Appendix C

Summary of
Stormwater Modeling Analysis

Appendix C Summary of Stormwater Modeling Analysis

Background and Purpose

Several comments expressed concern that coverage in community centers would have the potential to generate a greater pollutant load than an equal area of coverage outside of a community center, or that concentrating coverage would increase pollutant loading from community centers. These comments generally did not distinguish between Regional Plan Update alternatives as each alternative would have the potential to increase coverage in community centers to some degree.

In response to concerns regarding the localized water quality impacts of further concentrating development within community centers, an additional stormwater modeling analysis using theoretical maximum coverage (as opposed to the Draft EIS analysis, which used estimates based on available allocations) was prepared to estimate the relative changes in pollutant loading that could occur within community centers as a result of proposed policies. The modeling results, which are summarized in Master Response 5, Effects of Concentrated Development on Water Quality, illustrate that even if policies that incentivize concentrated development result in maximum allowable coverage in all community centers (a condition for which sufficient commodities may not be available), the result would be a decrease in pollutant loading from community centers as compared to existing conditions as a result of implementing required water quality regulations.

This appendix documents the technical approaches and assumptions informing the stormwater modeling analysis summarized in Master Response 5, Effects of Concentrated Development on Water Quality. The analysis was prepared using the Pollutant Load Reduction Model (PLRM). The PLRM is a publicly available, long-term, continuous simulation model used to evaluate and compare alternatives for stormwater quality improvement projects in the Tahoe Basin. The PLRM is the primary tool used by jurisdictions in the Region to support Lake Tahoe TMDL estimates of baseline pollutant loading and pollutant load reduction planning. The model incorporates data on land use types, impervious coverage, and BMP implementation to generate estimates of fine sediment, nitrogen, and phosphorus loading and stormwater runoff.

Coverage Analyses Based on Development Allocations vs. Maximum Allowable Coverage

The coverage analysis developed in this technical appendix quantifies the theoretical maximum area of coverage for the land use types (e.g., commercial, tourist accommodation, mixed use, and multi-family residential) that could result within community centers. Though this scenario is unlikely to be realized given the limitations in available allocations and other limits on development potential, this approach was necessary to generate modeling inputs in the format required by PLRM for each applicable land use. The coverage analysis presented herein differs from the analysis used in the Draft EIS, which evaluated region-wide coverage changes based on additional coverage assuming build-out of proposed development allocations. Estimates derived from theoretical maximum allowable coverage represent another set of reasonable, though conservative, estimates of maximum possible coverage in community centers, which are appropriate for use when calculating changes in pollutant loading relative to existing conditions through PLRM simulations.

The coverage analysis presented in the Draft EIS estimates increases in coverage in community centers, based on the total number and type of development allocations allowed under each Regional Plan Update alternative (see Section 3.7 of the Draft EIS, Impact 3.7-1). Development potential, expressed in the Draft EIS coverage analysis as the acreage of new coverage resulting from a Regional Plan Update alternative, was calculated by multiplying the average coverage per unit (CFA, TAU, multi- and single-family residential units) by the total number of units proposed for each alternative.

Table 3.7-8 of the Draft EIS summarizes the results of the development allocation analysis and presents an estimate of the maximum amount of additional coverage in community centers under each Regional Plan Update alternative. To assist the reader, those estimates are summarized in Table C-1 below. In addition to the analysis assessing coverage-related impacts in Section 3.7, Geology, Soils, Land Capability, and Coverage, and Section 3.8, Hydrology and Water Quality,, Draft EIS Appendix H, Coverage Information, describes in detail the supporting assumptions and calculations used to estimate potential changes in coverage Region-wide. This methodology represents likely maximum increases in coverage that could result from each alternative; it likely overestimates total coverage because it does not incorporate future decreases in coverage that would result from accelerated implementation of the excess coverage mitigation program and continued coverage reductions resulting from public Environmental Improvement Projects.

Table C-1 Estimated Additional Coverage in Community Centers

Alternative	Estimated Total New Coverage (acres)
Alternative 1	28
Alternative 2	38
Alternative 3	64
Alternative 4	48
Alternative 5	56

MAXIMUM ALLOWABLE COVERAGE ANALYSIS INFORMING PLRM

The following steps were taken to develop coverage inputs to inform a PLRM stormwater simulation for community centers.

