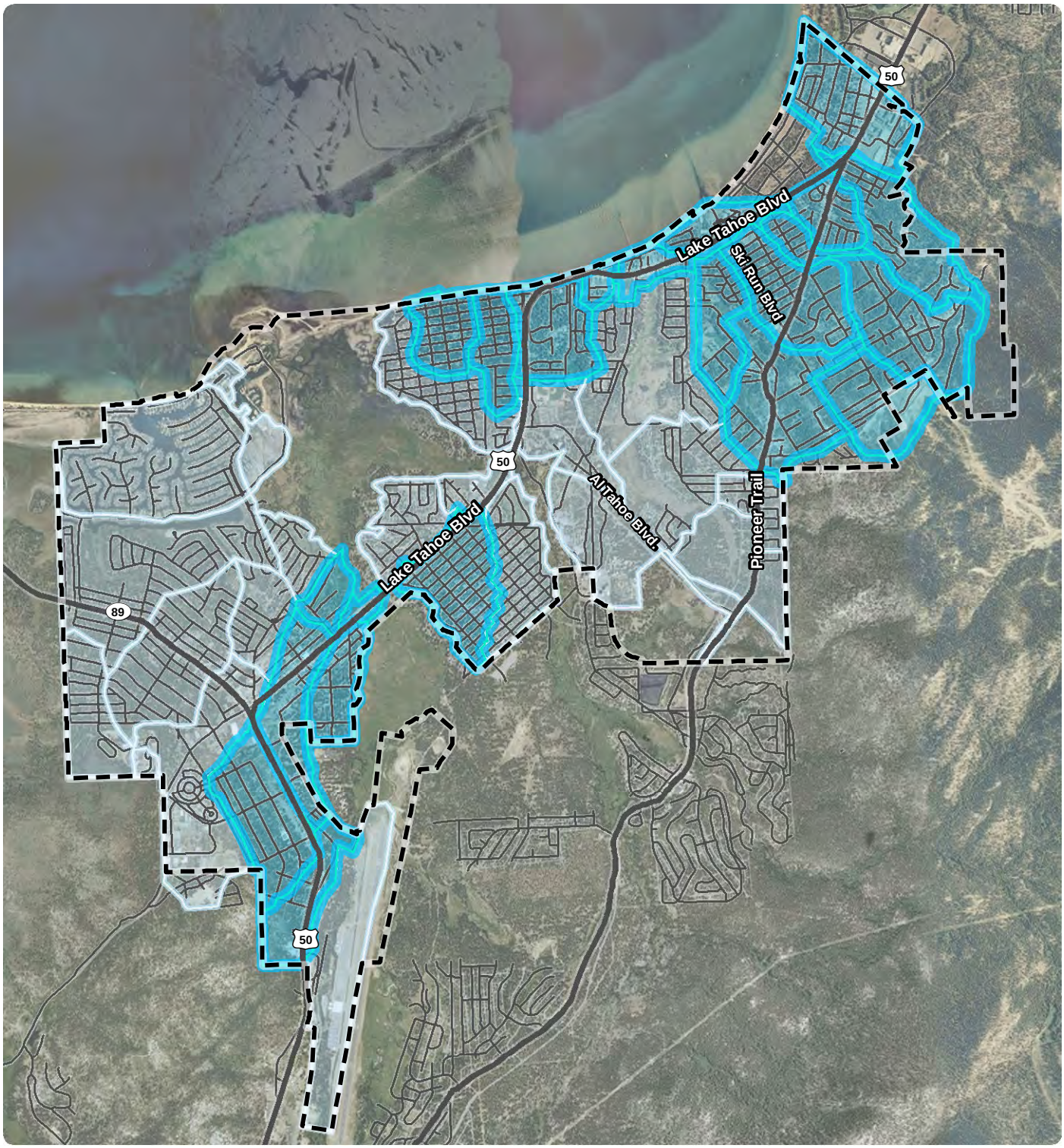
The concept of catchment connectivity plays an important role in the City's Strategy Report. Water quality improvement actions implemented in UPCs with low connectivity factors produce less load reduction benefit relative to water quality improvement actions implemented in UPCs directly connected to Lake Tahoe. Therefore, the most effective investments the City can make to reduce

pollutant loading to meet Lake Tahoe TMDL targets will be water quality improvement actions sited in UPCs that discharge directly to Lake Tahoe or a stream flowing to Lake Tahoe. The Strategy Report assesses the cost effectiveness of potential water quality improvement actions under this premise. However, it is important to note that meadows surrounding the City have ecological, biological, and recreational benefits that could be jeopardized from the discharge of very high pollutant loads. Therefore, past and future actions that improve the quality of runoff discharged to meadows are viewed as necessary improvements to ensure long-term viability regardless of the Lake Tahoe TMDL Credits achieved.

Figure 1.1 identifies UPCs with connectivity factors equal to 100 percent. Relative to information presented in the City's *Baseline Pollutant Load Estimate Report (CSLT 2011: Figure D-1),* the classification of a few UPCs was changed from directly connected to indirectly connected based on more detailed field investigations conducted in the spring of 2012. The classification of the following UPCs was revised in the Strategy Report to indicate connectivity factors less than 100 percent:

- Drainage area encompassing the City Airport (UPC = "Airpt")
- Drainage area encompassing the Lake Tahoe Community College (UPC = "STPUD")
- Drainage area encompassing the South Lake Tahoe Middle School (UPC = "G1")

Connectivity factors were updated using the best available information to ensure that water quality improvement actions prioritized within the Strategy Report are within directly connected catchments. These updates are not currently reflected within the City's baseline loading estimate (CSLT 2011). The City's MS4 permit (2011a: p. 25) recognizes that additional information gathered in the future will enhance the accuracy of the baseline load analysis, and the City has the option to request that Lahontan amend the baseline load estimate based on new information. At this time, an amendment is not recommended because: 1) the identified changes to connectivity factors will not markedly alter the City's required load reduction under the current Five Year Pollutant Load Reduction Plan; and 2) additional information will likely be gathered during implementation of the current Five Year Pollutant Load Reduction Plan that can be used to further refine the City's current baseline loading estimate. For these reasons, it is recommended that the City revisit the baseline loading estimate calculations concurrently with preparation of the Updated Pollutant Load Reduction Plan, which is due to Lahontan in June of 2016.



Data Sources: ArcGIS Online Basemaps, 2012.

Legend

- City Limits
- Directly Connected UPCs
- Indirectly Connected UPCs
- Primary Roads
- Secondary Roads

City of South Lake Tahoe
Pollutant Load Reduction Strategy

Stormwater Discharge Assessment

Scale - 1:48,000 1 inch = 4,000 feet

0 2,000 4,000 8,000 Feet

CA State Plane, Zone II	NAD 83	horiz. units: feet
northwest hydraulic consultants	project no. 500019	September 2012

Figure 1.1 - Stormwater Discharge Assessment

1.4 OVERVIEW OF APPROACH

This Strategy Report categorizes and analyzes water quality improvement actions using the primary concepts for pollutant load reduction to organize and present performance and cost estimates.

Using this general framework, an existing conditions assessment for 2012 was conducted to estimate the amount of Lake Tahoe TMDL Credits the City could potentially register based on water quality improvement actions completed since the 2004 baseline period. Following the existing conditions assessment, each primary concept for load reduction is assessed under various assumptions, including varying levels of implementation, to estimate both potential load reductions and associated cost. Finally, recommendations on near-term and long-term load reduction strategies are provided. The report is organized as follows:

- Section 2 assesses existing conditions to estimate load reductions the City has achieved since the baseline period.

- Section 3 assesses implementation options for water quality improvement actions intended to reduce the existing condition pollutant load. Options are evaluated by identifying specific actions that consider catchment connectivity and assess both performance and cost effectiveness under varying levels of implementation.

- Section 4 presents a recommended strategy to meet 2016 load reduction target and the future load reduction targets through the 2026 Clarity Challenge.

This Strategy Report builds upon the City's Baseline Load Estimate work using PLRM as the primary analytical tool. Numerous PLRM simulations were developed to generate estimates of load reduction and to assess the benefit of specific actions. For brevity, these results are summarized and interpreted in this report. Digital PLRM files and associated documentation included in Appendix A illustrates the detailed PLRM methods and assumptions supporting the results and findings.

1.5 MODELING UNCERTAINTY

Pollutant load estimates presented herein rely on estimates developed from the PLRM, which contains a number of assumptions and uncertainties that can be reduced through continued stormwater monitoring and validation efforts. As noted above, Lahontan plans to accept the risk associated with modeling uncertainties and will honor baseline load estimates and load reduction estimates produced by PLRM through at least the duration of the current permit (Larsen, pers. comm. 21 April 2011).

The following are key considerations regarding modeling uncertainties:

- The PLRM simulates performance of a stormwater treatment facility or infiltration BMP continuously over an 18-year time period. The current version of PLRM uses static input parameters (e.g., infiltration rate) to simulate performance over the simulation period and

does not explicitly account for changes in condition over time, which can be influenced by maintenance activities or a lack of maintenance activities. Therefore, if adequate maintenance is not performed on stormwater treatment facilities and infiltration BMPs, the PLRM may over-predict actual performance.

- PLRM algorithms relate specific actions for road operations to changes in the condition of the road, which in turn influences the characteristic runoff concentration (CRC) for the road. While this approach is considered a reasonable methodology to determine relative road conditions on an average annual basis, there are gaps in available supporting water quality data to confidently link specific actions for road operations to a magnitude of water quality improvement.

- The current version of the PLRM does not include algorithms to vary estimated pollutant generation from private land uses (e.g., commercial, single family residential, etc.) based on the condition of the land use. The PLRM uses Lake Tahoe TMDL stormwater monitoring data to estimate CRCs for average Tahoe Basin conditions for each private land use. If land use conditions notably vary for a collection of City parcels relative to average Tahoe Basin conditions, the PLRM may not reasonably predict pollutant loads from that collection of parcels. For example, PLRM would likely under-predict pollutant loads generated from single-family residential parcels with unpaved driveways.

- Because private property BMPs are predominantly constructed and maintained by individual parcel owners, improper construction and unreliable maintenance are potential performance issues. The PLRM assumes that private BMPs are constructed correctly and are maintained to ensure proper function (e.g., continue to infiltrate at or above the design target). If a significant number of installed private property BMPs are not maintained over the long-term, the average load reduction for private property BMP implementation estimated by PLRM may not be representative.

2.0 EXISTING CONDITIONS ASSESSMENT

This section assesses existing conditions to estimate load reductions achieved by the City since the baseline period and their associated costs. Existing conditions are assessed using the primary concepts for load reduction:

- Road maintenance operations for water quality
- Public water quality improvement projects
- Private parcel BMPs.

2.1 WATER QUALITY ROAD OPERATIONS

Among urban land uses generating stormwater runoff in the Tahoe Basin, the Lake Tahoe TMDL identified roads as the primary source of pollutants impacting lake clarity (Lahontan 2010). Winter application of traction abrasives is a significant source of pollutants from roads. City road operations related to road abrasive applications and the recovery of pollutants on City roads through street sweeping and vactoring are summarized below.

