Section 5
Monitoring Results

This section presents the monitoring results from the first three years of TRWQMP implementation (WY 2010 to WY 2012). Results are presented for rapid assessments, bioassessments, community and tributary level water quality sampling and the Martis Creek continuous discharge monitoring. A load based evaluation for the Martis Creek watershed, based on mean concentrations and stream discharge estimates, is also presented.

5.1 Rapid Assessment Methodology

This section presents the results of the WY 2012 RAM surveys and discusses differences observed from the WY 2010 results. Monitoring using the rapid assessment methodology (RAM) was conducted in Squaw Creek, Bear Creek, Martis Creek, West Martis Creek, East Martis Creek, Donner Creek, Trout Creek, and the Truckee River within the Town corridor. The 2012 rapid assessments were conducted in the fall during periods of low flow when discharge at the Tahoe City dam ranged from about 150 – 350 cfs. Discharge in the tributaries was very low during this time period due to the dry preceding winter.

The reach level RAM results tables and the original field data forms are provided in Appendix A. The RAM results were also incorporated into the project database and includes the name of the stream interval, reach ID, observation dates, discharge rate at the Tahoe City dam, the percentage of particle measurements less than 2mm in diameter, the average percent cobble embeddedness, and median particle diameter (D50) calculated for each reach. Combined average values for the entire surveyed stream segment are also provided.

An overall summary of the RAM results is presented in Figure 5-1 which illustrates the percentage of reaches falling into each 10 percent category in each of the stream intervals surveyed during WY 2012. The results indicate that Bear Creek has the least amount fine sediment on the channel bottom with over 70 percent of the surveyed reaches falling into the 0 – 10 percent range and the remainder falling in the 11-20 and 21-30 percent ranges. On average, 9 percent of the Bear Creek stream bottom was covered in particles less than 2mm. The channel substrate in the main stem of Martis Creek, the Truckee River, Donner Creek, and East Martis Creek consists of less than 20 percent fine particles. Squaw Creek, West Martis Creek, and Trout Creek each contain the largest percentages of fine sediment substrate with values of 25, 38, and 52 percent, respectively. West Martis Creek and Trout Creek were the only monitored streams to contain reaches with 71-80 percent fine sediment substrate.

The WY 2012 RAM results were compared to results collected at the same locations in WY 2010 to determine whether stream conditions are changing with time. Table 5-1 provides a summary of these comparisons showing the total number of reaches where increases or decreases in fine sediment were observed and the average change in fine sediment substrate for the entire stream segment. These results should be qualified due to the increased measurements that were collected in 2012 for each monitoring reach (11 transects in 2012 compared to 6 transects in 2010). For the Truckee River, the comparisons only include reaches surveyed in both 2010 and 2012.

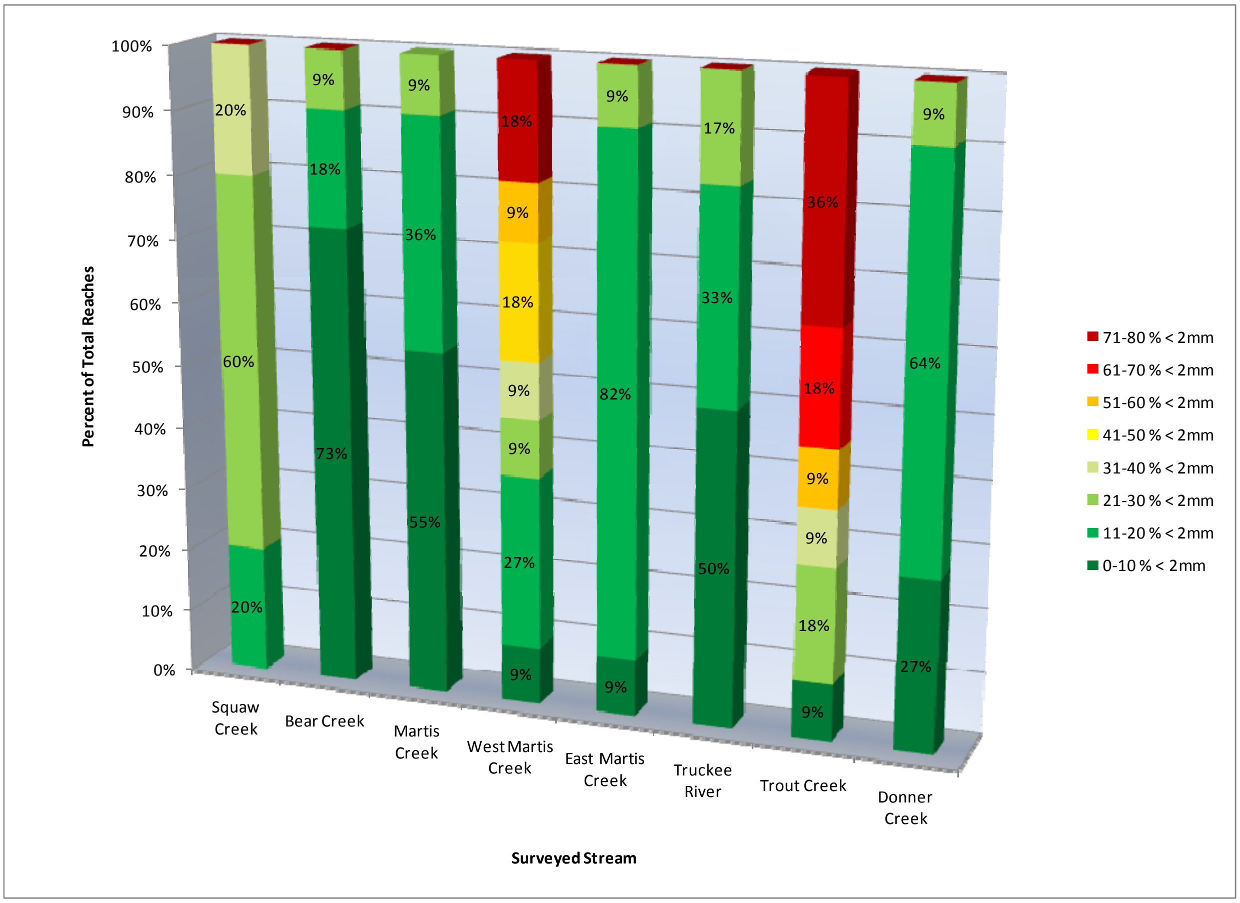


Figure 5-1
Summary of RAM Results

Table 5-1. Comparison of 2010 vs. 2012 Results

Stream Name	No. of Reaches with Increases	No. of Reaches with Decreases	Average Percent Change
Squaw Creek	4	1	7.2
Bear Creek	3	8	-2.7
Martis Creek	1	10	-10.2
West Martis Creek	7	4	10.0
East Martis Creek	4	7	-7.2
Donner Creek	1	10	-7.5
Trout Creek	5	6	0.0
Truckee River	6	5	-2.1

The subsections below discuss RAM results for each surveyed stream segment in detail. The discussions are organized to include the WY 2012 RAM results, a temporal analysis to compare the WY 2010 versus WY 2012 results and a stream gradient analysis to explore potential correlations with sediment deposition areas.

The RAM results for WY 2012 are presented in maps showing the locations of reaches and their fine sediment classifications. The results of the temporal analysis are also shown on the maps. For the gradient analysis, a USGS Digital Elevation Model (DEM) was used to estimate stream gradient. The resolution of the DEM is 1/3 arc second (10 meters), and it is not highly accurate for calculating small differences in slope. A single plot was developed for each stream to illustrate the average gradient and the percentage of fine sediment substrate in each reach for both 2010 and 2012. As expected, the results generally show that fine substrate increases as the stream gradient decreases; however, there are some exceptions. The photographs in Figures 5-2 and 5-3 provide examples of typical channel substrate conditions in higher and lower gradient reaches. Another major factor that influences fine sediment deposition is the existence of beaver dams.

Figure 5-2. Upper West Martis Creek: Example of Low Percentage Fine Sediment Substrate

Figure 5-3. Martis Creek: Example of High Percentage Fine Sediment Substrate

Squaw Creek

The gradient analysis for does not clearly indicate a consistent correlation between gradient and the amount of fine substrate. Figure 5-4 shows that in WY 2010 fine substrate generally increased as the gradient decreased but in WY 2012 the deposition patterns did not follow this trend.

In WY 2012, all reaches within the surveyed segment of Squaw Creek contained 11 to 40 percent fine substrate with an average value of 25 percent. Almost all of the fine substrate was classified as sand rather than fines. The stream segment contains a large number of cobbles with a median diameter of 96mm. The percentage of fine substrate increased in all reaches except for the reach farthest downstream. The amount of fine substrate in Reach 4 increased by 22 percent even though this reach has the steepest gradient. These results are presented graphically in Figure 5-5 below.

After the 2010 RAM surveys, a very large winter, and spring runoff event, occurred which could explain the consistent increase in fine sediment throughout the stream segment. The land adjacent to the monitored segment of Squaw Creek consists of natural forested areas with some private residences. The upstream watershed consists of steep slopes with a large ski resort and high traffic roadways, commercial and residential land uses also exist. Each of these conditions contributes a portion of the fine sediment that is present in the Squaw Creek channel.