Step 1

TRPA parcel data were cross-referenced with the locations of community centers, existing coverage based on 2010 aerial LiDAR (Light Detection and Ranging) data, and land capability based on the Bailey land capability map. This analysis produced the following information by parcel:

- Associated community center
- Existing coverage
- Estimated land capability

Step 2

Using the estimated land capability of individual parcels, the maximum allowable coverage for each parcel was calculated pursuant to policies proposed for each Regional Plan Update alternative, where coverage regulations for non-sensitive lands (LCDs 4–7) within community centers would allow the following coverage for commercial facilities and land uses classified as tourist, multi-family (5 units or more), public service, and recreation:

- *Alternatives 1 and 5*: 50 percent allowable coverage for existing development and 70 percent allowable coverage for new development
- *Alternative 2*: 50 percent allowable coverage for existing development and 50 percent allowable coverage for new development
- *Alternatives 3 and 4*: 70 percent allowable coverage for existing development and 70 percent allowable coverage for new development

Step 3

The Final Draft Plan, incorporating important revisions to Alternative 3, prohibits increases in maximum allowable coverage for community centers within 300 feet of the high water mark of Lake Tahoe and reduces maximum allowable coverage for new development in these areas to 50 percent on high capability lands (with exemptions on the land side of State Routes 89 and 28 within the Tahoe City and Kings Beach Town Centers).

Parcel data were cross-referenced with location to identify parcels within community centers that are within 300 feet of the Lake Tahoe high water mark. A tabulation of potential additional coverage on parcels within 300 feet of the high water mark for Lake Tahoe within community centers is estimated to result in the following:

- 0.5 acre of additional coverage at 50 percent allowable coverage for non-sensitive lands
- 2.3 acres of additional coverage at 70 percent allowable coverage for non-sensitive lands

The results of this analysis highlight that the 300-foot setback provision reduces potential additional coverage in community centers by 1.8 acres. Reductions in coverage from the 300-foot setback provision are limited because proposed coverage polices are linked to land capability. Within community centers, most of the non-sensitive land within the 300-foot setback already exceeds proposed maximum coverage limits. Note that the calculation does not consider potential excess coverage reductions from redevelopment of parcels for which existing coverage exceeds the maximum allowable and is required to be mitigated.

In the coverage calculations performed in Step 4, all parcels within community centers within 300 feet of the high water mark of Lake Tahoe were assigned 50 percent maximum allowable coverage for new and existing development for the Final Draft Plan (see Table C-2).

Step 4

For parcels where maximum allowable coverage is greater than existing coverage (i.e., additional coverage is available), the difference was summed across those parcels to estimate additional coverage within community centers under each Regional Plan Update alternative. The results of the analysis are presented in Table C-2. Note that the results do not include single-family residential parcels in community centers because the proposed maximum allowable coverage policies in community centers are only applicable to commercial facilities and for land uses classified as tourist, multi-family (5 units or more), public service, and recreation (Final Draft Code Section 30.4.2.B.1.b).

The estimates shown in Table C-2 represent the potential increase in coverage that could result from attaining maximum allowable coverage limits for affected land uses in all community centers under each Regional Plan Update alternative. The estimates of increased coverage in Table C-2 are lower than estimates of potential coverage increases presented in the Draft EIS, which were derived using the development allocations approach (Table C-1). The actual acreage of additional coverage within each community center is not possible to predict as it would be influenced by individual project proposals and site-specific factors such as field verifications of land capability and limitations on coverage available for transfer in some HRAs. So, although actual coverage increases could vary from the values shown in Table C-2, these values nonetheless represent another set of reasonable estimates of maximum possible coverage change for each alternative.