2.1.1 APPLICATION OF ROAD ABRASIVES

The City applies road abrasives during winter storms using one or two sanding trucks equipped with Monroe spreaders, delivering abrasives from the sanding truck to the road at controlled rates. Abrasives are generally applied on steep or heavily trafficked roads, school bus routes, and key intersections. It is estimated that the City applies abrasives to roughly 20% of its jurisdictional roads (2NDNATURE 2012; p. 4.8). Over the past five winter seasons, the City has applied an average of 554 tons of road abrasives per year (Table 2.1). An additional 200 tons per year of road abrasives are estimated to be applied by Heavenly on City roads leading to the California Base Lodge. The City typically spends $10,500 per year on road abrasive material at an average cost of roughly $19 per ton.

Table 2.1 – Annual Road Abrasive Application

Winter Season	Road Abrasives Applied (tons)
2006/2007	699
2007/2008	393
2008/2009	413
2009/2010	745
2010/2011	519
Average	554

El Dorado County and Caltrans have led research assessing the potential for road abrasives to generate FSP in stormwater runoff in the Tahoe Basin. A recent Caltrans study (2010) tested 22 samples from abrasive sources in close proximity to the Tahoe Basin for FSP and nutrients, including species of nitrogen and phosphorus. Material samples were analyzed before and after pulverization; the pulverized state was simulated using an apparatus developed by the Caltrans North Region Materials Laboratory. Road abrasive sources used in 2009 by El Dorado County, the

City of South Lake Tahoe, and Caltrans were included in the study. Through the 2011-2012 winter season, the City used the same abrasive supply (volcanic cinders) that was assessed in the Caltrans study.

While additional research is necessary to draw definitive conclusions, a preliminary finding of the Caltrans study indicates that the volcanic cinder road abrasives used by the City contain a relatively high amount of FSP compared to other road abrasives. Two-thirds of the tested road abrasives supplies had lower amounts of FSP than the volcanic cinders. El Dorado County switched, during the 2010-2011 winter season, from the same volcanic cinders used by the City to a road abrasive supply ranked as having one of the lowest amounts of FSP in the Caltrans study (Wigart, pers. comm. 16 July 2012).

2.1.2 POLLUTANT RECOVERY

The City recovers pollutants generated from the road network through street sweeping and vactoring of storm drain infrastructure. Street sweeping is performed citywide one or two times during the summer and fall months, and more frequently in priority areas when deemed necessary. The most frequent street sweeping activities occur during winter months to target recovery of road abrasives applied during snow events. In the winter months, sweeping is performed as resources allow, generally after snow removal activities are complete throughout the City, and when the pavement is dry.

The City uses a conventional mechanical broom sweeper and two dustless regenerative air sweepers. The following list summarizes the advantages and disadvantages of each type of sweeper relative to the other:

- The mechanical broom sweeper can operate during relatively poor road conditions, including conditions with significant pine needles.
- The regenerative air sweeper employs a dust separation and filtration system, which is more efficient at recovering and retaining FSP.
- The regenerative air sweeper is the most expensive to acquire, typically costing in the range of $300,000 per sweeper.
- The regenerative air sweeper requires the most daily maintenance and cleaning. The City maintenance department estimates typically spending three hours cleaning and maintaining the regenerative air sweeper per day of use.

The City averages $145,000 per year on sweeper operations (Table 2.2), according to estimates provided by the City maintenance department. Current cost recovery for sweeper purchases is estimated at $125,000 per year when annualized over a six-year period, which is the typical life cycle of a street sweeper before repair costs become excessive. The most recent purchase of two regenerative air sweepers used the City's TRPA Water Quality Mitigation Funds. Adding the annualized cost of sweeper purchases to operational costs, yields an estimated total cost of $270,000 per year that the City expends on street sweeper operations (Table 2.2). On average, the City maintenance department estimates 950 roadway miles are swept per year, at a unit cost of $284 per roadway mile swept.

Table 2.2 – Street Sweeping Cost

Description of Annual Expenditure	Average Annual Cost Estimate
Labor - Sweeper Operation	$57,000
Labor - Sweeper Repairs	$32,000
Material Disposal Cost	$25,000
Fuel	$12,000
Replacement Parts and Expenses	$19,000
Subtotal for Operations and Maintenance:	$145,000
Cost Recovery for Sweeper Fleet	$125,000
Total Cost Including Sweeper Cost Recovery:	$270,000

Using annual estimates of material disposed from sweeping and vactoring, City maintenance efficiency reports indicate that street sweeping operations collect sediment and debris more quickly and at less cost than vactor truck operations. The City estimates spending six cents per pound to recover sediment and debris through sweeping and nineteen cents per pound to recover sediment and debris through vactoring (CSLT 2010).

2.1.3 TRACKING ROAD OPERATIONS

Through the 2011-2012 winter season, the City has tracked sanding and sweeping operations using field data sheets that summarize daily operations within eight sanding and sweeping zones. When the field data sheets are analyzed, the information provides a useful summary of citywide sanding and sweeping operations. However, the current resolution of road operations tracking is too coarse to reasonably inform PLRM simulations to estimate pollutant load reductions achieved from existing road operations. City road operations would need to be tracked geographically at the scale of UPCs, or by specific roads, to create meaningful stormwater models that could estimate changes in pollutant loading from City road operations relative to baseline conditions.

The City has made initial steps to develop better tracking systems by installing GPS devices on sanding trucks for the 2012-2013 winter season. As of September 2012, there are no tracking devices installed on City street sweepers, nor is there a database in place to store and assess detailed GPS tracking information. Table 2.3 presents a qualitative assessment of how existing City road operations compare to PLRM baseline modeling assumptions and the potential implications on existing condition pollutant loading. Section 3 of this report estimates load reductions that might be achieved from changes to road operations in targeted areas of the City.

Table 2.3 – Existing Road Operations and Baseline Modeling Assumptions

PLRM Model Input	Lake Tahoe TMDL Baseline Modeling Input	Summary of Existing City Practices	Implication on Existing Condition FSP Loading
Road Abrasive Application Rate	Minimal Controls - Road abrasives are judiciously applied to maintain traffic safety, but a number of technological and operational improvements may be possible to reduce FSP generation from road abrasives	Equivalent to baseline assumption	Equivalent to baseline load
Type of Sweeper	Mechanical broom	Mechanical broom and dustless regenerative air	Marginally better than baseline condition load estimates
Frequency of Sweeping	2 to 4 times per year depending upon the type of road	Minimum of 2 times per year; more frequent on certain roads but specific locations not tracked	

2.2 WATER QUALITY IMPROVEMENT PROJECTS

The City's approach for reducing stormwater pollutant loads has focused on implementation of capital water quality improvement projects (WQIPs) in accordance with TRPA's Environmental Improvement Program (EIP). Over the past decade, this approach has been supported by stable sources of federal and state grant funding. Recently, available grant funding for implementation of WQIPs has significantly diminished.

Since the Lake Tahoe TMDL baseline period the City has constructed seven WQIPs. Performance and cost estimates for the seven completed WQIPs are presented in Table 2.4. The following notes apply to Table 2.4.

- Project delivery costs include planning, environmental documentation, permitting, design, acquisitions and construction costs.

- FSP load reduction estimates are derived from preliminary PLRM models developed by the City, or consultants to the City. While these models have been peer reviewed, additional model refinement and quality assurance will be necessary before registering each WQIP with the Lake Tahoe TMDL program. Final load reduction numbers registered with the Lake Tahoe TMDL program for each WQIP may be different than shown in Table 2.4.

- The City tracks total cost expended for citywide maintenance of storm drainage systems, but does currently track or report resources expended to maintain the water quality performance of stormwater treatment systems (e.g., dry basins) built as part of a WQIP (CSLT, 2010). The annual water quality maintenance cost shown in Table 2.4 is an estimate of the resources likely required to maintain the function of key stormwater treatment facilities within each constructed WQIP. The estimate was made by identifying the key stormwater treatment facilities in each WQIP and multiplying by an estimated annual maintenance cost as follows:

- Dry Basin or Infiltration Basin - $2,500 per year
- Wet Basin - $5,000 per year[1]
- Stormwater Filtration Vault - $5,000 per year
- Pervious Pavement– $0.05/square foot times average of 30,000 square feet installed on WQIP using pervious concrete = $1,500 per year

Table 2.4 – Completed WQIP Performance and Cost Estimates

Water Quality Improvement Project	Project Area (Acres)	Year Built	Project Delivery Cost	Annual Water Quality Maintenance Cost	FSP Load Reduction Estimate (lb/year)	Lake Tahoe TMDL Credits	% of City's Baseline FSP Load
Glorene and 8th	178	2004	$3,710,000	$10,000	4,250	21	1.1%
Rocky Point 1 and 2	168	2004	$4,340,000	$10,000	4,000	20	1.0%
Rocky Point 3 and 4	65	2008	$8,130,000	$7,500	760	4	0.2%
Sierra Tract Phase 1	91	2010	$6,480,000	$7,500	420	2	0.1%
Sierra Tract Phase 2	43	2005	$2,200,000	$5,000	340	2	0.1%
Al Tahoe Phase 1	75	2010	$3,500,000	$6,500	3,900	20	1.0%
Al Tahoe Phase 2	73	2012	$2,650,000	$11,500	2,900	14	0.7%
Totals:	693	n/a	$31,010,000	$58,000	16,570	83	4.3%

The following points summarize and interpret the data presented in Tables 2.4:

- WQIPs completed by the City from 2004 to 2012 have a total project delivery cost of $31 million.

- The load reduction achieved from the seven WQIPs can be registered with the Lake Tahoe TMDL program to obtain Credits toward attainment of the 2016 load reduction target. The completed WQIPs will provide the City with approximately:

    - 83 Lake Tahoe TMDL Credits. Attainment of the 2016 load reduction target will require 195 Lake Tahoe TMDL Credits.
    - A 4.3% reduction in FSP relative to the City's baseline load. Attainment of the 2016 load reduction target will require a 10% reduction in FSP.

- In certain cases for completed WQIPs, the load reduction achieved relative to the project delivery cost demonstrates a low cost/benefit ratio (e.g., Sierra Tract Phase 1 and Phase 2). In these cases, the WQIPs were implemented in UPCs that discharge stormwater to meadows which subsequently were found to have low connectivity factors. Consequently, the load reduction benefit of the water quality improvements was diminished because much of the stormwater and pollutant loads generated in the pre-project condition were not

[1] Cost estimate assumes maintenance of wet basins will not require environmental permitting. If permitting is required, then cost could be significantly higher.

reaching Lake Tahoe. Moving forward, the City has incorporated the concept of catchment connectivity into the project prioritization process and all active WQIPs are within UPCs that discharge stormwater directly to Lake Tahoe or streams flowing to Lake Tahoe (see Section 3.2).