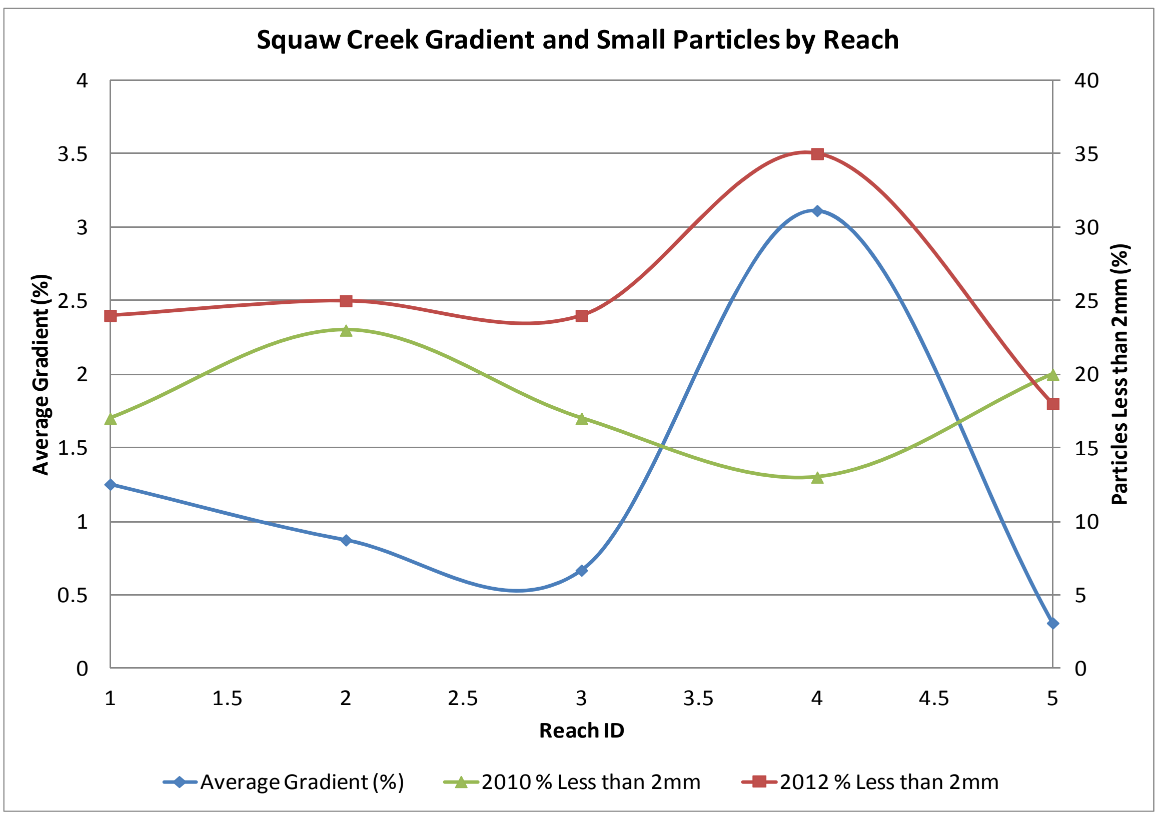
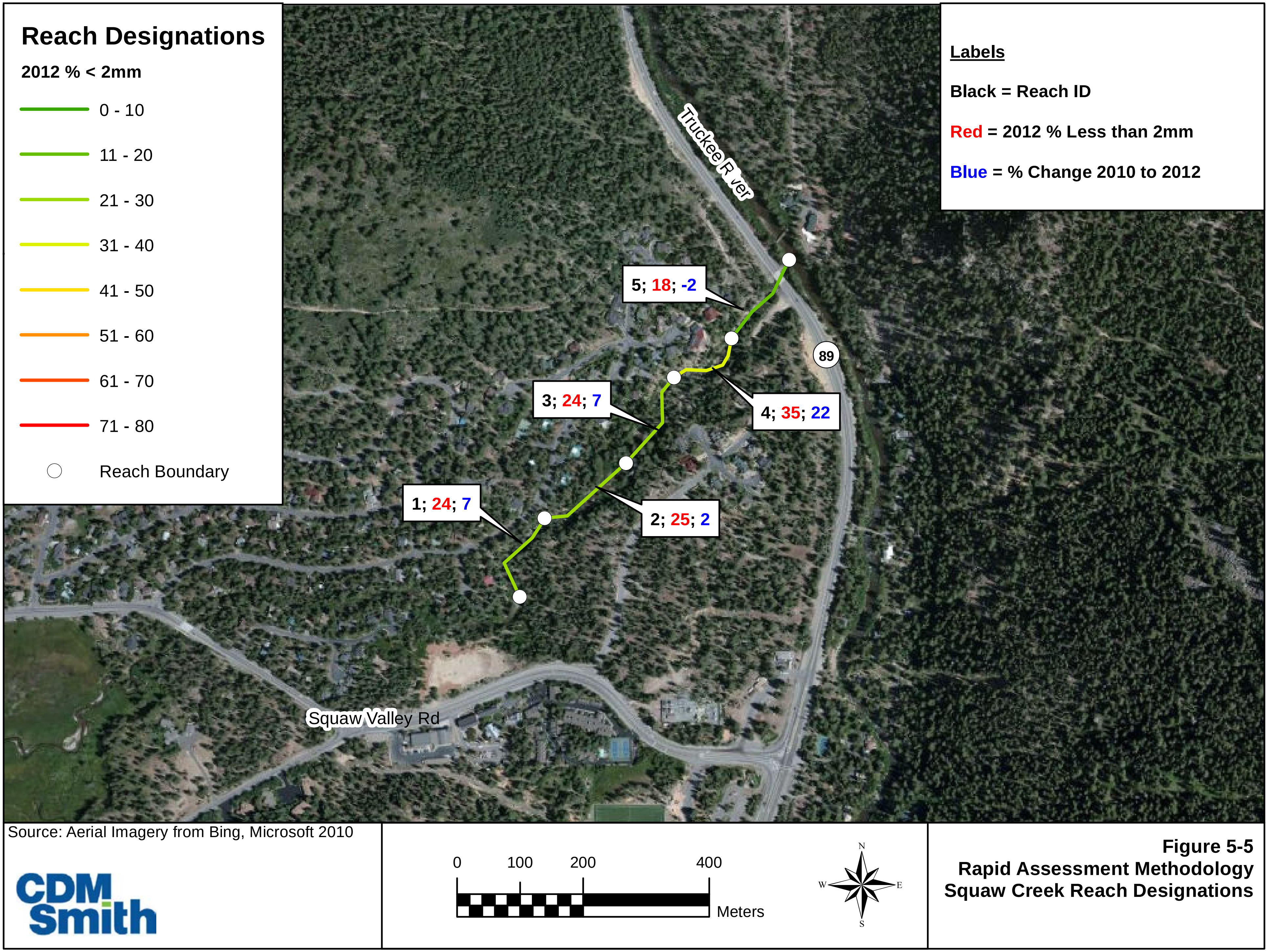


Figure 5-4
Squaw Creek Gradient vs. Fine Sediment



Source: Aerial Imagery from Bing, Microsoft 2010

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Figure 5-5
Rapid Assessment Methodology
Squaw Creek Reach Designations

Bear Creek

The stream gradient analysis at Bear Creek for WY 2010 and WY 2012 in Figure 5-6 was affected by beaver dams which slow flows and provide additional opportunity for sedimentation. The largest percentages of fine sediment occurred in the lower gradient reaches and in ponded areas behind the beaver dams.

In WY 2012, all reaches of Bear Creek contained between 0 and 30 percent fine substrate with an average value of 9 percent. This was the lowest value observed for all streams monitored in WY 2012. Six percent of this substrate was classified as sand and 2 percent was classified as fines. The surveyed portion of the stream contains a high percentage of cobbles, and the median diameter particle size was 89mm. The amount of fine substrate varied on reach by reach basis; however, the overall amount of remained fairly consistent from WY 2010 to WY 2012. This is attributed to the existence of beaver dams in the creek. Reaches with large increases in fine substrate were observed to have beaver dams in WY 2012 where none existed in WY 2010. For the largest decreases, beaver dams existed in WY 2010 that were no longer present in WY 2012. These results are presented graphically in Figure 5-7 below.

The land adjacent to the monitored segment of Bear Creek consists of forested areas that generally provide a good buffer from nearby roadways. The upstream watershed consists of steep hillsides with a large ski resort and residential development both of which contribute excess sediment to this stream.

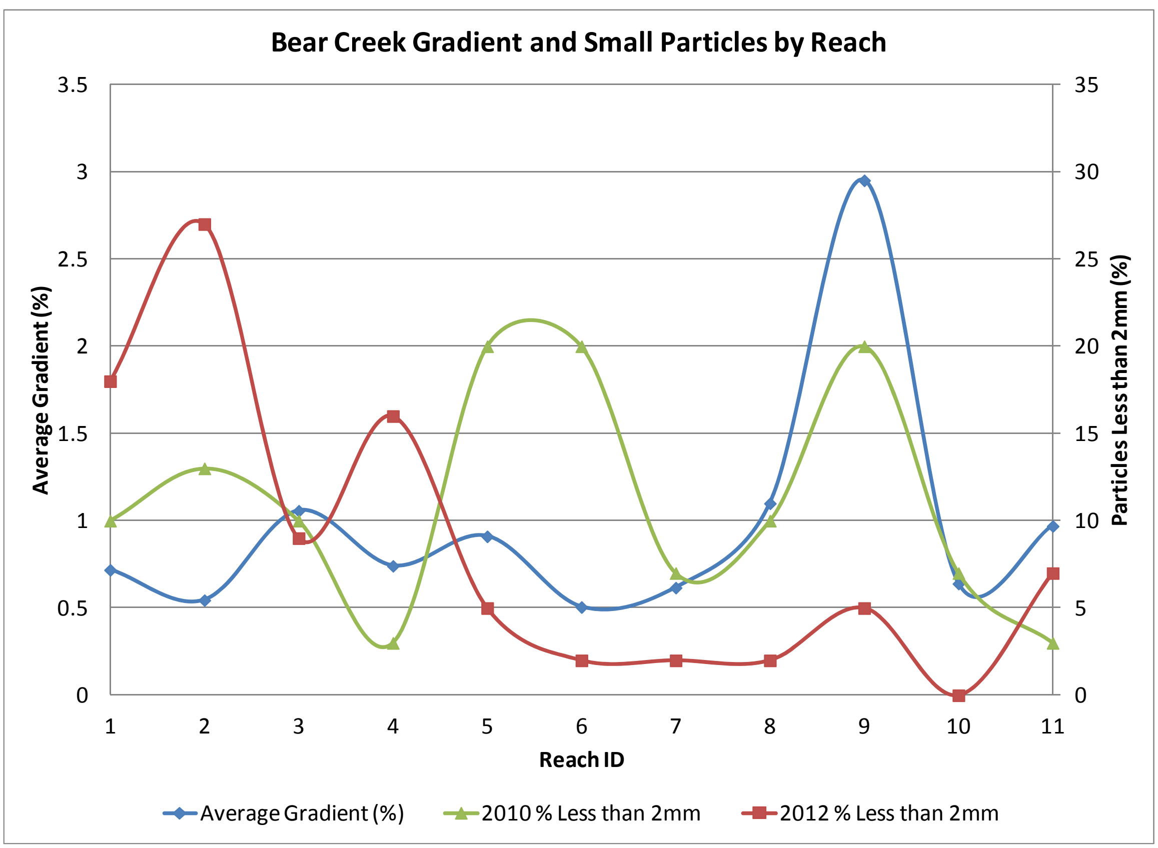
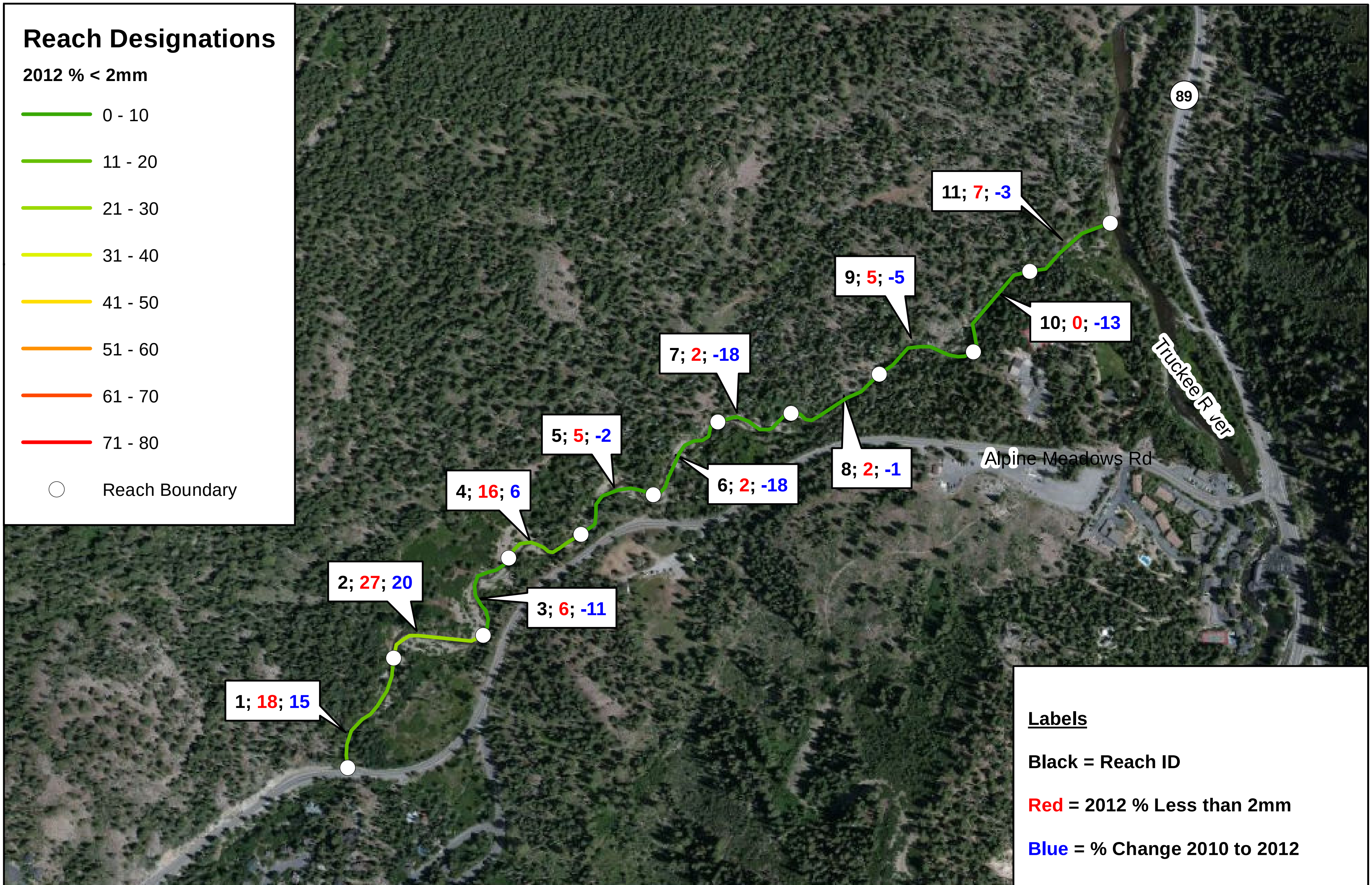