Table C-2 Estimated Maximum Potential Coverage for Affected Land Uses* in Community Centers Resulting from Proposed Maximum Allowable Coverage Limits	
Alternative	**Maximum Additional Coverage (acres)**
Alternative 1	26.1
Alternative 2	25.8
Alternative 3	56.9
Alternative 4	56.9
Alternative 5	26.1
Final Draft Plan	55.1
Existing Coverage (acres)	501
*Commercial facilities and land uses classified as tourist, multi-family (5 units or more), public service, and recreation (does not include additional coverage for single-family development, public service coverage exemptions, and other uses not affected by proposed change).	

The following points summarize and interpret the results presented in Table C-2:

- Relative to Alternative 1, Alternative 2 would reduce maximum allowable coverage for undeveloped parcels on non-sensitive lands from 70 percent to 50 percent. This difference in coverage policy would not produce a substantial difference in coverage between Alternative 1 and Alternative 2 (estimated at 0.3 acre). Based on review of individual parcel data (i.e., maximum allowable coverage and estimates of existing coverage), this result is attributable to the following conditions:
  - Few undeveloped parcels remain in community centers with land uses that would qualify under this policy (approximately 90 parcels out of 2,300 parcels in community centers).
  - Among the remaining undeveloped parcels in community centers that qualify, very little non-sensitive land is available for development (approximately 1.7 acres total).
- Relative to Alternative 1, Alternative 3 would allow up to 29 acres of additional coverage in community centers. This additional coverage would result from increasing maximum allowable coverage for developed parcels on non-sensitive land from 50 percent to 70 percent. As described in the Draft EIS (pages 3.7-33 to 3.7-36), all of this allowable coverage would require transfers of coverage from elsewhere, which would result in a net reduction in coverage and a reduction in coverage in sensitive lands Region-wide.

Effect of Maximum Allowable Coverage on BMP Implementation and Pollutant Loading

The parcel-level data described above were used to generate inputs to inform the stormwater modeling simulation using the PLRM. The modeling analysis focuses on relative changes in pollutant loading that may result from the maximum allowable coverage policy of the Final Draft Plan, (Table C-2).

The following steps were taken to develop a regional pollutant loading estimate.

Step 1

As described above, the TRPA land uses eligible for additional maximum allowable coverage within community centers under the Final Draft Plan are commercial, tourist, multi-family (5 units or more), public service, and recreation. For PLRM modeling purposes, these land uses were assigned the appropriate Lake Tahoe TMDL land use classifications, which are used by the PLRM:

- CICU – Commercial/Institutional/Communications/Utilities
- MFR – Multi-Family Residential

Step 2

To estimate relative changes in pollutant loading under Final Draft Plan policies, an estimate of existing coverage and total parcel area with BMP certification was developed from the parcel data for the Lake Tahoe TMDL land use classifications of CICU and MFR (Table C-3).

Table C-3 Estimate of Existing Coverage and BMP Certification

Lake Tahoe TMDL Land Use	Total Area (acres)	Coverage (acres)	Percent Coverage	BMP Certificates (acres)	BMP Percentage
CICU	589	409	69%	186	32%
MFR	85	34	40%	19	22%
Total	674	443	66%	205	30%

Step 3

Total coverage and the total parcel area with BMP certification was estimated under proposed coverage policies for the Final Draft Plan. This estimate assumed the maximum allowable increase of 55 acres of coverage would occur for CICU and MFR land uses (Table C-2). Because any coverage increase would be associated with an approved project, the coverage increase would be required to comply with BMP requirements. Therefore, the area of parcels eligible for coverage increases, after accounting for eligible parcels with current BMP certificates, was tabulated to estimate the total area of increased BMP certification resulting from the Final Draft Plan coverage policy (Table C-4). Based on comparison of Tables C-3 and C-4, the proposed policy would result in 124 acres of additional urban area with BMP certification in community centers.

Table C-4 Final Draft Plan Estimate of Additional Coverage and BMP Certification

Lake Tahoe TMDL Land Use	Total Area (acres)	Coverage (acres)	Percent Coverage	BMP Certificates (acres)	BMP Percentage
CICU	589	444	75%	272	46%
MFR	85	54	63%	57	66%
Total	674	498	74%	329	49%

Step 4

Using the data in Tables C-3 and C-4, a conceptual PLRM model was developed to estimate the relative effect on pollutant loading within community centers under proposed maximum allowable coverage policies. Tables C-3 and C-4 document the primary PLRM inputs used in the simulation for land use type, land use area, coverage, and BMP certification. Additional PLRM inputs and key input assumptions are described in more detail below.