- Existing data on City expenditures for maintenance of stormwater treatment facilities associated with WQIPs was not available. The annual cost of $58,000 per year was developed to provide an estimate of future costs to maintain the function of constructed WQIPs in accordance with maintenance requirements that will likely be required under the Lake Tahoe TMDL program.

2.3 PRIVATE PROPERTY BMP IMPLEMENTATION

Records for private property BMP compliance published within a TRPA white paper (2012) report that 34% of developed parcels in the Tahoe Basin have obtained a BMP Certificate. Comparison of BMP compliance in California versus Nevada shows that the percentage of BMP certified parcels within Nevada is significantly higher than California for all urban land uses (Table 2.5). Based on 2011 BMP data supplied to the City by TRPA, the percentage of BMP certified parcels within the City is less than the California average for all urban land uses, and significantly less than the percentages for Nevada urban land uses (Table 2.5).

Table 2.5 – Status of BMP Compliance

Land Use	Lake Tahoe TMDL 2004 Baseline (Lahontan 2010)	Percentage of Developed Parcels with BMP Certificates as of December 2011 (TRPA 2012)			
		Tahoe Basin	Nevada	California	City of South Lake Tahoe
Single Family Residential (SFR)	7%	26%	46%	21%	18%
Multi-Family Residential (MFR)	19%	62%	72%	52%	6%
Commercial (CICU)	5%	28%	60%	18%	11%
Total Developed Parcels	Not reported	34%	58%	26%	14%

For the Lake Tahoe TMDL baseline estimate, all jurisdictions in the Tahoe Basin were required to use BMP compliance percentages by urban land use averaged for the Tahoe Basin in the baseline year of 2004 (Table 2.5: SFR = 7%; MFR = 19%; and CICU =5%). The Lake Tahoe TMDL took this approach to ensure jurisdictions would receive their fair share of load reduction credits (or penalties) when registering existing condition loads relative to the standard baseline assumptions for the Tahoe Basin.

The PLRM models used to estimate City baseline FSP loads were modified to estimate the effect of existing private property BMP implementation on pollutant loading. PLRM output from the individual existing condition models of City UPCs was summed and extrapolated to develop an estimate of citywide FSP loading at the existing level of private property BMP implementation. As

shown in Table 2.6, the analysis estimates the current status of BMP compliance citywide has produced a modest FSP load reduction of 3,900 pounds per year, or a 1% reduction in the City's baseline FSP load. Table 2.6 displays BMP compliance using PLRM inputs, which use the percentage of certified BMP area by land use. These numbers differ slightly from City numbers presented in Table 2.6, which accounts for the number of parcels with BMP Certificates.

Table 2.6 – Existing BMP Compliance and Effect on Pollutant Loading

Parameter	Lake Tahoe TMDL Baseline Assumptions	City Existing Conditions (2011)
Single Family Residential (SFR) BMP Implementation - Area Based PLRM Input	7%	16%
Multi-Family Residential (MFR) BMP Implementation - Area Based PLRM Input	19%	15%
Commercial (CICU) BMP Implementation - Area Based PLRM Input	5%	8%
City FSP Load Estimate (lb/year)	389,000	385,100
FSP Load Reduction from Baseline (lb/year)	n/a	3,900
% FSP Load Reduction Compared to Baseline	n/a	1.0%

A planning level cost estimate of private property BMP implementation from 2004 through 2011 was developed using the 2011 BMP data supplied to the City by TRPA and cost information published in the Pollutant Reduction Opportunities (PRO) Report (Lahontan and NDEP 2008). The following planning level costs for BMP implementation and annual maintenance were taken from the PRO Report:

- CICU averages $50,000 per acre
- MFR averages $24,000 per acre
- SFR average $17,500 per acre
- BMP maintenance averages 3% of capital cost annually

Table 2.7 presents a summary of the number of parcels that received a BMP certificate in the City from 2004-2011 along with an estimated capital cost of $9.8 million expended to implement the BMPs. Table 2.7 also estimates an annual maintenance cost of $294,000 per year to ensure the BMPs are maintained to function as designed.

Table 2.7 – 2004 to 2011 BMP Implementation and Estimated Cost

Land Use	Number of Developed Parcels Obtaining BMP Certificates (2004-2011)	Urban Area (Acres)	Average Parcel Size (Square Feet)	Capital Cost Estimate	Annual Maintenance Cost Estimate ($/year)
CICU	67	64	41,800	$3,200,000	$96,000
MFR	104	61	25,700	$1,500,000	$45,000
SFR	1,872	303	7,000	$5,100,000	$153,000
Totals	2,043	429	n/a	$9,800,000	$294,000

2.4 EXISTING CONDTIONS SUMMARY

Table 2.8 summarizes the project delivery cost and load reduction performance estimates for water quality improvement actions undertaken citywide from 2004 through the 2012 construction season. Additionally, Table 2.8 provides an estimate of annual operations and maintenance cost.

Table 2.8 – Existing Condition Performance and Cost Summary

Load Reduction Concept	Existing Condition Estimates			
	Project Delivery Cost	Annual Water Quality Maintenance Cost ($/year)	FSP Load Reduction from Baseline (lb/year)	% FSP Load Reduction Compared to Baseline
Water Quality Road Operations	Calculated as operational cost	$270,000	Unable to calculate with existing data	Unable to calculate with existing data
Water Quality Improvement Projects (Constructed 2004 - 2012)	$31,010,000	$58,000	16,600	4.3%
Private Property BMP Implementation (Constructed 2004 - 2011)	$9,800,000	$294,000	3,900	1.0%

The following points summarize and interpret the results presented in Tables 2.8:

- WQIPs completed by the City from 2004 to 2012 and private property BMPs installed from 2004 to 2011 have a total project delivery cost of roughly $41 million.

- The $270,000 cost for water quality road operations reflects current average annual expenditures by the City when accounting for annualized cost recovery of the City's current sweeper fleet purchased using TRPA Water Quality Mitigation Funds. Annual WQIP and private BMP maintenance cost of $352,000 are estimated to ensure constructed facilities function as designed for continued water quality performance.

- BMP data received from TRPA reports that roughly 1,900 City parcels have received BMP certificates since 2004. The cost effectiveness of this level of private property BMP implementation on actual load reductions would be much higher than what is reported in Table 2.8. The point of Table 2.8 is to estimate load reductions the City has achieved relative to the baseline condition set by the Lake Tahoe TMDL, which includes fixed values for BMP implementation that were averaged across the Tahoe Basin in 2004.

- Summing the load reductions achieved from completed WQIPs and private property BMPs, the City could take credit for roughly a 5% reduction in FSP loading. A 10% reduction will be required by 2016 to meet the current MS4 permit requirement. Section 3.0 evaluates various options the City could explore to meet the first load reduction target in 2016, as well as subsequent load reduction targets.

3.0 LOAD REDUCTION OPTIONS

Section 3 assesses options to reduce the City's existing condition pollutant load through water quality improvement actions. The evaluation incorporates both performance and cost effectiveness under varying levels of implementation for the primary concepts for load reduction:

- Road operations for water quality
- Public water quality improvement projects
- Private parcel BMPs.

3.1 WATER QUALITY ROAD OPERATIONS

Options to reduce FSP loading generated from City roads are categorized into two primary actions: 1) minimizing the amount of road abrasives applied; and 2) maximizing the recovery of FSP on targeted roads with frequent street sweeping.

3.1.1 ROAD ABRASIVE APPLICATIONS

Three options to manage road abrasive applications to control FSP generation from City roads are described below.

<u>Option 1 – Use Abrasive Supplies with Negligible FSP in Source Material</u>

Preliminary Caltrans results (2010) indicate that the current City abrasive supply used through the 2011-2012 winter season (volcanic cinders - #004 in Caltrans study) has comparably high amounts of FSP relative to other available sources. For example, El Dorado County currently uses a deicing sand (#022 in Caltrans study) with approximately 0.01% FSP, compared to the 0.3% FSP contained in volcanic cinders (Caltrans 2010: p. 4-1).

The small percentages of FSP within an abrasive supply can become a relatively significant FSP load when calculating total abrasives applied citywide on an annual basis. For example, switching to the abrasive supply used by El Dorado County could reduce the amount of FSP applied on City roads by approximately 3,200 lb per year (Table 3.1). The actual load reduction in the City's baseline load from this action, however, would be less than 3,200 pounds of FSP because the calculations in Table 3.1 do not consider fate and transport of material applied to City roads. A PLRM estimate of actual load reduction is provided at the end of this section.

Table 3.1 – Estimated FSP Applied to City Roads from Road Abrasives

Abrasive Supply	FSP Count (particle count / kg abrasive)[1]	FSP Mass (kg FSP / kg abrasive)[2]	FSP Percentage by Mass in Abrasive Supply	Average Annual City Abrasives Applied (tons)	FSP Applied (lb/year)	Estimated Unit Price ($/ton)	Annualized Cost Estimate
Volcanic Cinders - Existing Source	3.29E+11	0.0030	0.30%	554	3,300	$19	$10,500
Deicing Sand - Current El Dorado County Source	6.94E+09	0.0001	0.01%	554	100	$26	$14,400

[1] Caltrans 2010: p. 4-1

[2] One kg FSP = 1.1×10^{14} particles FSP (Lahontan and NDEP 2011: Equation 0.3)

Option 2 – Use Best Available Technology on Sanding Trucks

Retrofitting existing sanding trucks with state-of-the-art distribution systems could improve the efficiency of abrasive applications, potentially resulting in reductions in the total amount of abrasive material applied while maintaining the current level of traffic safety. For example, Washoe County switched to an advanced technology Epoke bulk spreader on their sanding truck in 2004. Washoe County credits this technology as the primary factor that led to roughly an 80% reduction in their annual road abrasives applications over the past decade (Minto, 2010).The Epoke system, and any functionally equivalent product, offers the following technological advantages:

- Abrasives within the hopper do not rest on the conveyer belt. Abrasives are supplied to the conveyor belt using an agitator and delivery roller, which allows for a more consistent application rate.
- Pre-wetting of abrasives occurs at the spreader disc, which allows more of the abrasives applied to stick to the road surface.
- Automated features provide width compensation, rate compensation, and road speed relation to ensure constant spreading rates.
- The system is controlled by a computer, which includes data logging features to record the mass of abrasives applied.

Besides mechanical improvements, the more advanced abrasive distribution systems can be equipped with GPS systems to both track application rates and control distribution of abrasives by location. Besides optimizing operations, GPS systems could also provide data to directly inform Lake Tahoe TMDL reporting. Acquisition and installation of advanced abrasive spreaders is estimated to cost $100,000 per sanding truck.

Option 3 – Implement advanced management measures

Accurate prediction of the type and severity of a winter storm, as well as antecedent road conditions (e.g., temperature) could allow the City to better target operational practices (e.g., brining activities) to the type of storm and the timing of precipitation. Advanced management measures potentially include the use of road temperature sensors, advanced meteorological monitoring, and supplementing road abrasive applications with limited brine applications.