Figure 5-6
Bear Creek Gradient vs. Fine Sediment



Source: Aerial Imagery from Bing, Microsoft 2010

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0 100 200 400 Meters

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Figure 5-7
Rapid Assessment Methodology
Bear Creek Reach Designations

Martis Creek Main Stem

The stream gradient analysis at Martis Creek for WY 2010 and WY 2012 in Figure 5-8 was affected by beaver dams which slow flows and increase time for sedimentation. The reach with the highest percentage of fine substrate was located at the downstream end of the monitoring segment where the slope increases but a beaver dam exists downstream.

In WY 2012, all reaches of the main stem of Martis Creek were categorized as having 0 to 30 percent fine substrate with an average value of 12 percent. Four percent of this substrate was classified as sand and 8 percent was classified as fines. The surveyed portion of the stream contains a low percentage of cobbles, and the median diameter particle size was 35mm. The amount of fine substrate decreased substantially from WY 2010 to WY 2012. This could be attributed to the large spring runoff in 2011 which may have caused scouring and transportation of fine substrate downstream. The section of stream monitored during the RAM was relatively flat with a longitudinal slope ranging from near 0 to 0.7 percent. These results are presented graphically in Figure 5-9 below.

The land adjacent to the monitored segment of Martis Creek consists of a large meadow and public use trails (non-motorized). The upstream watershed consists of moderately steep hillsides and contains a portion of the Northstar Ski Resort. The upper portions of the creek pass through a large area of undeveloped forest land before reaching the Martis Camp and Lahontan residential communities. The monitored segment of Martis Creek lies in Martis Valley downstream of these communities and their incorporated golf courses.

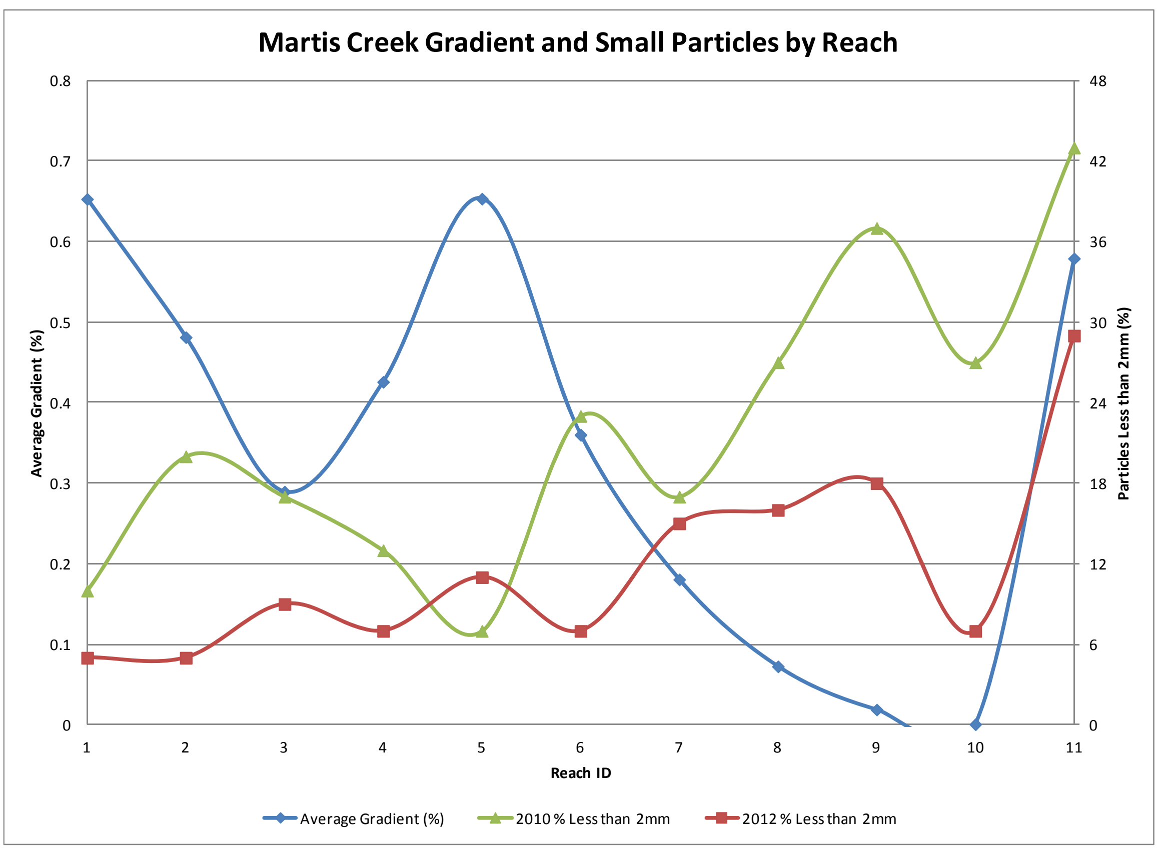
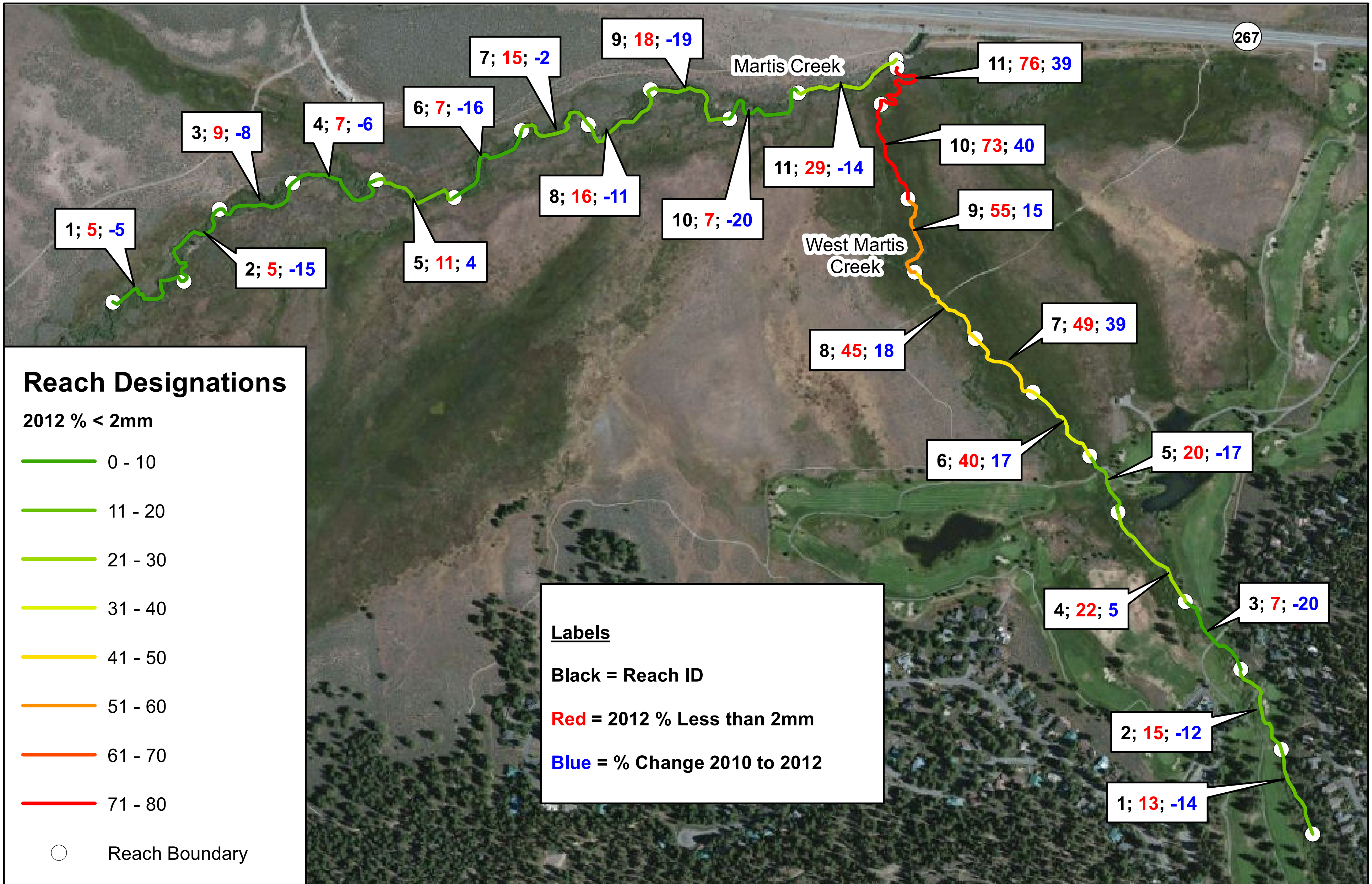


Figure 5-8
Martis Creek Gradient vs. Fine Sediment



Source: Aerial Imagery from Bing, Microsoft 2010

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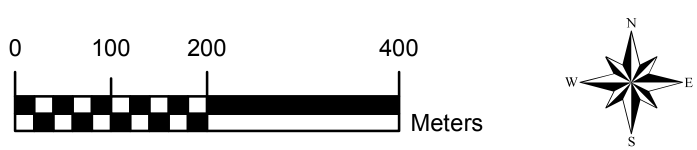


Figure 5-9
Rapid Assessment Methodology
Martis Creek and West Martis
Creek Reach Designations

West Martis Creek

The gradient analysis for West Martis Creek shown in Figure 5-10 clearly shows the relationship between and fine sediment deposition and the channel gradient with the amount of fine substrate increasing as slope decreases. The pattern is more pronounced in WY 2012 and may also be partially attributed to a beaver dam that was recently established downstream of the surveyed segment.