Table C-5 displays the results of the PLRM simulation, which serve as a relative comparison of estimated changes in pollutant loading that could result from policies included in the Final Draft Plan. It is important to note that the estimates in Table C-5 should not be considered representative of actual pollutant loads generated from community centers within the Region. Site-specific analysis and detailed stormwater modeling would be necessary to generate a representative estimate of pollutant loading in specific community centers. The Lake

Tahoe TMDL requires local jurisdictions to complete load reduction plans that identify catchments (i.e., sub-watersheds) and their respective pollutant loading to Lake Tahoe. Estimates of existing condition pollutant loading in community centers, developed by local jurisdictions using site-specific analysis and detailed stormwater modeling, will differ from the existing condition estimate presented in Table C-5.

Table C-5 Estimated Changes in Pollutant Loading in Community Centers

Conceptual Scenario	Surface Runoff (acre-feet/year)	Fine Sediment Particles (lb/yr)	Total Nitrogen (lb/yr)	Total Phosphorus (lb/yr)
Existing Condition	520	248,000	3,500	970
Alternative 3 - Maximum Allowable Coverage in Centers with Associated BMPs	480	222,000	3,200	880

The following points summarize and interpret the results presented in Table C-5:

- The PLRM results indicate that realization of the maximum allowable coverage for affected land uses in all community centers would produce a pollutant load reduction relative to existing conditions for Lake Tahoe TMDL pollutants of concern. This result is attributable to the following modeling inputs and assumptions:
  - The average percentage of BMP certification for the targeted land uses (CICU and MFR) is relatively low (30 percent) within community centers for the existing condition.
  - The targeted land uses (CICU and MFR) in the existing condition are assumed to have relatively poor land use conditions and drainage conditions that generate relatively high pollutant loads from community centers.
  - Eligible parcels within community centers would be required to implement BMPs for the entire area of the parcel as part of any action that increases coverage to the maximum allowed. This policy would primarily affect developed parcels, including parcels with existing coverage that do not currently meet water quality requirements. Modeling demonstrates that the increased BMP implementation would result in a pollutant load reduction across community centers while accommodating the increase in coverage.
- The PLRM performance estimates assume that BMPs are correctly designed, installed, and maintained to retain and infiltrate the 20-year 1-hour design storm (generally taken as 1 inch of runoff from impervious surfaces on a parcel). These water quality requirements could be accomplished through either parcel-based BMP implementation or area-wide water quality treatment approved by TRPA under a conforming Area Plan.

- The estimated increase in acreage with BMP certification does not account for potential water quality improvements on developed parcels that currently exceed maximum allowable coverage limits. Additional BMP-certified acreage in community centers or excess coverage reductions would decrease pollutant loading relative to the estimate shown for the Final Draft Plan.

- The performance estimate does not account for water quality improvements achieved from coverage removal on sending parcels. Depending on site-specific land use conditions and drainage conditions on sending parcels, decreases in coverage on sending parcels would likely reduce Region-wide pollutant loading, but such a reduction is not estimated in the modeling analysis.

POLLUTANT LOAD REDUCTION MODEL (PLRM) INPUTS AND TECHNICAL ASSUMPTIONS

This section documents all inputs used to inform the PLRM simulation and provides a discussion on modeling approaches and sensitivities. Additional background information on the PLRM may be reviewed in the following documents available on the Tahoe Integrated Information Management System (TIIMS) website http://www.tiims.org/TIIMS-Sub-Sites/PLRM/docs-downloads.aspx:

- PLRM User's Manual (December 2009)
- PLRM Model Development Document (October 2009)
- PLRM Applications Guide (October 2010)

The results of the modeling analysis can be reproduced by downloading the PLRM software from the TIIMS website and reproducing the simulation using the inputs presented in the worksheets below. The following points discuss the key nuances of the inputs and modeling approaches. Each discussion point is cross-referenced to the PLRM inputs presented in the worksheets at the end of this appendix.