Performance and Cost Estimate

The PLRM models used to estimate City baseline FSP load were modified to simulate the reduction of pollutant loading by improved control of road abrasives. PLRM models were adjusted to “moderate control” for road abrasive applications across all City roads, an increase from the baseline condition assumption of “minimal control”. The “moderate control” option was selected to predict the City load reduction from near-term road operation improvements that include: 1) Use Abrasive Supplies with Negligible FSP in Source Material; and 2) Use Best Available Technology on Sanding Trucks. PLRM also contains an “advanced control” level of road abrasive application, but the modeled scenarios were not set to this input to provide a conservative estimate of near-term load reductions recognizing that 1) optimization of City road practices to achieve advanced abrasive controls will be an iterative process; and 2) current PLRM algorithms that relate control of road abrasives to changes in water quality concentrations in runoff need additional monitoring and validation (see Section 1.5).

Results from PLRM models estimate improvements to City road abrasive practices may produce a FSP load reduction of 19,500 pounds per year (Table 3.2), which equates to a 5% reduction in the City's baseline load. A key premise for the estimated load reduction from this action is that a portion of road abrasives applied to City roads are pulverized by vehicles into FSP, where roads with higher traffic volumes generate more FSP from road abrasive pulverization. Therefore, minimizing the amount of abrasive material on City roads is assumed to result in less FSP generation because less abrasive material will be available for pulverization.

Table 3.2 – Improved Road Operations Performance and Cost Estimate

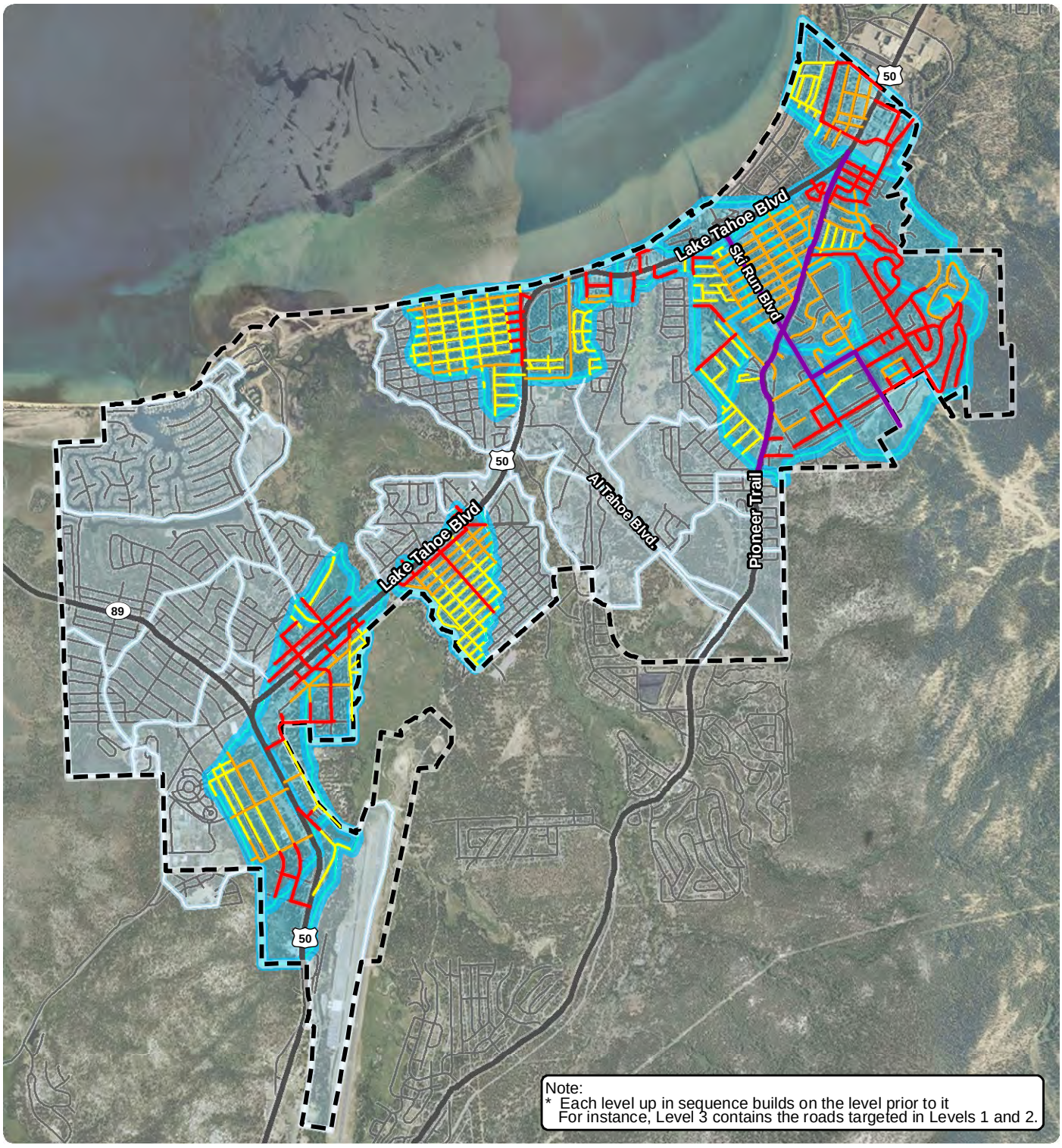
Recommended Operation Improvement	Capital Cost Estimate ($)	Increased Operational Cost Estimate ($/year)	PLRM Input	FSP Load Reduction (lb/year)	% of City's Baseline FSP Load
Use Abrasive Supplies with Negligible FSP in Source Material	n/a	$3,900	Moderate Abrasive Controls (All City Roads)	19,500	5.0%
Use Best Available Technology on Two City Sanding Trucks	$200,000	n/a			

3.1.2 POLLUTANT RECOVERY

As described in Section 2.1.2, the City conducts street sweeping on a regular basis using one mechanical broom sweeper and two dustless regenerative air sweepers. PLRM model results suggest refinement and possible augmentation of current City sweeping operations could improve the amount of pollutant load reductions credited to City street sweeping operations.

Figure 3.1 illustrates a recommended approach to target high risk roads (high potential to generate pollutants) in UPCs discharging stormwater runoff directly to Lake Tahoe. The modeled approach presumes that targeted streets would be swept after each winter abrasive application, as road conditions allow, and once a month otherwise. This equates to the most frequent sweeping interval in PLRM. For cost estimating purposes this modeling input was assumed to equate to an average street sweeping frequency of 20 times per year. Four levels of increasing effort for street sweeping are presented based on the presumed water quality risk of specific City roads in directly connected UPCs (Figure 3.1):

- Level 1 – All Primary Roads
- Level 2 – All Primary Roads plus High Risk Secondary Roads
- Level 3 – All Primary Roads plus High and Moderate Risk Secondary Roads
- Level 4 – All Roads



Data Sources: ArcGIS Online Basemaps, 2012.

Legend

- City Limits
- Directly Connected UPCs
- Indirectly Connected UPCs

Targeted Sweeping Level *

- Level 1 - 3.4 miles
- Level 2 - 20.7 miles
- Level 3 - 41.3 miles
- Level 4 - 60.7 miles
- Primary Roads
- Secondary Roads

City of South Lake Tahoe
Pollutant Load Reduction Strategy

Options for Targeted Street Sweeping

Scale - 1:48,000 1 inch = 4,000 feet

0 2,000 4,000 8,000 Feet

CA State Plane, Zone II	NAD 83	horiz. units: feet
northwest hydraulic consultants	project no. 500019	September 2012

Figure 3.1 - Options for Targeted Street Sweeping

Table 3.3 displays load reduction estimates from PLRM simulations predicted for the four levels of targeted street sweeping (Figure 3.1). Additionally, Table 3.3 estimates annual cost for street sweeping assuming targeted roads are swept an average of 20 times per year at a cost of $284 per road mile swept (unit cost estimate developed in Section 2.1.2). Performance and cost estimates shown in Table 3.3 for each level of street sweeping are cumulative and should not be added between levels. For example, Level 3 includes the roads targeted for street sweeping in Level 2.

Table 3.3 was developed with an objective to maximize Lake Tahoe TMDL Credits using limited resources for street sweeping operations. The estimates shown do not account for current City street sweeping operations conducted for purposes other than Lake Tahoe TMDL load reductions, which are necessary operations to reduce debris on City streets and prevent excessive material from entering City storm drainage infrastructure or drainage courses.

Table 3.3 – Targeted Street Sweeping Performance and Cost Estimate

Parameter	Targeted Sweeping Approach			
	Level 1	Level 2	Level 3	Level 4
Total Road Miles Frequently Swept	3.4	20.7	41.3	60.7
Percentage of City Roads (133 road miles in City)	3%	16%	31%	46%
Estimated Frequency of Sweeping (times/year)	20	20	20	20
Unit Cost of Sweeping ($/road mile)	$284	$284	$284	$284
Annualized Cost Estimate ($/year)	$19,000	$118,000	$235,000	$345,000
FSP Load Reduction Estimate (lb/year)	4,700	18,700	24,200	26,500
% FSP Load Reduction Compared to Baseline	1.2%	4.8%	6.2%	6.8%
Annualized Unit Cost ($/lb FSP removed/year)	$4.00	$6.30	$9.70	$13.00

The results of PLRM simulations indicate a FSP load reduction of roughly 5% to 6% of the City's baseline loading may be achievable from frequent street sweeping on high and moderate risk roads (Level 2 or Level 3) in directly connected UPCs. Figure 3.2 displays the results in Table 3.3 graphically to demonstrate the relationship between cost-effectiveness and the level of sweeping effort. Cost-effectiveness declines as street sweeping expands to lower risk roads that have less potential to generate pollutants. Frequent sweeping on roads designated as low risk diminishes the value of load reduction achieved per dollar spent because the loads recovered per roadway mile swept decreases.

The cost for street sweeping was estimated to linearly increase per mile swept (Figure 3.2). To some degree, the cost per mile swept would like decrease as the number of miles swept increases. However, the City maintenance staff note that the dustless regenerative air sweepers typically require on average three hours per day for cleaning and general maintenance. Recognizing this maintenance burden, the cost per mile swept was conservatively assumed to linearly increase regardless of the number of miles swept.