In WY 2012, the West Martis Creek RAM Segment contained between 0 and 80 percent fine substrate (82 percent). West Martis Creek had the second highest average percentage of fine substrate during WY 2012 at 38 percent. Thirteen percent of this substrate was classified as sand and 25 percent was classified as fines. The surveyed portion of the stream contains a low percentage of cobbles at its lower end in the meadow, and a moderate amount of cobbles in the upper extent outside the meadow. The median diameter particle size was 26mm. The amount of fine sediment in WY 2012 decreased in the upper reaches where stream gradient was greatest and increased in the lower meadow reaches. It is possible that fine substrate from the upper reaches was flushed downstream during the large WY 2011 but it is not clear why new sediment loads from upstream did not replace it. These results are presented graphically in Figure 5-9 above.

The land adjacent to the monitored segment of Martis Creek consists of a natural meadow, public use trails, a golf course, and residential development. The upstream watershed consists of moderately steep hillsides and a large portion of the Northstar Ski Resort. Commercial, residential, and golf course land uses also exist in the upper watershed. A comparison of RAM results between other surveyed Martis Creek segments and West Martis Creek indicates that the highly developed watershed of West Martis Creek is likely contributing to the elevated amount of fine substrate observed in the channel.

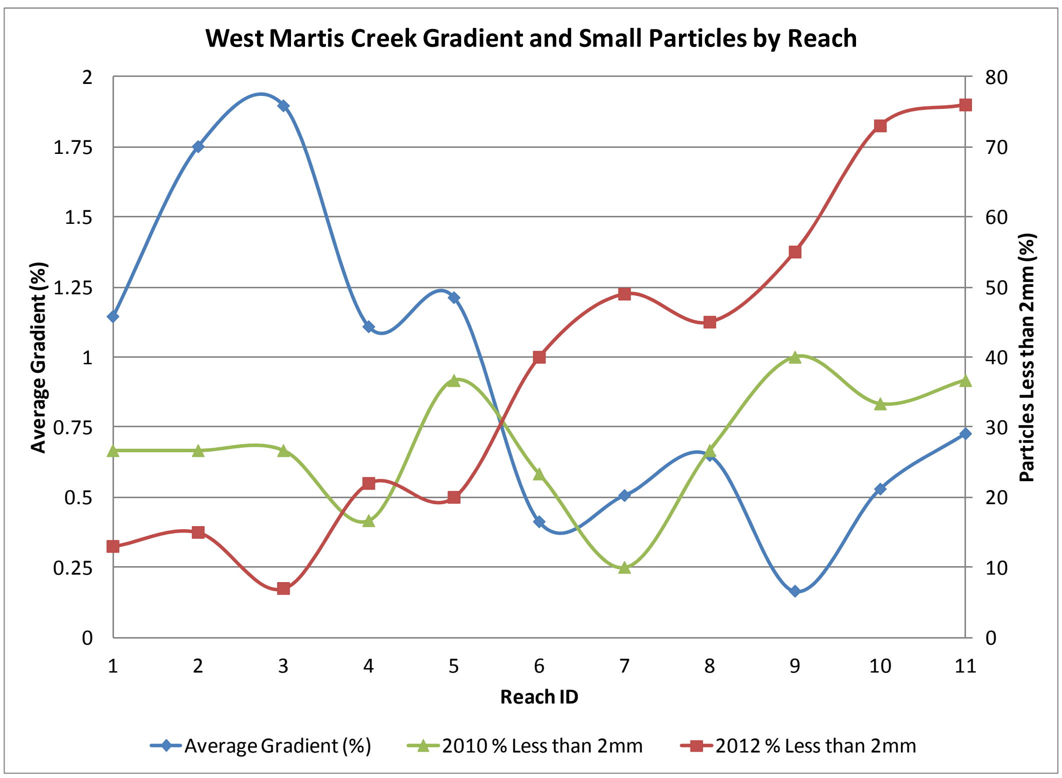


Figure 5-10
West Martis Creek Gradient vs. Fine Sediment

East Martis Creek

The stream gradient analysis for East Martis Creek, illustrated in Figure 5-11, shows some correlation between fine deposition and channel gradient but the pattern is not as clear as in other surveyed streams.

In WY 2012, all reaches of East Martis Creek were categorized as having 0 to 30 percent fine substrate with an average value of 16 percent. Five percent of this substrate was classified as sand and 11 percent was classified as fines. The surveyed portion of the stream contains a low percentage of cobbles at its lower end in the meadow, and a moderate amount of cobbles in the upper extent outside the meadow. The median diameter particle size was 39mm. The amount of fine substrate was fairly consistent between WY 2010 and WY 2012 but there was an overall decrease of 7 percent. The greatest change was in Reach 11 where previously deposited lake sediments may have been flushed downstream by the large WY 2011 runoff events. These results are presented graphically in Figure 5-12 below.

The land adjacent to the monitored segment of Martis Creek consists of a natural meadow, public use trails and unpaved roads. The upstream watershed is moderately steep with undeveloped forested hillsides and some existing dirt roads.

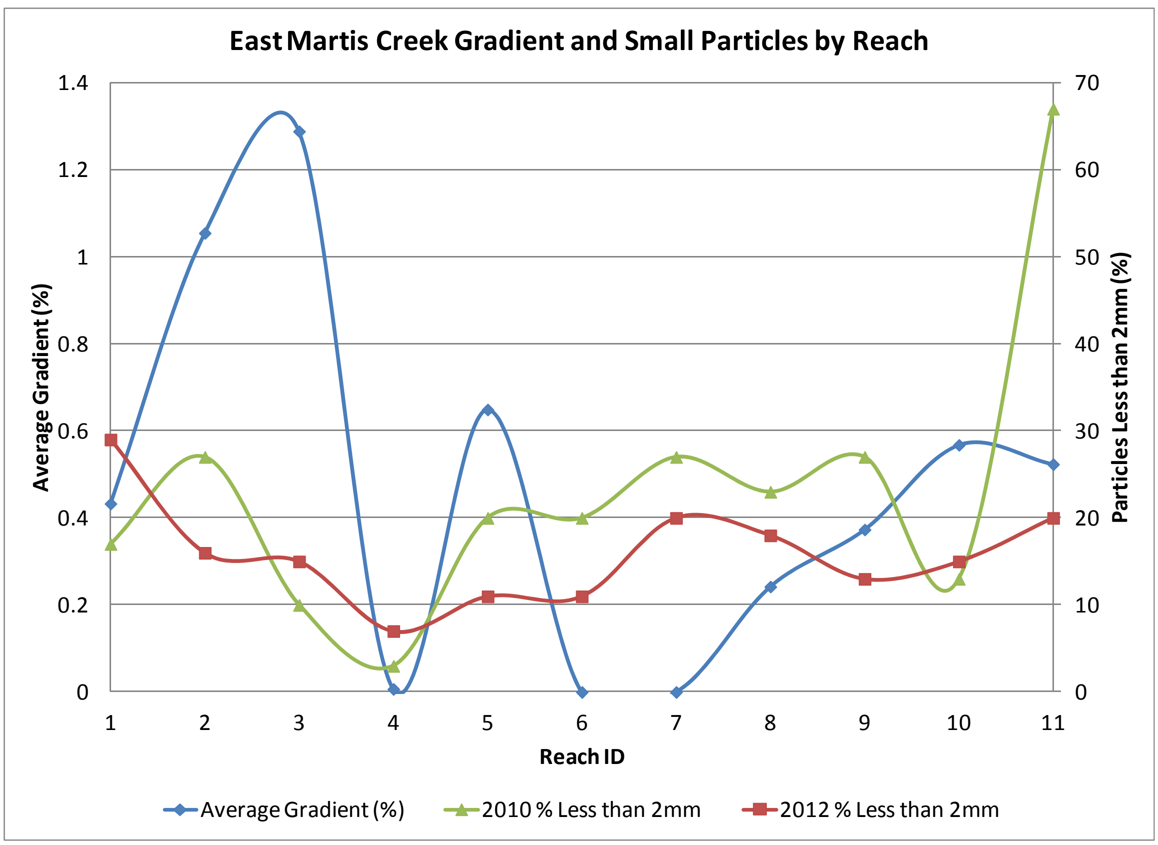
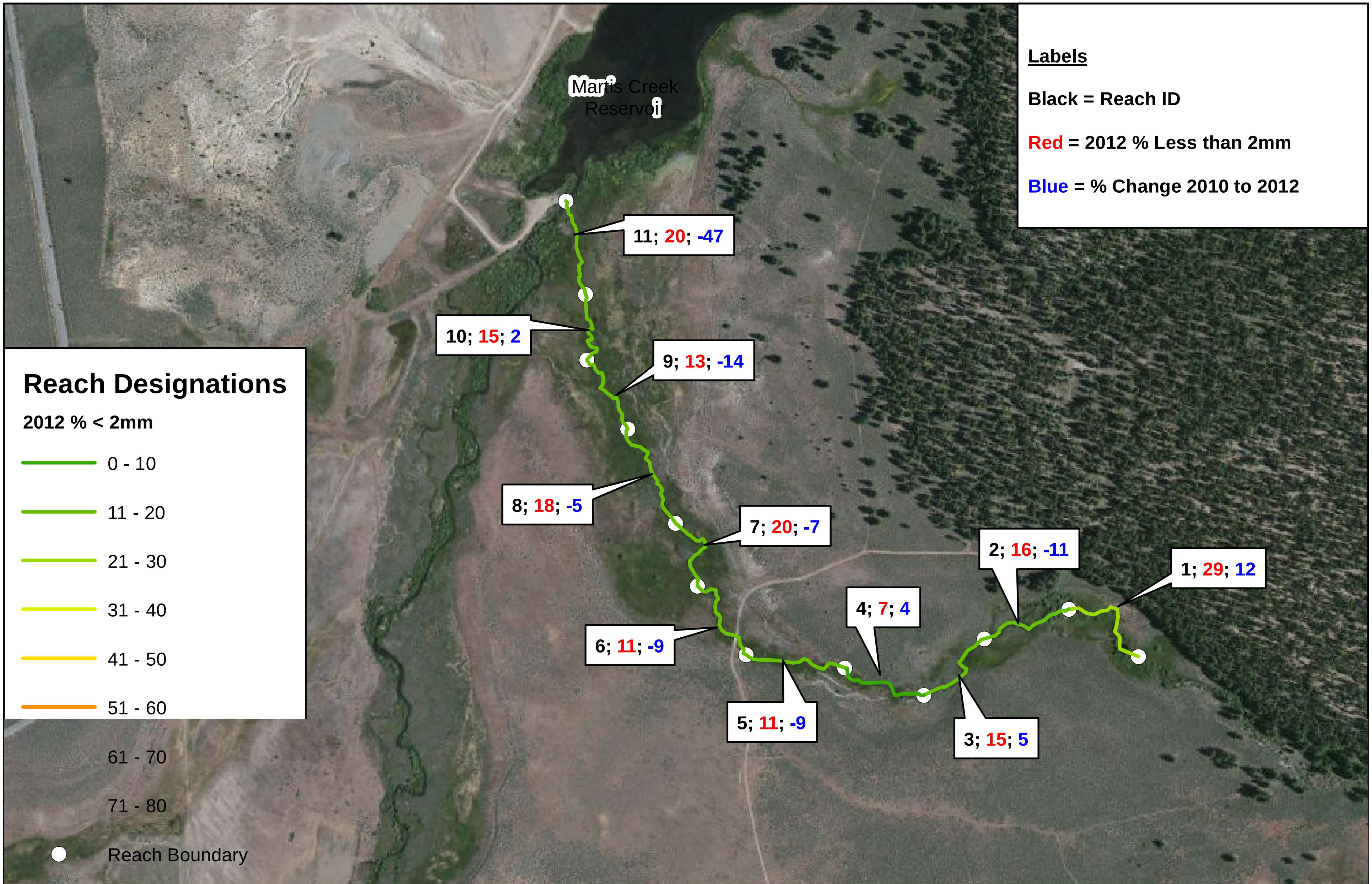