Discussion Point #1

The PLRM predicts pollutant loading in the Tahoe Region using a long-term continuous simulation, which is informed by algorithms that estimate location-specific hourly precipitation and temperature time-series data. For a PLRM Project, only one meteorological location may be specified. The meteorological grid cell used in the modeling analysis (204) is the time-series data of precipitation and temperature for the Tahoe City community center. Given Tahoe City's location on the West Shore of Lake Tahoe, PLRM algorithms estimate that this location will receive more precipitation than community centers located on the East Shore of Lake Tahoe due to orographic effects in the Region. If a meteorological grid cell on the East Shore were used for the analysis, the magnitude of pollutant loading would be less for both the existing condition estimate and the Final Draft Plan estimate because precipitation inputs would decrease.

As noted above, the simple conceptual PLRM model developed for the analysis is only valid as a relative comparison of estimated changes in pollutant loading that could result from coverage policies. The estimates should not be considered representative of actual pollutant loads generated from community centers within the Region. Site-specific analysis and detailed stormwater modeling would be necessary to generate a representative estimate of pollutant loading in community centers.

Discussion Point #2

The selected modeling approach uses one PLRM scenario and two PLRM catchments, where one PLRM catchment in the scenario represents existing land use conditions and the other PLRM catchment represents potential land use conditions under proposed maximum allowable coverage policies for the Final Draft Plan. An equivalent modeling approach could have been used with two separate PLRM scenarios, each modeling one PLRM catchment representing existing land use conditions and potential land use conditions under proposed maximum allowable coverage policies for the Final Draft Plan. Both modeling approaches would generate the same result.

Discussion Point #3

The aggregate area of community centers in the Region was modeled using a single PLRM catchment for both the existing land use condition and the potential land use conditions under proposed maximum allowable coverage policies for the Final Draft Plan. The single PLRM catchment representing the aggregate area of community centers totals 674 acres. While there are no restrictions on the size of catchments modeled in PLRM, the recommended range is 10 to 100 acres (PLRM User's Manual 2009: page 147). The recommended range in catchment size is provided by the PLRM model developers to caution PLRM users that modeling inaccuracies can increase when very small or very large catchments are simulated. The potential issue arises because hydrologic

algorithms employed by PLRM were constrained by the PLRM developers to reduce and simplify data entry needs on the PLRM end user. For this analysis, the simplified and conceptual representation of land use conditions and BMP implementation in community centers allows the modeled scenario to be scaled, and therefore the results are not sensitive to the modeled catchment size.

Discussion Point #4

The land use inputs for CICU and MFR representing total area and total impervious area were derived from the calculations presented in Tables C-3 and C-4, above.

Discussion Point #5

The percentage of private property BMP certification for the CICU and MFR land uses were developed in Tables C-3 and C-4, above.

Note that the private property BMP algorithm in PLRM simulates the aggregate effect of parcel-based infiltration systems by using a single drainage area and single infiltration system for each modeled land use. By default, this infiltration system is sized to retain and infiltrate the 20-year 1-hour design storm. The results are not sensitive to the type of BMPs employed to meet regulatory requirements (i.e. parcel-based infiltration systems or area-wide treatment systems), provided that the treatment systems are correctly designed, installed, and maintained to retain and infiltrate the 20-year 1-hour design storm.

Discussion Point #6

PLRM documentation defines directly connected impervious area (DCIA) as the percentage of impervious surfaces draining to a conveyance system (PLRM User's Manual 2009: page 77). The percentage of impervious area defined as DCIA is a highly sensitive input parameter that will notably influence pollutant loading estimates. The key implication for this analysis is that PLRM predicts the largest pollutant load reductions can be achieved from BMP implementation on parcels with high amounts of DCIA. As called out in the worksheets below, the value for MFR DCIA was set to 60 percent and the value for CICU DCIA was set to 70 percent for community centers. These DCIA inputs represent the lower range of DCIA values used in PLRM models for community centers developed by Placer County and the City of South Lake Tahoe to support their Lake Tahoe TMDL baseline loading estimates. The lower range of DCIA values used in the analysis provide a conservative estimate of pollutant load reductions that may be achieved through increased BMP implementation in community centers while accounting for the increase in coverage allowed under the Final Draft Plan. Actual pollutant load reductions would vary between and within community centers; and aggregate pollutant load reductions would be greater than the estimate provide3d here if the actual percent of directly connected impervious area is greater than the conservative estimates included in the model.