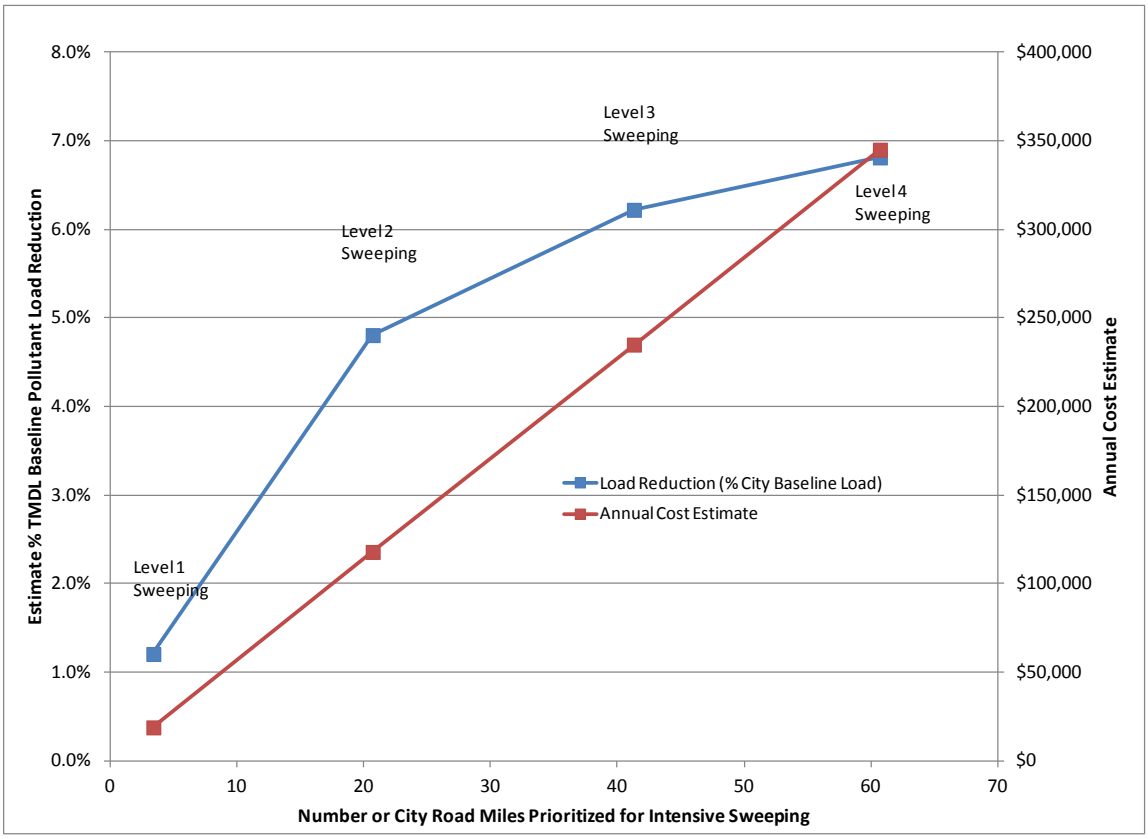


Figure 3.2 – Street Sweeping Cost Effectiveness Estimate

The sweeping levels shown in Figure 3.1 are intended as initial guidance to target City streets assumed to generate a disproportional amount of pollutants based on estimated traffic volumes and the condition of adjacent urban land uses. Utilization of data collected from GPS systems installed on City sanding trucks could better inform street sweeping operations to target pollutant recovery based on actual sanding practices. This type of system would require interpretation of raw data from sanding trucks into a GIS map of abrasive loading by City street to form navigation routes for sweepers after sanding events. In the near-term, a simplified version of this idea could be developed to refine Figure 3.1, where sanding truck movements tracked in GPS could be averaged across a winter season to generate prioritized routes for sweepers.

3.2 WATER QUALITY IMPROVEMENT PROJECTS

Section 3.2 assesses potential load reductions from active WQIPs currently in planning and design stages, as well as potential future projects with notable load reduction opportunities.

3.2.1 ACTIVE PROJECTS

The City anticipates at least three WQIPs in various stages of planning and design will be constructed by the deadline for the first pollutant load reduction target (September 2016). The three WQIPs include:

- Bijou Commercial Core Project
- Harrison Avenue Project
- Sierra Track Phase 3 & 4

Preliminary performance and cost estimates for the three active WQIPs are presented in Table 3.4. The following notes apply to Table 3.4.

- Project delivery costs include planning, environmental documentation, permitting, design, acquisition, and construction cost.

- FSP load reduction estimates are derived from preliminary PLRM models that typically reflect the preferred alternative for project design. Additional refinement and quality assurance of these preliminary PLRM models will be necessary after project construction to ensure the models appropriately represent constructed water quality improvements. Final load reduction numbers registered with the Lake Tahoe TMDL program for each WQIP will likely differ from Table 3.4.

- Average annual water quality maintenance costs were estimated using the approach described in Section 2.2. First, the type and number of key stormwater treatment facilities proposed for each WQIP was tabulated. Next, an annual maintenance cost was estimated based on the type of stormwater treatment facility and summed by WQIP. One project, the Bijou Commercial Core Project, will be an actively managed treatment system involving stormwater pumping. Consequently, the annual water quality operations and maintenance cost for the Bijou Commercial Core project is notably higher than estimates for other City WQIPs.

Table 3.4 – Active WQIP Performance and Cost Estimates

Water Quality Improvement Project	Project Area (Acres)	Estimated Construction Year	Estimated Project Delivery Cost	Annual Water Quality Maintenance Cost	FSP Load Reduction Estimate (lb/year)	Lake Tahoe TMDL Credits	% of City's Baseline FSP Load
Bijou Commercial Core	54	2013/2014	$9,970,000	$115,000	11,200	56	2.9%
Sierra Tract Phase 3 and 4	80	2015	$3,000,000	$17,500	7,400	37	1.9%
Harrison Avenue	14	2013	$4,100,000	$7,500	3,500	17	0.9%
Totals:	148	n/a	$17,070,000	$140,000	22,100	110	5.7%

The following points summarize and interpret the data presented in Table 3.4.

- Active WQIPs have an estimated project delivery cost of roughly $17 million. To date, the City has secured approximately $9.8 million in grant funding for construction of the Bijou Commercial Core Project. The Sierra Track Phase 3 & 4 and Harrison Avenue Projects are awaiting award of potential grant funds for construction.

- The load reduction achieved from the three WQIPs shown in Table 3.4 can be registered with the Lake Tahoe TMDL program to obtain Credits towards attainment of the 2016 load reduction target. The active WQIPs, if constructed by September 2016, will provide the City with approximately:

    - 110 Lake Tahoe TMDL Credits. Attainment of the 2016 load reduction target will require 195 Lake Tahoe TMDL Credits.
    - A 5.7% reduction in FSP relative to the City's baseline load. Attainment of the 2016 load reduction target will require a 10% reduction in FSP.

- The three active WQIPs target construction of improvements in dense urban areas of the City. These areas directly discharge stormwater runoff to Lake Tahoe or streams flowing to Lake Tahoe (connectivity factor equal to 100 percent). Additionally, these WQIPs highlight a new City strategy to incorporate stormwater treatment of runoff from dense commercial land uses into each project. Consequently, the WQIPs are forecasted to provide much greater load reductions than achieved from past City WQIPs on a per unit area (Table 2.4). However, this strategy also results in increased project delivery costs and annual water quality maintenance costs compared to past City WQIPs. Project delivery costs increase because the dense areas of the City present numerous challenges for engineering design and construction of water quality improvements. Furthermore, there are typically few public lots available within these areas to site stormwater treatment facilities. Water quality maintenance costs increase because stormwater runoff from these areas contains significant pollutant loads, meaning stormwater treatment facilities require frequent maintenance to ensure they perform as designed.

- The Bijou Commercial Core project is a joint effort with Caltrans. The project delivery cost estimate shown in Table 3.4 is for the City and excludes a Caltrans contribution of $4.735 million to the project. Additionally, the load reduction is an estimate of the City's negotiated share of credited load reduction for the project with Caltrans. Including Caltrans contributions in the project total returns an estimated project delivery cost of $14.7 million and total load reduction of 22,400 pounds of FSP per year.

- The estimates shown in Table 3.4 for the Sierra Tract Phase 3&4 project are the City's estimated project delivery cost and FSP load reduction for the preferred alternative. These estimates exclude Caltrans stormwater runoff, which currently commingles with City stormwater runoff in the project area. Depending upon the City's potential future coordination with Caltrans on the final project design, the load reductions achieved from the Sierra Tract Phase 3&4 project could be greater than shown in Table 3.4 when including treatment of Caltrans runoff.

3.2.2 POTENTIAL NEW PROJECTS AND PROJECT RETROFITS

Recognizing that additional WQIPs and/or retrofit of past erosion control projects may be a necessary approach to meet upcoming Lake Tahoe TMDL load reductions targets, the City identified cost-effective opportunities for water quality improvement in the following studies:

- *Tahoe Valley Water Quality Improvement Project Streamlined Existing Conditions Analysis and Conceptual Layout of Alternatives (CSLT 2012a)*
- *Conceptual Project Layouts for Potential Near-Term Water Quality Improvements (CSLT 2012a)*

The following summarizes the most significant and cost-effective opportunities identified. Given anticipated funding limitations for design and construction of WQIPs, the assessment targeted:

- urban areas discharging stormwater directly to Lake Tahoe
- stormwater quality improvements on publicly available land
- retrofit of existing stormwater treatment facilities

<u>Tahoe Valley Water Quality Improvement Project</u>

The Tahoe Valley WQIP encompasses a 320 acre drainage area located in the western portion of the City near the "Y". The upper portion of the drainage area is predominantly composed of high density residential lots, transitioning to moderate density commercial uses adjacent to U.S. 50. The lower portion of the drainage area is composed of moderate density commercial uses on the east side of Highway 50 south of the "Y", and dense commercial uses along both sides of Highway 50 east of the "Y".

Runoff from the entire drainage area concentrates into a primary drainage path discharging to the Upper Truckee River via a constructed ditch along the northern property boundary of the

Sky Meadows subdivision. A refined PLRM baseline modeling scenario of the drainage area estimates that 44,800 pounds per year of FSP discharges to Lake Tahoe, which constitutes 11.5% of the City's baseline load. This baseline load estimate excludes 8.4 acres of Caltrans right-of-way within the drainage area.

To date, alternatives have been formulated for the Tahoe Valley WQIP but a preferred alternative has not been selected. The alternative that appears to be most feasible to implement in the near-term (Alternative 2) would: 1) construct new stormwater treatment facilities on publicly owned lots near or adjacent to the primary Tahoe Valley drainage course; and 2) expand and retrofit existing stormwater treatment facilities in the drainage area to improve load reduction performance.

Osgood Basin Retrofit and Expansion

The existing Osgood Basin (also known as Ski Run Basin) is located on the east side of Ski Run Boulevard, one block south of U.S. 50. The basin receives runoff from the dense residential area on both sides of Ski Run Boulevard, which extends to south of Pioneer Trail. The approximate drainage area with relatively dense development is 110 acres. Additionally, the predominantly forested Keller Canyon drainage (also known as Little Heavenly Creek) contributes a base flow to Osgood Basin in late spring and through the summer in wet years. Osgood Basin is significantly undersized for its drainage area. Runoff from the basin is discharged into the Ski Run Marina.