Figure 5-11
East Martis Creek Gradient vs. Fine Sediment



Source: Aerial Imagery from Bing, Microsoft 2010

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Meters

Figure 5-12
Rapid Assessment Methodology
East Martis Creek Reach Designations

Donner Creek

The stream gradient analysis at Donner Creek for WY 2010 and WY 2012 in Figure 5-13 illustrates the limitations in the available topographic data. This data indicates that Reaches 4-7 have a zero percent gradient while it is known that this is not the case. Fine sediment deposition patterns do not appear to have a strong correlation with gradient in this case.

In WY 2012, all reaches of Donner Creek were categorized as having 0 to 30 percent fine substrate with an average value of 13 percent. Six percent of this substrate was classified as sand and 7 percent was classified as fines. The surveyed portion of the stream contains a high percentage of cobbles, and the median diameter particle size was 117mm. The amount of fine substrate decreased between WY 2010 and WY 2012 in all but one reach with an average decrease of 8 percent. These results are presented graphically in Figure 5-14 below.

The land adjacent to the monitored segment of Donner Creek includes primary roadways, a railroad, commercial and residential areas. Flows in the monitored portion of Donner Creek are combined discharges from Donner Lake (regulated) and Coldstream Creek (unregulated). The upstream watershed below Donner Lake is relatively flat along Interstate 80. The Coldstream Creek watershed is steep and consists of undeveloped forested hillsides with some existing dirt roads, a railroad, and legacy mining impacts.

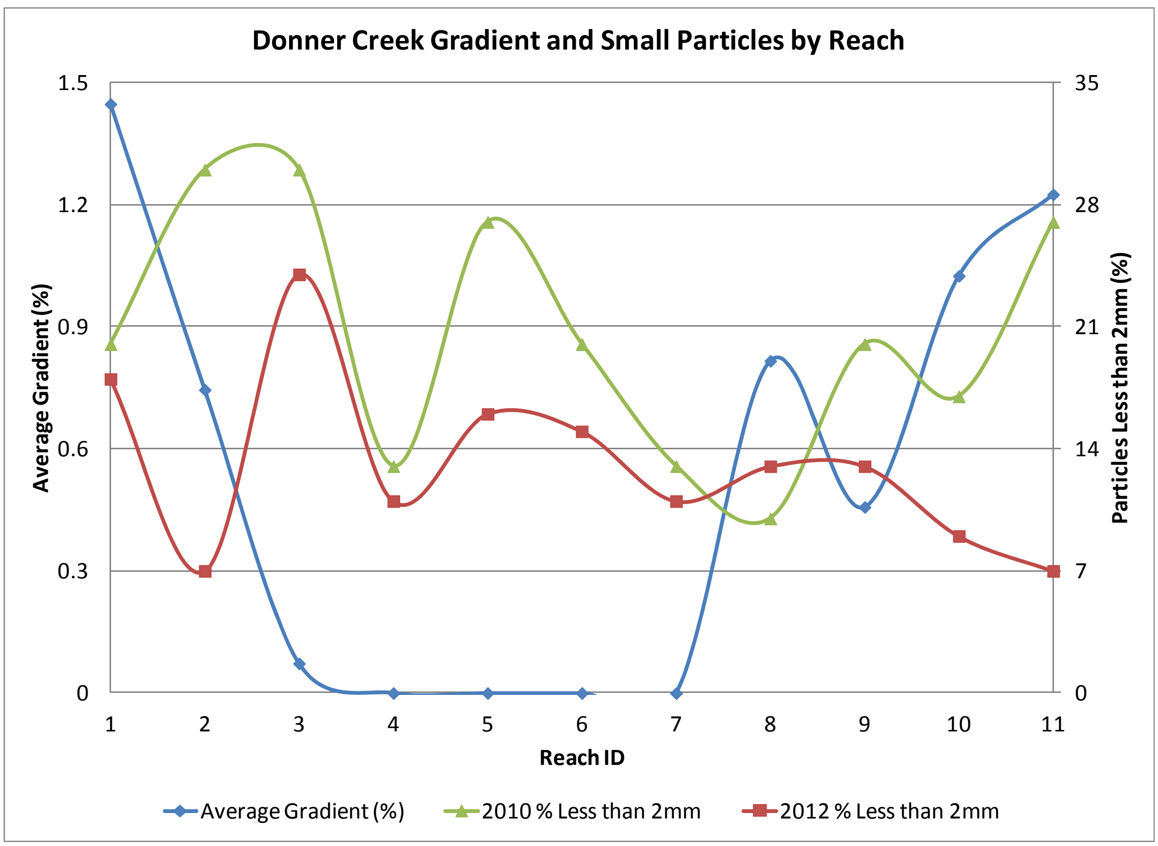
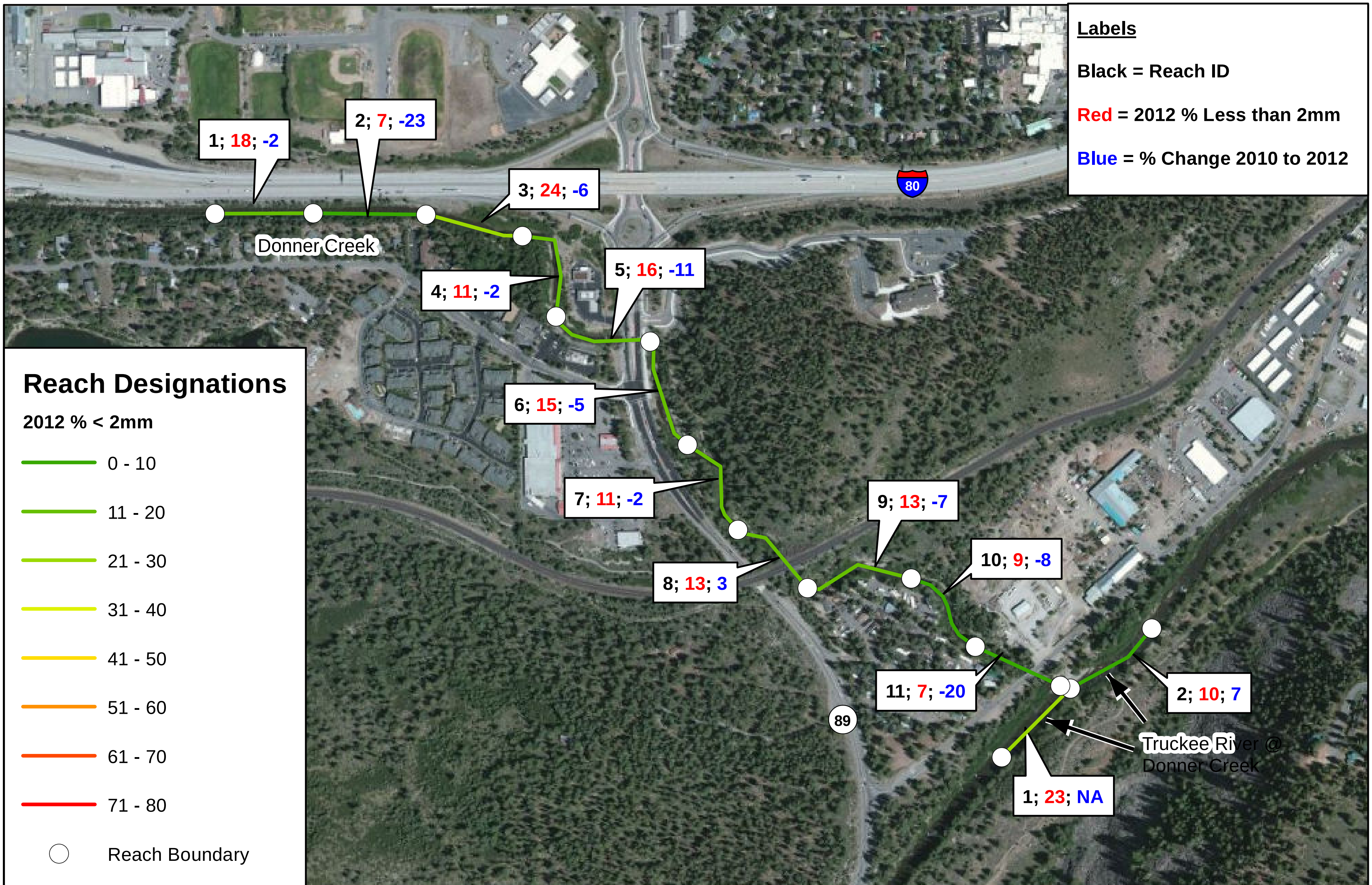


Figure 5-13
Donner Creek Gradient vs. Fine Sediment



Source: Aerial Imagery from Bing, Microsoft 2010

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Figure 5-14
Rapid Assessment Methodology
Donner Creek and Truckee River
at Donner Creek Reach Designations

Trout Creek

The stream gradient analysis at Trout Creek for WY 2010 and WY 2012 presented in Figure 5-15 illustrates that the amount of fine substrate in this creek increases as stream gradient decreases. This figure also shows the consistency in results from WY 2010 to WY 2012. Beaver dams throughout the surveyed segment also influence deposition patterns.

In WY 2012, approximately 60 percent of the surveyed reaches in Trout Creek were categorized as having 51 to 80 percent fine substrate with an average value of 52 percent. This was the highest value observed during WY 2012. Five percent of this substrate was classified as sand and 47 percent was classified as fines. The surveyed portion of the stream contains a low percentage of cobbles at its downstream end while the recently restored area in the upper reaches contain a moderate amount of cobbles and the median diameter particle size was 53mm. The amount of fine substrate in Trout Creek remained fairly consistent from WY 2010 to WY 2012 but decreased in Reaches 2-3 in the restored portion of the channel. These results are presented graphically in Figure 5-16 below.