Field	Description
PLRM Project Name:	Community_Centers
Project Description	
Urban Planning Catchment (UPC):	Not applicable
Additional UPC in Urban Area?:	Not applicable
PLRM Met Grid Number:	204
PLRM Database Version Used:	v15.2
Planning Documents Used:	n/a
Dates of Field Inspections:	n/a
Initals of inspector(s)	n/a
Name of PLRM Scenario:	Community Center Analysis
Scenario Description:	
Number of Catchments in Scenario:	2
Number of SWTs in Scenario:	0

Discussion Points Legend
Discussion Point 1
Discussion Point 2
Discussion Point 3
Discussion Point 4
Discussion Point 5
Discussion Point 6

Table 1: Catchment ID and Routing	Description
Name:	Existing Conditions
Description:	
Outfall Name	Existing Conditions
Type of Outfall (SWT, Outlet, Junction, or Diversion)?	Outlet
If SWT, what type?	n/a

Table 2: Catchment Properties	Value
Area (Acres)	674.0
Average Slope (% as whole number)	4%

Table 3: Land Uses Present	% of Catchment	% Impervious for Land Use	Area (acres)
CICU	87.4%	69%	589.1
Multi Family Residential	12.6%	40%	84.9
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Check (should be 100%):	100%	n/a	674.0

Table 4: Soils Present (list Map Unit number)	% of Catchment as Whole Number
7042	100%
Check (should be 100%):	100%

Table 6: Parcel Methodology (Private BMPs)	BMP Implementation (% Area)			Notes on BMP Implementation Decision
	No BMPs	Source Control Certification	BMP Certification	
Multi Family Residential	78%	0%	22%	
CICU	68%	0%	32%	

Table 7: Drainage Area by Land Use	% of Area	Area (acres)	Impervious Area (acres)	DCIA (%)	Ksat of Drainage Area (in/hr)	Ksat of HSC (in/hr)	Notes on Connectivity Decisions
Multi Family Residential							
To Infiltration Facility	22%	18.7	7.5	100%	default	0.5	
To Outlet	78%	66.2	26.5	60%	default	-	
CICU							
To Infiltration Facility	32%	188.5	130.1	100%	default	0.5	
To Outlet	68%	400.6	276.4	70%	default	-	

Table 1: Catchment ID and Routing	Description
Name:	Draft Final Plan
Description:	
Outfall Name	Draft Final Plan
Type of Outfall (SWT, Outlet, Junction, or Diversion)?	Outlet
If SWT, what type?	n/a

Table 2: Catchment Properties	Value
Area (Acres)	674.0
Average Slope (% as whole number)	4%

Table 3: Land Uses Present	% of Catchment	% Impervious for Land Use	Area (acres)
CICU	87.4%	75%	589.1
Multi Family Residential	12.6%	63%	84.9
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Check (should be 100%):	100%	n/a	674.0

Table 4: Soils Present (list Map Unit number)	% of Catchment as Whole Number
7042	100%
Check (should be 100%):	100%

Table 6: Parcel Methodology (Private BMPs)	BMP Implementation (% Area)			Notes on BMP Implementation Decision
	No BMPs	Source Control Certification	BMP Certification	
Multi Family Residential	34%	0%	66%	
CICU	54%	0%	46%	

Table 7: Drainage Area by Land Use	% of Area	Area (acres)	Impervious Area (acres)	DCIA (%)	Ksat of Drainage Area (in/hr)	Ksat of HSC (in/hr)	Notes on Connectivity Decisions
Multi Family Residential							
To Infiltration Facility	66%	56.0	22.4	100%	default	0.5	
To Outlet	34%	28.9	11.5	60%	default	-	
CICU							
To Infiltration Facility	46%	271.0	187.0	100%	default	0.5	
To Outlet	54%	318.1	219.5	70%	default	-	