To date, alternatives have been formulated to retrofit and/or expand the Osgood Basin but a preferred alternative has not been selected. The alternative that appears to be most feasible to implement in the near-term (Alternative 1) would: 1) slightly increase the water quality storage volume in the Osgood Basin; and 2) construct a low flow diversion to route a portion of the stormwater in the Osgood Basin for treatment in the southern cells of the Wildwood Basins.

Wildwood Basins Retrofit

The southern cells of the Wildwood Basins are located along Wildwood Avenue adjacent to U.S. 50. The northernmost cells of the Wildwood Basins are located behind the Embassy Suites in the Ski Run Marina. Through the 2012 water year, a storm drainage connection problem had allowed stormwater runoff from the southern cells to bypass the northern cells, except in the largest runoff events. Consequently, the northern cells received less stormwater than the design treatment capacity.

The recommended approach for improving the performance of the Wildwood Basins is to retrofit the existing storm drainage connection to convey stormwater runoff from the southern cells to the northern cells. In September of 2012, the City made field modifications to the storm drainage connection with the intention of meeting this objective. Visual observation and monitoring of flows within the system will be necessary to determine if the field modifications have been successful, or if additional engineering design and construction will be necessary to retrofit the drainage system to function as intended.

Estimated Performance and Cost Summary

Performance and cost estimates for the identified load reduction opportunities are presented in Table 3.5. Performance and cost estimates are shown for alternatives with the highest feasibility for near-term implementation.

Table 3.5 – Key Opportunities for Future WQIPs

Significant Near-Term WQIP Opportunities	Estimated Project Delivery Cost	Annual Water Quality Maintenance Cost	FSP Load Reduction Estimate (lb/year)	Lake Tahoe TMDL Credits	% of City's Baseline FSP Load
Tahoe Valley WQIP - Alternative 2	$1,500,000	$20,000	14,400	72	3.7%
Osgood Basin Retrofit - Alternative 1	$500,000	$12,500	6,500	32	1.7%
Wildwood Basins Retrofit	$50,000	$7,500	1,300	6	0.3%
Totals:	$2,050,000	$40,000	22,200	111	5.7%

The following points summarize and interpret the data presented in Table 3.5.

- The identified opportunities have an estimated project delivery cost of roughly $2 million. Relative to completed and active WQIPs, the overall project delivery cost is quite low. This result was expected given the targeted scope of the assessment, which identified potential opportunities for water quality improvements using publicly available land and the retrofit of existing stormwater treatment facilities.

- The Tahoe Valley WQIP provides a notable opportunity for load reduction at a relatively low project delivery cost. The following factors contribute to this finding:

    - The urban drainage area is both relatively large (340 acres) and directly connected to the Upper Truckee River
    - A significant proportion of the drainage area is comprised of land uses that generate high pollutant loads (i.e. dense commercial land uses, primary roads, and high risk secondary roads)
    - A few large public lots are available along the primary stormwater drainage course for siting new stormwater treatment facilities, or to expand existing stormwater treatment facilities.

- The project delivery cost of the Wildwood Basins Retrofit assumes a limited amount of engineering design and construction would be required to ensure the storm drainage connection problem is corrected and will function as intended across a wide range of runoff events.

3.3 PRIVATE PROPERTY BMP IMPLEMENTATION

As documented in Section 2.3, the City has less private property BMP certification compared to average percentages across California jurisdictions in the Tahoe Basin, and significantly less BMP certification relative to average percentages across Nevada jurisdictions (Table 2.5). Current TRPA regulations define private property BMPs as mandatory, but compliance has not been broadly enforced. Increasing compliance will likely require an institutional shift involving a combination of incentives, funding, and enforcement to accelerate implementation of private parcel BMPs and to ensure adequate maintenance is performed. While an evaluation of potential policy changes that could accomplish accelerated BMP implementation is beyond the scope of the Strategy Report, the technical analysis does highlight that private property BMP implementation could be an effective approach for the City to meet future load reduction targets.

Commercial land uses (CICU), which are estimated to generate relatively high pollutant loads (Placer County 2011), comprise almost one quarter of the developed area of the City. The City is comprised of the following acreages for developed private property totaling approximately 3,200 acres (private property is defined as any developed urban land use not owned or maintained by the City, but included in the City's Lake Tahoe TMDL allocation):

- Commercial/institutional/communications/utilities (CICU)
    - 730 total acres
    - 67 acres with BMP Certificates
- Multi-Family Residential (MFR)
    - 410 total acres
    - 63 acres with BMP Certificates
- Single Family Residential (SFR)
    - 2,065 total acres
    - 330 acres with BMP Certificates

The PLRM models used to estimate the City's existing FSP load with current levels of private property BMP implementation were adjusted to estimate the effect of increased BMP implementation on pollutant loading. Using the findings from the Placer Strategy (2011), which indicated SFR land uses have the lowest pollutant generation rate among urban land uses, the scenarios primarily evaluated BMP implementation for CICU and MFR land uses within the City.

> Scenario 1 - Obtain Current Level of Nevada BMP Certification: increase BMP certificates citywide to existing levels averaged across Nevada jurisdictions (60% CICU; 72% MFR; and 46% SFR).
>
> Scenario 2 - 100% CICU BMP Implementation: obtain 100% BMP certification for the CICU land use citywide; with MFR and SFR BMP certificates remaining at existing levels

Scenario 3 - 100% CICU and MFR BMP Implementation: obtain 100% BMP certification for the CICU and MFR land uses citywide; with SFR BMP certificates remaining at existing levels

Scenario 4 - 100% CICU BMP Implementation: obtain 100% BMP certification for the CICU land use in directly connected UPCs.

Performance and cost estimates for the four private property BMP scenarios described above are displayed in Table 3.6. The results were derived from PLRM simulations extrapolated to the entire urban area of the City. The following notes apply to Table 3.6.

- Planning level cost estimates for BMP implementation come from Section 2.3:
    - CICU averages $50,000 per acre
    - MFR averages $24,000 per acre
    - SFR average $17,500 per acre
    - BMP maintenance averages 3% of capital cost annually
- Active City WQIPs reflect a new water quality improvement strategy, which incorporates stormwater treatment of CICU land uses with project improvements as site-specific opportunities allow. PLRM models associated with each of these WQIPs account for the load reduction achieved from stormwater improvements to CICU land uses contained in these project areas (Section 3.2). To avoid potential double-counting, the load reduction benefit and associated area for CICU BMP implementation was omitted from the calculations shown in Table 3.6 for the following areas:
    - Bijou Commercial Core Project – 31 acres of CICU
    - Harrison Avenue Project – 6.5 acres of CICU
    - Sierra Tract Phase 3&4 – 15 acres of CICU
    - Tahoe Valley – 23 acres of CICU west and south of the “Y”
    - Stateline Redevelopment – 45 acres of CICU south of Highway 50 that drains to the constructed Park Avenue Basins

Table 3.6 – Private Property BMP Scenario Evaluation

Scenarios	Acreage of Newly BMP'd Parcels			Project Delivery Cost Estimate	Annual Maintenance Cost Estimate ($/year)	FSP Load Reduction from Baseline (lb/year)	% FSP Load Reduction Compared to Baseline	Cost Effectiveness ($/lb FSP reduced/year)
	CICU	MFR	SFR					
Scenario 1 - Obtain Current Level of Nevada BMP Certification	222	217	578	$26,400,000	$790,000	76,000	20%	$350
Scenario 2 - 100% CICU BMP Implementation (Citywide)	542	0	0	$27,100,000	$810,000	115,900	30%	$230
Scenario 3 - 100% CICU and MFR BMP Implementation (Citywide)	542	348	0	$35,500,000	$1,070,000	144,000	37%	$250
Scenario 4 - 100% CICU BMP Implementation (Directly Connected UPCs)	290	0	0	$14,500,000	$440,000	70,800	18%	$200

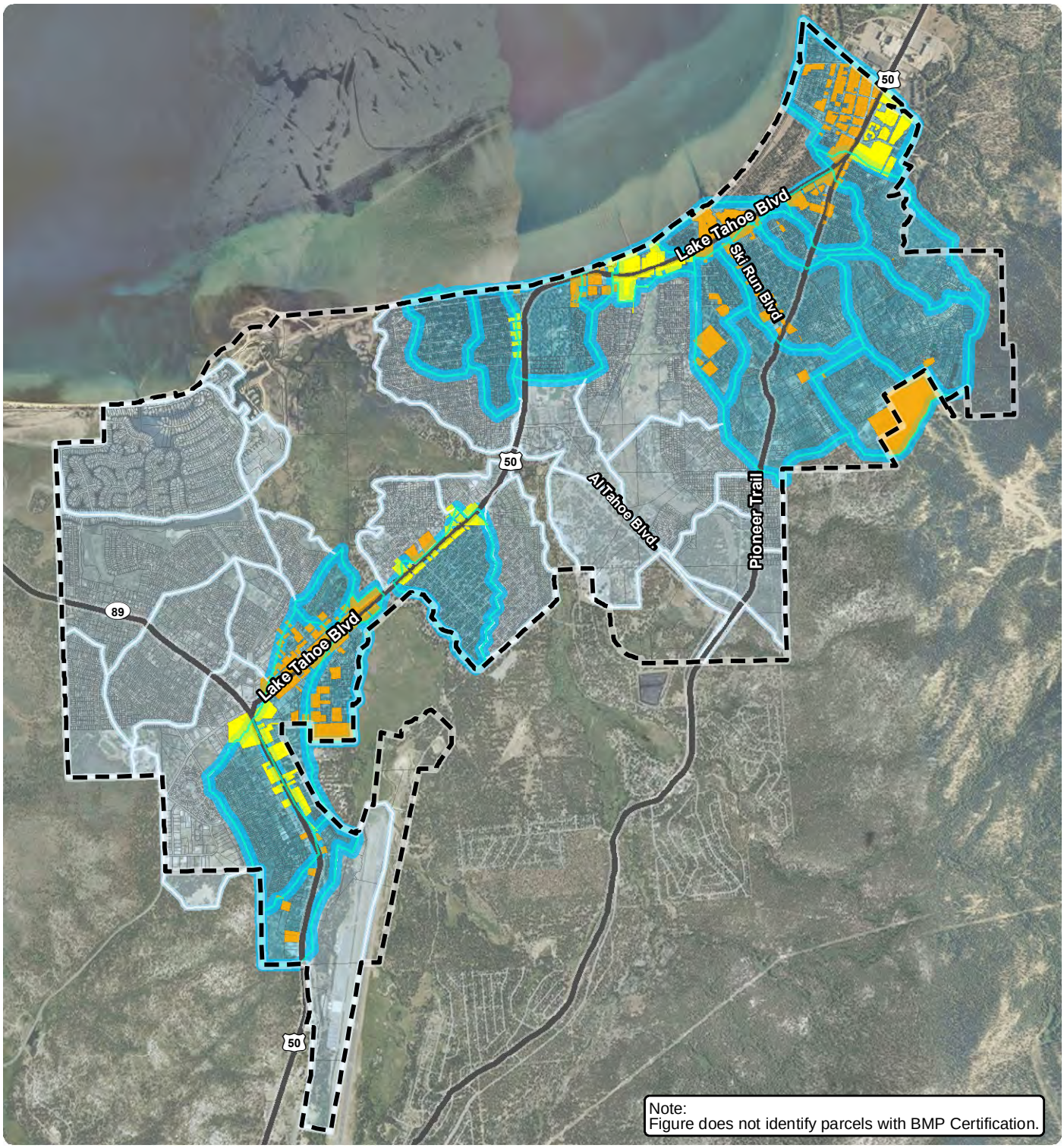
The following points summarize and interpret the data presented in Table 3.6.