The land adjacent to the monitored segment of Trout Creek consists of industrial and commercial areas, primary roadways and a railroad. The upstream watershed is moderately steep and consists of a large residential community and incorporated golf courses. Due to the amount of fine substrate in the upper restored, it appears that development and activities upstream are a significant source of fine sediment to Trout Creek.

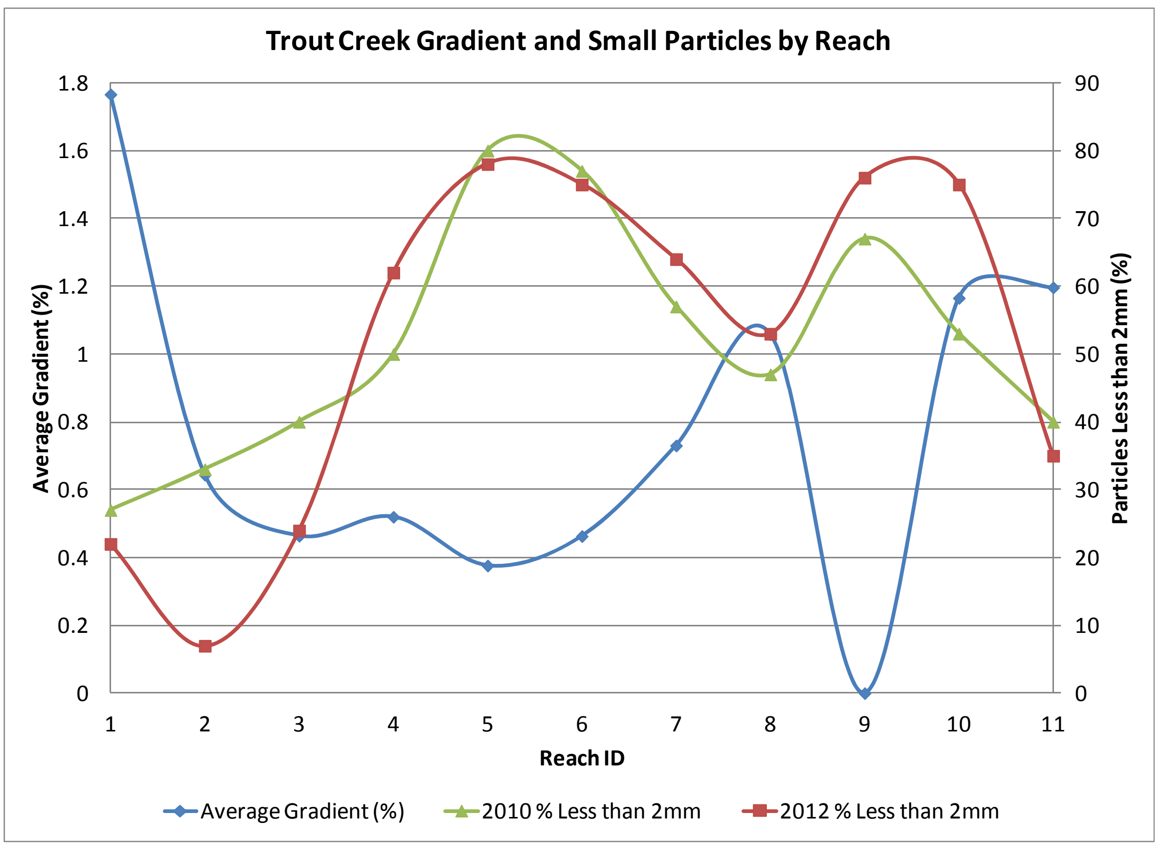
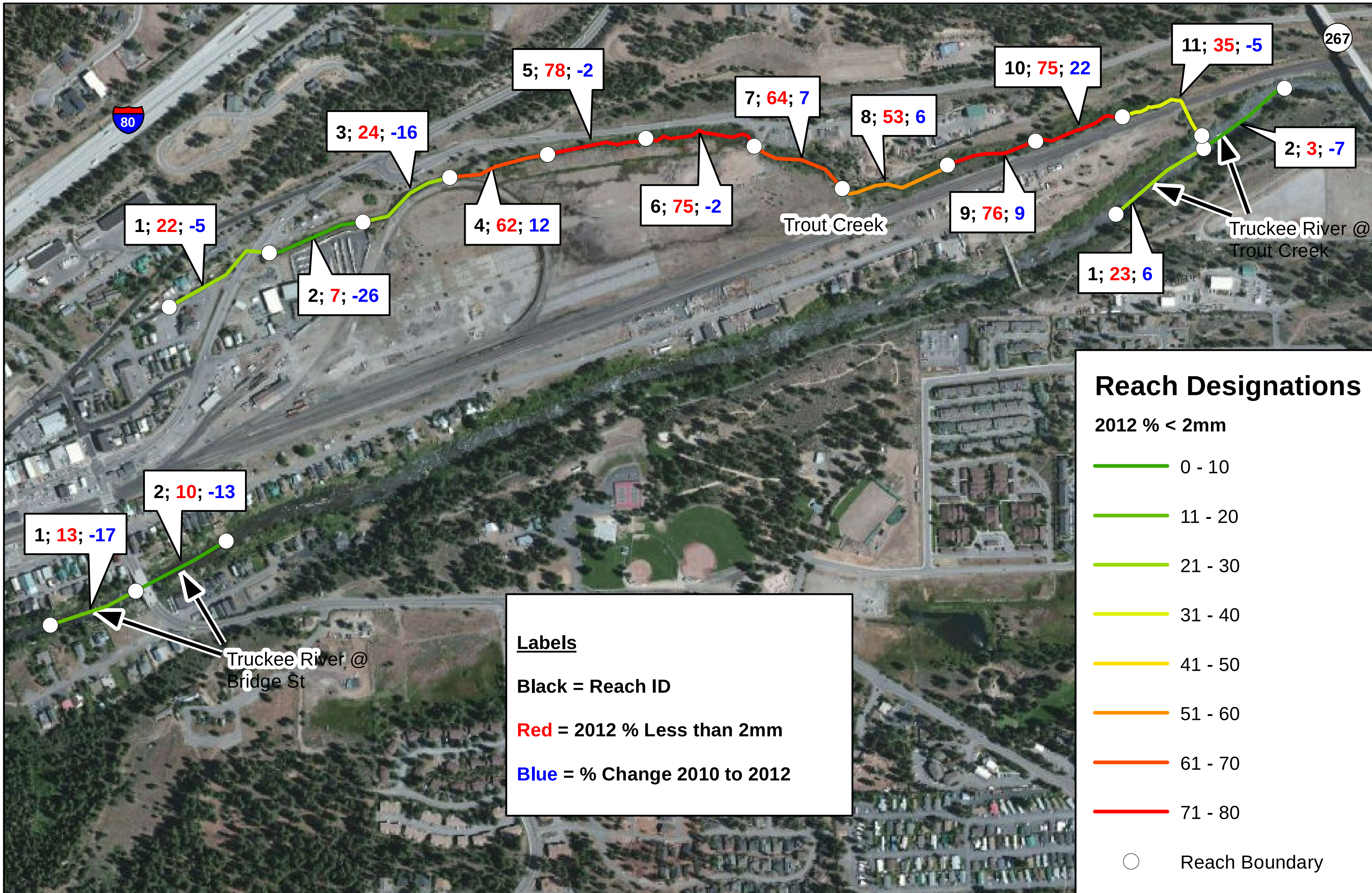


Figure 5-15
Trout Creek Gradient vs. Fine Sediment



Source: Aerial Imagery from Bing, Microsoft 2010

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Figure 5-16
Rapid Assessment Methodology
Trout Creek and Truckee River
Reach Designations

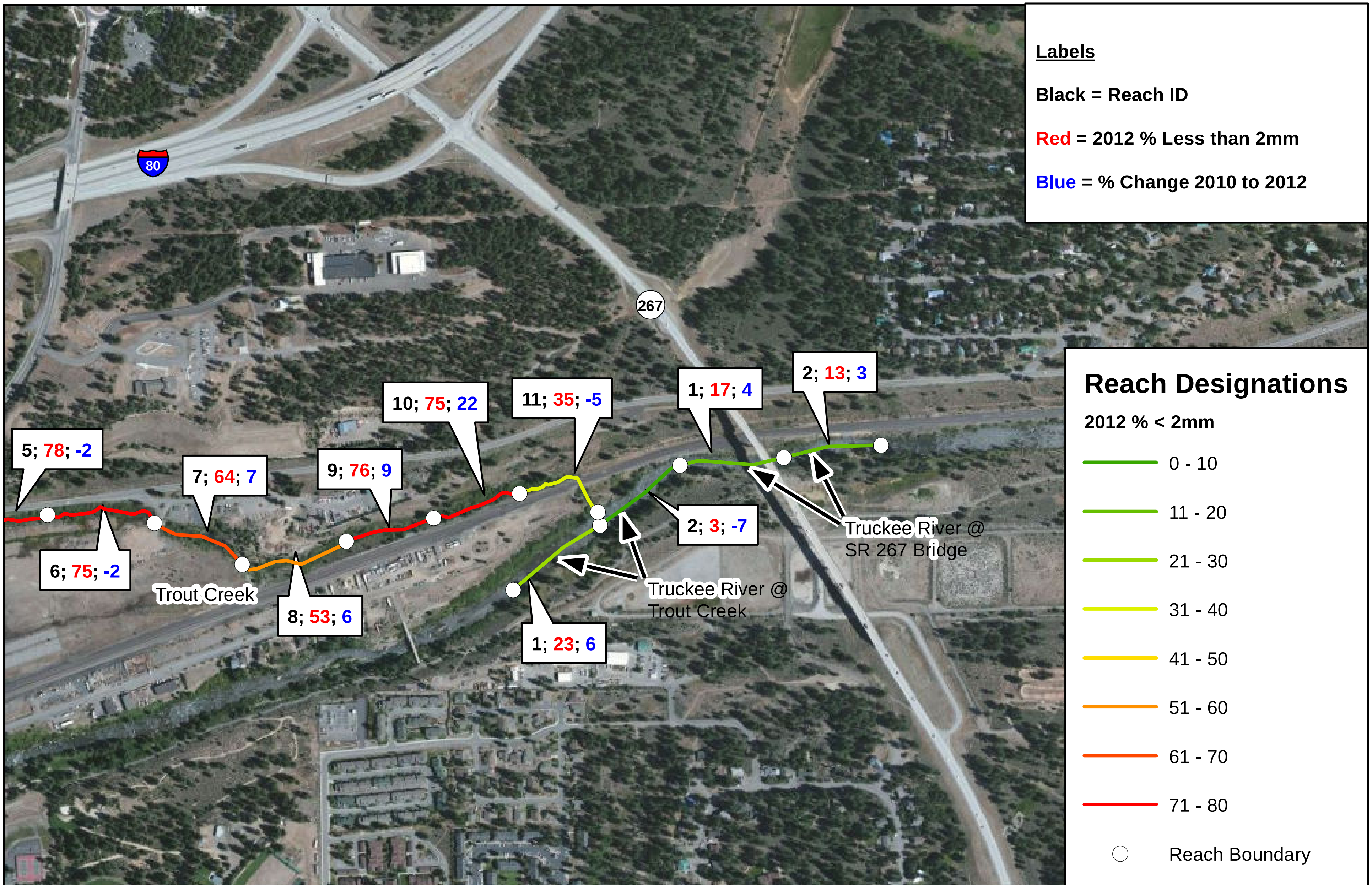
Truckee River

The stream gradient analysis for the Truckee River generally shows that the fine substrate decreases as stream gradient increases; however, due to the length of the surveyed segment and differences between the survey locations between 2010 and 2012, the data is too complex to graph effectively.