- All evaluated scenarios indicate a significant load reduction can be achieved from increased private property BMP implementation in the City. For example, if the City's level of private BMP implementation reached current levels for Nevada jurisdictions, the City could reduce baseline FSP loading by 20%.

- PLRM estimates suggest that targeting CICU parcels for BMP implementation is the most cost-effective strategy and provides a more significant load reduction relative to targeting MFR and SFR parcels for BMP implementation. However, PLRM simulates average land use conditions when predicting pollutant loading for CICU, MFR, and SFR land uses. Certain MFR parcels and SFR parcels may provide notable load reductions from BMP implementation when site-specific evaluations identify poor land use and drainage conditions in need of BMP retrofit. For example, PLRM would under-predict pollutant loads generated from single-family residential parcels with unpaved driveways.

- Targeted CICU BMP implementation in directly connected UPCs represents the most cost effective near-term strategy to obtain significant load reductions (unit cost estimate of $200 per pound of FSP reduced per year). Figure 3.3 highlights these parcels while distinguishing between CICU land uses that may be targeted for water quality improvement as part of an active WQIP or future coordinated opportunity.

- The capital and maintenance costs for private property BMP implementation would not come from the City. However, if this option were pursued, there would likely be City costs incurred for facilitating BMP implementation (i.e., education, incentive programs, and involvement in developing regulatory programs).



Data Sources: ArcGIS Online Basemaps, 2012.

Legend

- City Limits
- Directly Connected UPCs
- Indirectly Connected UPCs

CICU in Directly Connected UPCs

- Highest Priority Parcels for BMP Retrofit
- Highest Priority Parcels Likely Addressed with WQIP
- Primary Roads
- Parcel Boundaries

City of South Lake Tahoe Pollutant Load Reduction Strategy

Targeted CICU BMP Implementation

Scale - 1:48,000 1 inch = 4,000 feet

0 2,000 4,000 8,000 Feet

CA State Plane, Zone II	NAD 83	horiz. units: feet
northwest hydraulic consultants	project no. 500019	September 2012

Figure 3.3 – Targeted CICU BMP Implementation

4.0 RECOMMENDED LOAD REDUCTION STRATEGY

This section outlines the recommended implementation approaches to meet the 2016 Load Reduction Target, as well as anticipated future load reduction targets through the 2026 Clarity Challenge. Recommendations include specific courses of action, a suggested timeline for implementation of actions, and estimated costs. The costs include those associated with project delivery, water quality operations and maintenance, and Lake Tahoe TMDL reporting and Rapid Assessment Methodologies (RAMs).

Although this Strategy Report provides specific recommendations for meeting the Clarity Challenge, it is important to note that implementation of water quality improvements actions will be an iterative process dependent upon available resources and evolving Tahoe Basin policy. The load reductions registered by the City for specific actions may differ than those reported here based on more detailed assessment of stormwater conditions or differences in analysis results when stormwater tools for the Tahoe Basin are refined. The Lake Clarity Crediting Program (Lahontan and NDEP 2011) is designed to be flexible, allowing for updates as the science underlying the Lake Tahoe TMDL and the PLRM evolves with future research.

4.1 FIRST LOAD REDUCTION TARGET (2016)

To date, the City has focused on implementation of WQIPs to reduce pollutant loads. Sections 2 and 3 assessed the City's progress towards meeting the first load reduction target by developing and tabulating PLRM estimates of pollutant load reductions for completed WQIPs (2004-2012) and active WQIPs with a high likelihood for completion by the end of the first load reduction plan timeline (September 2016). The analysis estimates that the City has achieved a 4.3% pollutant load reduction relative to its baseline pollutant load as of September 2012 (Table 2.4). If all active WQIPs currently in various planning and design stages are completed by 2016, an additional 5.7% reduction may be achieved by 2016 (see Table 3.4). Based on this estimate, it may be possible for the City to register the necessary 10% FSP reduction in baseline loading through the implementation of WQIPs alone. However, this overall load reduction estimate is relatively uncertain as a number of individual WQIP performance estimates are based preliminary PLRM models, which in some cases reflect the preferred alternative for project design. Therefore, a more diversified strategy is recommended that would register water quality improvement actions in addition to the completion of WQIPs to ensure the required 10% FSP reduction is met by 2016.

The analysis in Section 3 (Load Reduction Options) suggests that the City has a number of opportunities to implement additional pollutant load reduction actions to meet the first TMDL milestone. Actions that could be implemented include additional WQIPs, improved road operations for water quality, or targeted approaches to increase the level of private property BMPs. To meet the first TMDL milestone by 2016 with a high degree of confidence, the following approach is suggested, which blends completion of ongoing WQIPs with improved road operations focusing on refinements to current City practices for road abrasive applications.

Action 1 - Register Completed WQIPs (2004-2012): Register the seven completed WQIPs highlighted in Table 2.4 with the Lake Tahoe TMDL program.

Action 2 - Construct and Register Active WQIPs (2013-2016): Register the three active WQIPs with a high likelihood for completion by the end of the first load reduction plan timeline (September 2016) as shown in Table 3.4.

Action 3 - Road Operations for Water Quality – Phase 1: These actions focus on reducing the average annual mass of abrasives and FSP applied to City roads through the use of best available technology and improved sources of abrasives, which include:

- Retrofitting the two City sanding trucks with best available technology bulk spreaders to increase the efficiency and control over the amount of road abrasives applied.
- Use of an abrasive source with negligible FSP in the source and higher durability (i.e., resists pulverization into FSP).

Table 4.1 summarizes the FSP load reduction and cost estimates associated with the three suggested actions above. FSP load reductions are presented as both a percent reduction relative to the City baseline load estimate and the number of Lake Clarity Credits that would be awarded. The total cost to meet the first TMDL milestone using the recommended actions is estimated to be roughly $48 million. Of this amount, approximately $34 million has already been expended on completed WQIPs and the planning and design of active WQIPs. The cost estimate includes annual operation and maintenance and Lake Tahoe TMDL reporting costs from 2012-2016, which average roughly $200,000 per year during that time period. Assumptions supporting development of cost estimates shown in Table 4.1 are documented in Appendix B.

Table 4.1 – Recommended Actions to Meet 2016 Load Reduction Target

Recommended Actions	FSP Load Reduction		Cost Estimates		
	% FSP Reduction	Lake Clarity Credits	Project Delivery Cost	Annualized Increase in O&M Cost ($/year)	Average Annual Lake Tahoe TMDL Costs[1] ($/year)
Action 1 - Register Completed WQIPs (2004-2012)	4.3%	83	$31,010,000	$58,000	$41,000
Action 2 - Construct and Register Active WQIPs (2013-2016)	5.7%	110	$17,070,000	$140,000	$25,000
Action 3 - Road Operations for Water Quality – Phase 1	5.0%	97	$500,000	$4,000	$23,000
2016 Load Reduction Totals:	**15.0%**	**290**			
2016 Load Reduction Target	**10.0%**	**195**			
Total Project Delivery Costs:			**$48,580,000**		
Average Annual Costs of Maintaining Recommended Actions ($/year):				**$202,000**	**$89,000**

4.2 ANTICIPATED TARGETS TO THE CLARITY CHALLENGE (2026)

The recommended strategy for the City to meet anticipated load reduction targets up to the Clarity Challenge blends the following actions: 1) continuation of WQIPs in directly connected UPCs with notable load reduction opportunities; 2) augmentation of Phase 1 advanced road operation actions to include frequent and targeted street sweeping; and 3) implementation of private property BMPs, focused on CICU land uses within directly connected UPCs.

A key strength of the recommended strategy is that it provides flexibility by identifying three separate water quality improvement actions that may be combined in various proportions, or on different timeframes, to meet anticipated load reduction targets. The recommended strategy recognizes the need to shift away from a heavy reliance on implementation of public WQIPs to a more balanced program that includes improvements in road operations for water quality and targeted implementation of private property BMPs. The following three actions are recommended to meet anticipated load reduction targets up to the Clarity Challenge. Actions 1-3 (implemented by 2016) will also need to be maintained to meet subsequent targets.

> Action 4 – Road Operations for Water Quality – Phase 2: This action would augment the Phase 1 actions to include targeted and frequent street sweeping on City roads. The specific action proposed would refine and augment current City practices to target frequent street sweeping on the 41 miles of City roads identified in the Level 3 street sweeping strategy, shown in Figure 3.1.
>
> Action 5 – Plan, Design and Construct New WQIPs: This action would continue to implement WQIPs in high priority areas of the City within directly connected UPCs. For planning purposes, load reduction estimates and associated costs are summarized in Table 4.2 for the near-term opportunities identified in Table 3.5. Additional WQIPs could be incorporated into this action as opportunities are identified in the future.
>
> Action 6 – Increased Private Property CICU BMP Implementation: This action would target increased private property BMP implementation on CICU land uses in directly connected UPCs not associated with a active of proposed WQIP (Figure 3.3). For planning purposes, load reduction estimates and associates costs assume that 50% of CICU land uses in the targeted areas (Figure 3.3) would achieve BMP Certification by the Clarity Challenge deadline in 2026. This equates to 145 acres of additional BMP Certification for existing CICU land uses.

Table 4.2 summarizes the FSP load reduction and cost estimates associated with Actions 4, 5, and 6. Table 4.2 also provides the total FSP load reduction and total cost estimates associated with Actions 1-3. The FSP load reductions are presented as both a percent reduction relative to the City baseline loading estimate and the number of Lake Clarity Credits that would be awarded. Table 4.2 sums the total load reduction that may be achieved from the recommended actions and compares the estimate to the City's anticipated Clarity Challenge target. The total cost to implement all six actions is estimated to be roughly $58.6 million. Of this amount, roughly

$34 million has already been expended on completed WQIPs and the planning and design of active WQIPs. Roughly $7.25 million is estimated to be contributed by the private sector for CICU BMP implementation. The cost estimate includes annual operation and maintenance cost as well as annual Lake Tahoe TMDL reporting and tracking costs, which once all actions are fully implemented, are estimated to cost roughly $750,000 per year. Assumptions supporting development of cost estimates shown in Table 4.2 are documented in Appendix B.