In WY 2012, all of the reaches surveyed in the Truckee River were categorized as having 0 to 30 percent fine substrate with an average value of 13 percent. All of this substrate was classified as sand with no fines observed. The surveyed portion of the river contains a high percentage of cobbles, and median diameter particle size was 195mm. The results indicate that all reaches had relatively low levels of fine substrate and that conditions remained fairly consistent from WY 2010 to WY 2012. Although monitoring efforts were focused on reaches directly upstream and downstream of key stream confluences and road crossings, no clear evidence exists regarding the impact these have on fine sediment in the river. It is likely that most of the fine substrate is transported downstream during periods of high discharge where it settles in locations that have flatter slopes and less energy. The results are presented graphically in Figures 5-14 and 5-16, above, and 5-17 and 5-18 below.

In addition to the reach based analysis, a more focused analysis was developed for the Truckee River in an attempt to identify areas of concern even though the average percent of fine substrate by reach is low. In this approach, both 2010 and 2012 RAM data was analyzed by examining the individual measurement locations to discern patterns of fine sediment deposition. The results indicate that most fine sediment is deposited along the edges of the stream channel, presumably due to the lower flow velocities that occur in these locations. Figures 5-19 through 5-24 illustrate these results, showing the locations where fine substrate was measured in WY 2010 and WY 2012. In the future, the RAM may be modified with more detailed surveys that focus on identified areas of concern.

The land uses adjacent to the monitored reaches of the Truckee River vary widely and include primary and secondary roadways, a railroad, industrial, commercial and residential areas and natural open space.



Source: Aerial Imagery from Bing, Microsoft 2010

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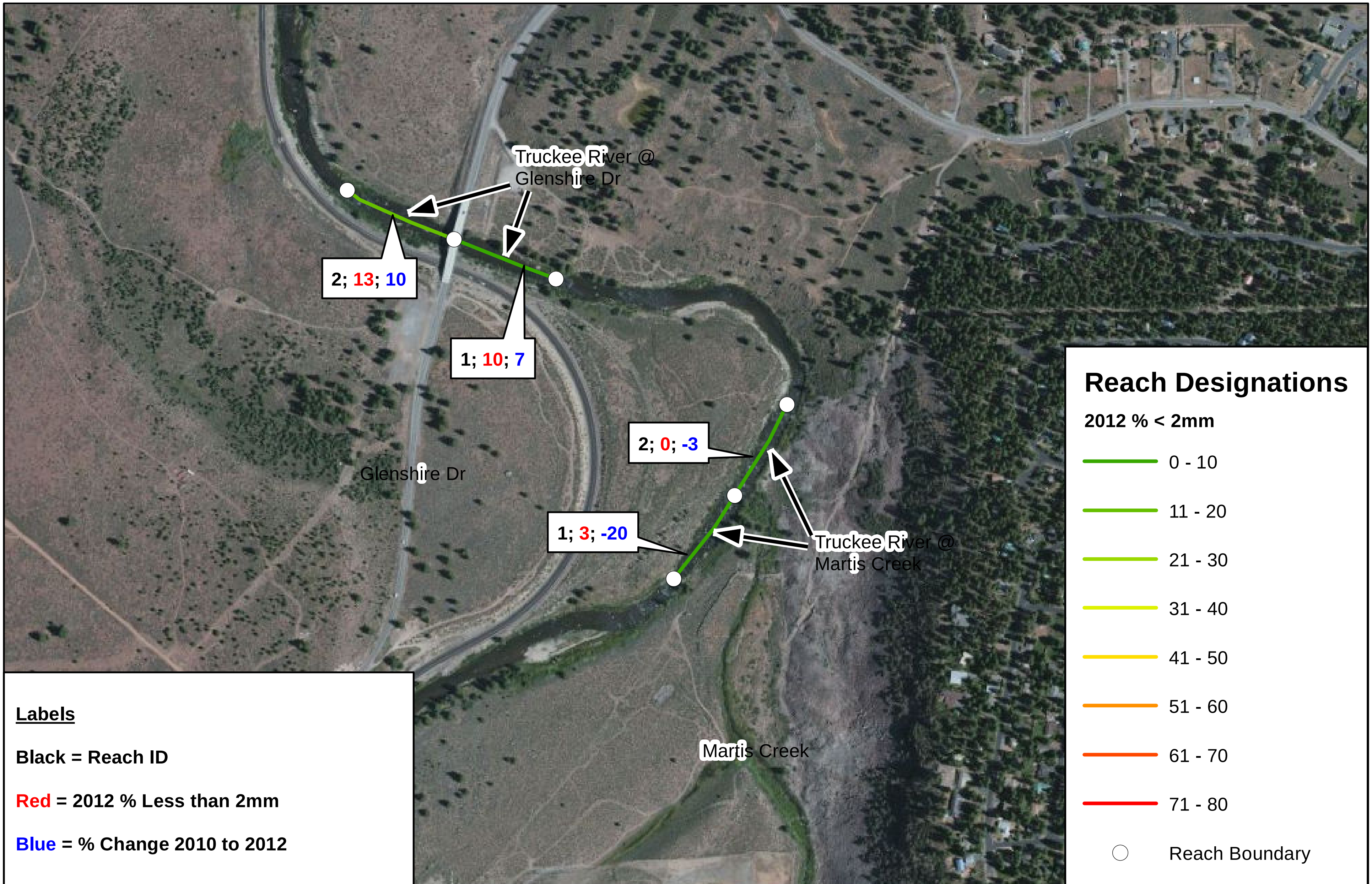
Figure 5-17
Rapid Assessment Methodology
Truckee River at Trout Creek and the SR 267 Bridge Reach Designations



Source: Aerial Imagery from Bing, Microsoft 2010

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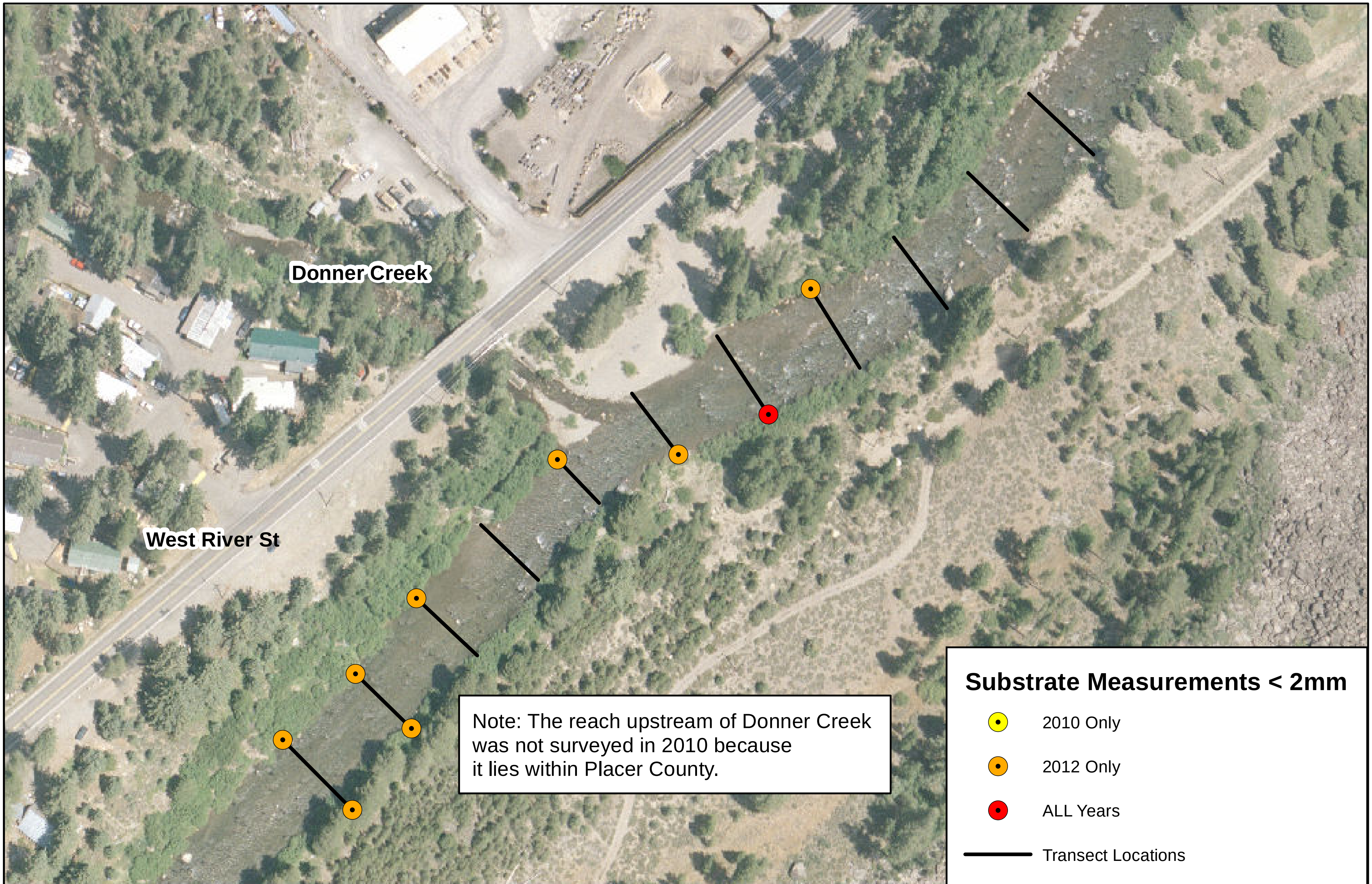
Figure 5-18
Rapid Assessment Methodology
Truckee River at Martis Creek and
Glenshire Dr Reach Designations