The estimated project delivery cost for the City's Load Reduction Strategy to meet the Clarity Challenge ($58.6 million) is notably lower than the estimate published for Placer County's Load Reduction Strategy ($115 million). The difference between the two estimates results from a large difference in assumed levels of future WQIP implementation and associated costs:

- City Estimate of Future WQIPs through Clarity Challenge
  - Six constructed WQIPs and/or retrofits of past projects
  - Project delivery cost totaling $19 million
- Placer County Estimate of Future WQIP through Clarity Challenge
  - Fifteen constructed WQIPs
  - Project delivery cost totaling $75 million

The Placer County Strategy Report (2011: p. 5.6) noted that the "cost/benefit of future WQIP implementation beyond 2016 may need to be reconsidered in light of the likelihood of siting and public resource limitations and the expected cost effectiveness of other load reduction concepts."

Table 4.2 – Recommended Actions to Meet Clarity Challenge

Recommended Actions	FSP Load Reduction Estimate		Cost Estimates		
	% FSP Reduction	Lake Clarity Credits	Project Delivery Cost	Annualized Increase in O&M Cost ($/year)	Average Annual Lake Tahoe TMDL Costs[1] ($/year)
Maintain Performance of Actions 1-3	15.0%	290	-	$202,000	$50,000
Action 4 – Road Operations for Water Quality – Phase 2	6.2%	121	$700,000	$235,000	$19,000
Action 5 – Plan, Design and Construct New WQIPs	5.7%	111	$2,050,000	$40,000	$13,000
Action 6 – Increased Private Property CICU BMP Implementation	9.1%	177	$7,250,000	$345,000	$21,000
Actions 4 Through 6 Totals:	**21.0%**	**408**			
Clarity Challenge Totals (Actions 1-6):	**36.0%**	**698**			
Clarity Challenge Target:	**34%**	**660**			
Total Project Delivery Costs:			**$10,000,000**		
Average Annual Costs of Maintaining Recommended Actions ($/year):				**$822,000**	**$53,000**

When reviewing Table 4.2 it is important to note that the analyses and recommendations contained in this report are intended to: 1) demonstrate that achievement of load reduction milestones is technically feasible; and 2) provide the City with estimates of associated costs and levels of effort for achieving load reduction targets. For this purpose, numeric estimates of load reductions associated with a particular blend of actions for water quality improvements are provided, which is used as the basis for estimation of both load reductions and costs using best available information.

Given present uncertainties in available funding for certain actions, a refinement of the strategy to meet anticipated load reduction targets beyond the 2016 target will likely be necessary prior to implementation. This refinement or update should occur by mid-2016. The actual strategy the City implements to meet future load reduction targets through the Clarity Challenge may include a different blend of Actions 4, 5, and 6 relative to what is presented based on: 1) resolution of institutional or policy changes required to resolve implementation challenges; 2) available funding; and 3) the results of monitoring and lessons learned from implementation of the 2016 Load Reduction Plan.

5.0 REFERENCES

2NDNATURE and Northwest Hydraulic Consultants (NHC). 2012. Focused Stormwater Quality Monitoring to Inform Assumptions & Evaluate Predictive Capabilities of Existing Tools. Final Technical Report. Prepared for USFS Pacific Southwest Research Station. June 2012. http://www.2ndnaturellc.com/wp-content/uploads/2012/06/FocusedStormwaterQualityResearch_2N2012.pdf

Caltrans. 2010. Particle Analysis of Abrasives Study. Technical Memorandum. CTSW-TM-10-209.41.1. October 2010.

City of South Lake Tahoe (CSLT). 2012a. Tahoe Valley Water Quality Improvement Project Streamlined Existing Conditions Analysis and Conceptual Layout of Alternatives. Prepared by Northwest Hydraulic Consultants. South Lake Tahoe, CA. June 2012.

CSLT. 2012b. Conceptual Project Layouts for Potential Near-Term Water Quality Improvements. Prepared by Northwest Hydraulic Consultants. South Lake Tahoe, CA. June 2012.

CSLT. 2011. Lake Tahoe TMDL Baseline Pollutant Load Estimate. Prepared by Northwest Hydraulic Consultants. South Lake Tahoe, CA. September 2011.

CSLT. 2010.Maintenance Efficiency Plan. Fiscal Year 2009-2010. October 2010.

Lahontan Regional Water Quality Control Board (Lahontan). 2011a. Updated Waste Discharge Requirements and National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water/Urban Runoff Discharges from El Dorado County, Placer County, and the City of South Lake Tahoe Within the Lake Tahoe Hydrologic Unit. Order Number: R6T-2011-0101. NPDES Number: CAG61600.

Lahontan. 2011b. Order to Submit Technical Reports in Accordance with Section 13267 of the California Water Code – The Lake Tahoe Urban Stormwater Implementation. February 2011.

Lahontan and Nevada Division of Environmental Protection (NDEP). 2011. Lake Clarity Crediting Program Handbook: for Lake Tahoe TMDL Implementation v1.0. Prepared by Environmental Incentives, LLC. South Lake Tahoe, CA. September 2011. http://www.swrcb.ca.gov/rwqcb6/water_issues/programs/tmdl/lake_tahoe/

Lahontan 2010. Final Lake Tahoe Total Maximum Daily Load. November 2010. http://www.swrcb.ca.gov/rwqcb6/water_issues/programs/tmdl/lake_tahoe/docs/tmdl_rpt_nov2010.pdf

Lahontan and NDEP. 2008b. Lake Tahoe TMDL Pollutant Reduction Opportunity Report v2.0. March 2008. http://www.swrcb.ca.gov/rwqcb6/water_issues/programs/tmdl/lake_tahoe/

Larsen, Bob. 2011. Personal communication with B. Wolfe (NHC). April 21, 2011.

Minto, Dick. 2010. Personal communication with B. Wolfe (NHC). August 3, 2010.

NHC, Geosyntec Consultants, and 2NDNATURE. 2009. PLRM Model Development Document. Prepared for Lake Tahoe Basin Storm Water Quality Improvement Committee. South Lake Tahoe, CA. http://www.tiims.org/TIIMS-Sub-Sites/PLRM/docs-downloads.aspx

NHC. 2010. PLRM Applications Guide. Prepared for Lake Tahoe Basin Storm Water Quality Improvement Committee. South Lake Tahoe. CA. http://www.tiims.org/TIIMS-Sub-Sites/PLRM/docs-downloads.aspx

Placer County. 2011. Placer County Stormwater TMDL Strategy. Final Technical Report. Prepared by 2NDNATURE and NHC. Prepare for USACE Sacramento District and Placer County. July 2011. http://www.2ndnaturellc.com/wp-content/uploads/2012/03/PlacerStormwaterTMDLStrategy_FinalTechDoc.pdf

Tahoe Regional Planning Agency (TRPA). 2012. TRPA Stormwater Management/BMP Retrofit Program Overview. Stateline, Nevada.

Wigart, Russ. 2012. Personal communication with B. Wolfe (NHC). July 16, 2012.

Appendix A – PLRM Methods and Assumptions

All files provided digitally.

Appendix B – Assumptions Supporting Section 4 Cost Estimates

Global Assumptions

Cost Estimates for Lake Tahoe TMDL Reporting costs use the following assumptions from the Placer County Strategy Report (2011):

- The initial catchment registration process for a WQIP requires 80 hours of staff time; this activity is done once
- BMP RAM observations and annual reporting for a registered catchment requires 25 hours of staff time per year
- The initial registration process for a jurisdictional action, such as improved road operations requires 80 hours of staff time; this activity is done once unless there are changes to operations.
- Road RAM observations and annual reporting for a jurisdiction requires 135 hours of staff time per year

The City recommended that a fully burdened cost of $130/hour be used to estimate costs associated with engineering staff time for Lake Tahoe TMDL program related costs.

Action 1 - Register Completed WQIPs (2004-2012)

Project Delivery Costs =

- Estimated cost of completed WQIPs provided by the City (Table 2.4)

Water Quality Operations and Maintenance Cost =

- Estimated cost developed in Section 2.2 (Table 2.4)

Lake Tahoe TMDL Costs =

- (7 WQIPs x 80 hours x $130/hour) / (averaged over 4 years) = $18,200/year; plus
- (7 WQIPs x 25 hours x $130/hour) = $22,750/year
- Total = $40,950/year

Action 2 - Construct and Register Active WQIPs (2013-2016)

Project Delivery Costs =

- Estimated cost developed in Section 3.2

Water Quality Operations and Maintenance Cost =

- Estimated cost developed in Section 3.2

Lake Tahoe TMDL Costs =

- (3 WQIPs x 80 hours x $130/hour) / (averaged over 2 years) = $15,600/year; plus
- (3 WQIPs x 25 hours x $130/hour) = $9,750/year
- Total = $25,350/year

Action 3 - Road Operations for Water Quality – Phase 1

Project Delivery Costs =

- $200k to install best available technology and two City sanding trucks; plus
- $100k per year for 3 years to monitor and evaluate potential water quality improvements from Action 3

Water Quality Operations and Maintenance Cost =

- Estimated cost of switching abrasive supply – see Section 3.1

Lake Tahoe TMDL Costs =

- (80 hours for jurisdictional registration x $130/hour) / (averaged over 2 years) = $5,200/year; plus
- (135 hours for Road RAM x $130/hour) = $17,550/year
- Total = $22,750/year

Action 4 – Road Operations for Water Quality – Phase 2

Project Delivery Costs =

- $700k for acquisition of two new dustless street sweepers

Water Quality Operations and Maintenance Cost =

- Estimated cost of street sweeping at $284/road mile and Level 3 sweeping strategy – see Table 3.3

Lake Tahoe TMDL Costs =

- (80 hours for jurisdictional registration x $130/hour) / (averaged over 10 years) = $1,040/year; plus
- (135 hours for Road RAM x $130/hour) = $17,550/year
- Total = $18,600/year

Action 5 – Plan, Design and Construct New WQIPs

Project Delivery Costs =

- Estimated cost developed in Section 3.2

Water Quality Operations and Maintenance Cost =

- Estimated cost developed in Section 3.2

Lake Tahoe TMDL Costs =

- (3 WQIPs x 80 hours x $130/hour) / (averaged over 10 years) = $3,120/year; plus
- (3 WQIPs x 25 hours x $130/hour) = $9,750/year
- Total = $12,870/year

Action 6 – Increased Private Property CICU BMP Implementation

Project Delivery Costs =

- Estimated cost developed in Section 3.3 for CICU implementation in directly connected catchments multiplied by 50% implementation

Water Quality Operations and Maintenance Cost =

- Estimated cost developed in Section 3.3 for CICU maintenance in directly connected catchments multiplied by 50% implementation; plus
- Annual amount of $125,000 for one full-time City position to support planning and implementation of private property BMPs in the City

Lake Tahoe TMDL Costs =

- (5 catchments registered x 80 hours x $130/hour) / (averaged of 10 years) = $5,200/year; plus
- (5 catchments x 25 hours x $130/hour) = $16,250/year
- Total = $21,450/year