Source: Aerial photograph provided by Town of Truckee

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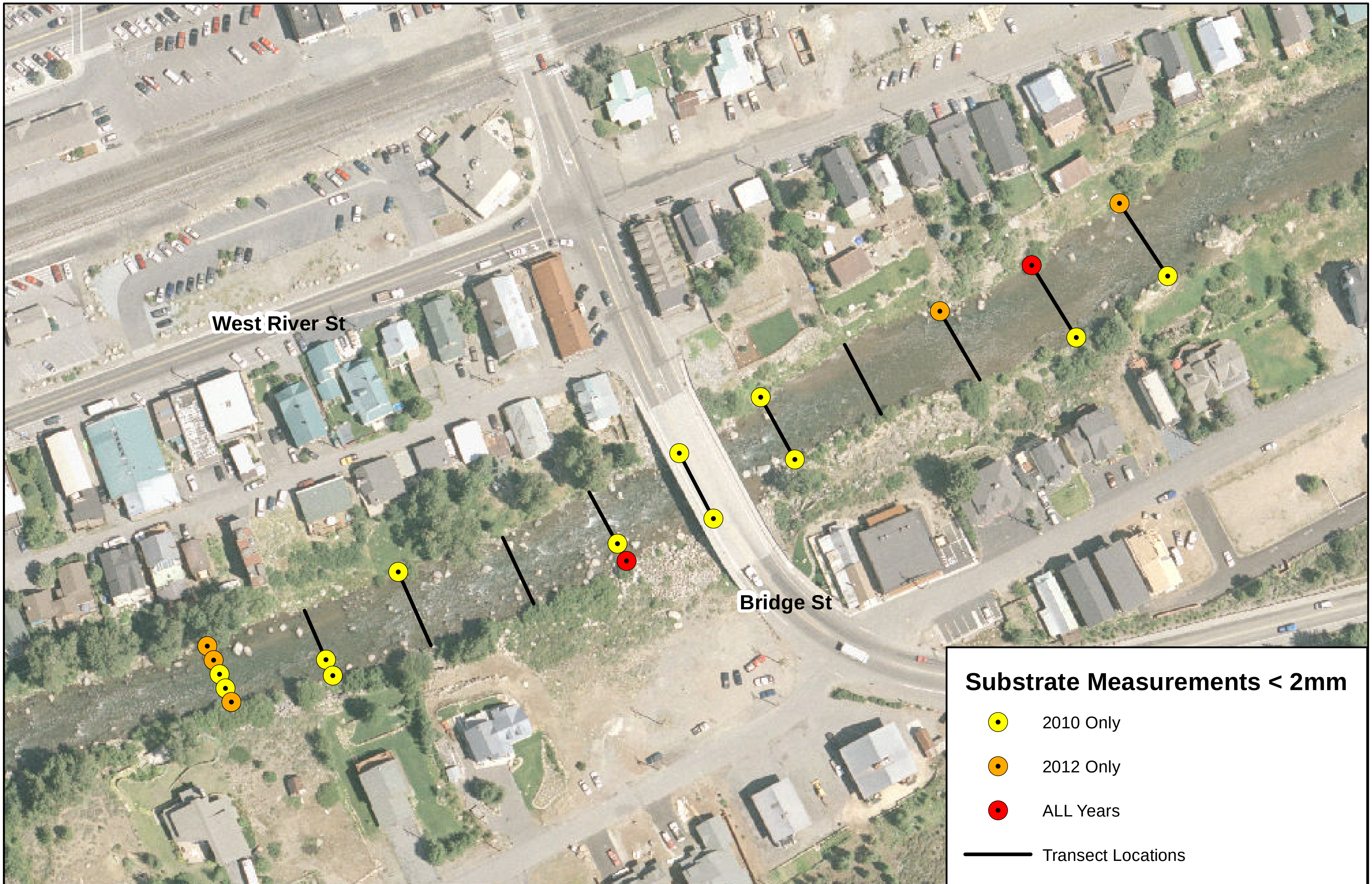
0 20 40 80 Meters

Figure 5-19
Rapid Assessment Methodology Measurements Less than 2mm
Truckee River at Donner Creek



Source: Aerial photograph provided by Town of Truckee

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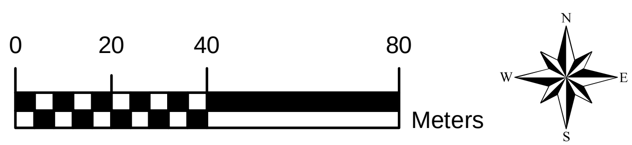
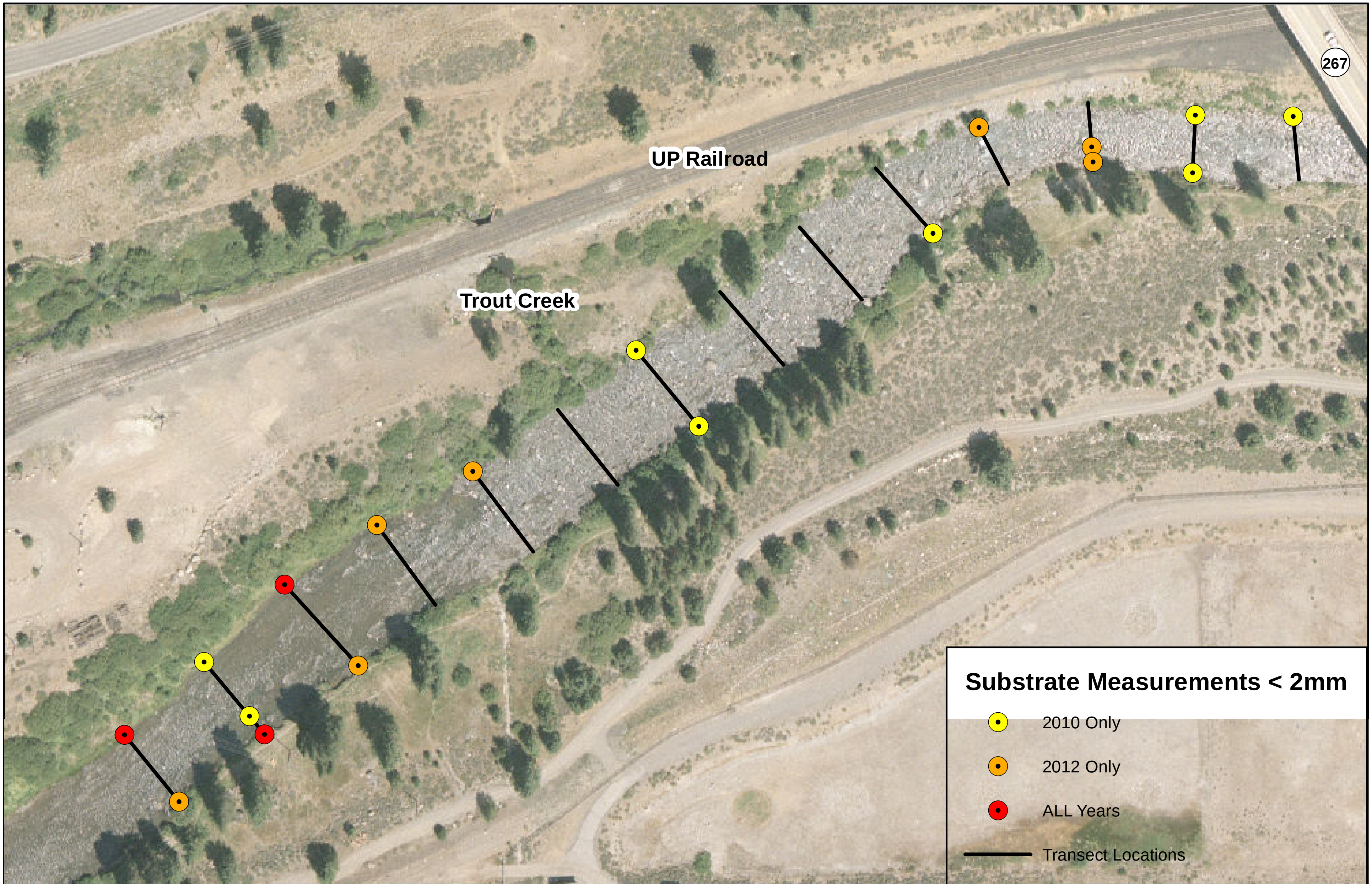


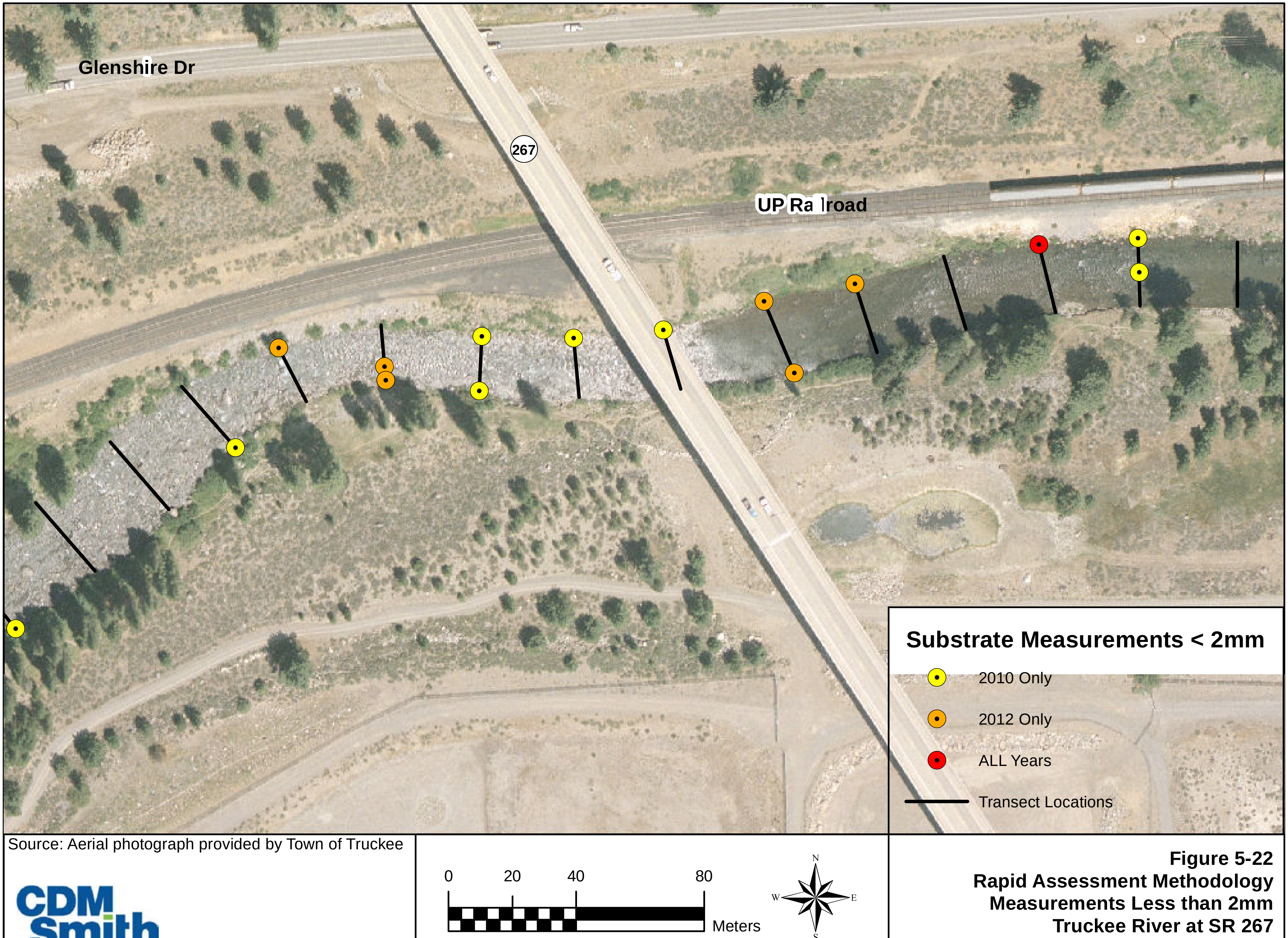
Figure 5-20
Rapid Assessment Methodology
Measurements Less than 2mm
Truckee River at Bridge Street



Source: Aerial photograph provided by Town of Truckee

CDM Smith

Figure 5-21
Rapid Assessment Methodology Measurements Less than 2mm Truckee River at Trout Creek



Source: Aerial photograph provided by Town of Truckee

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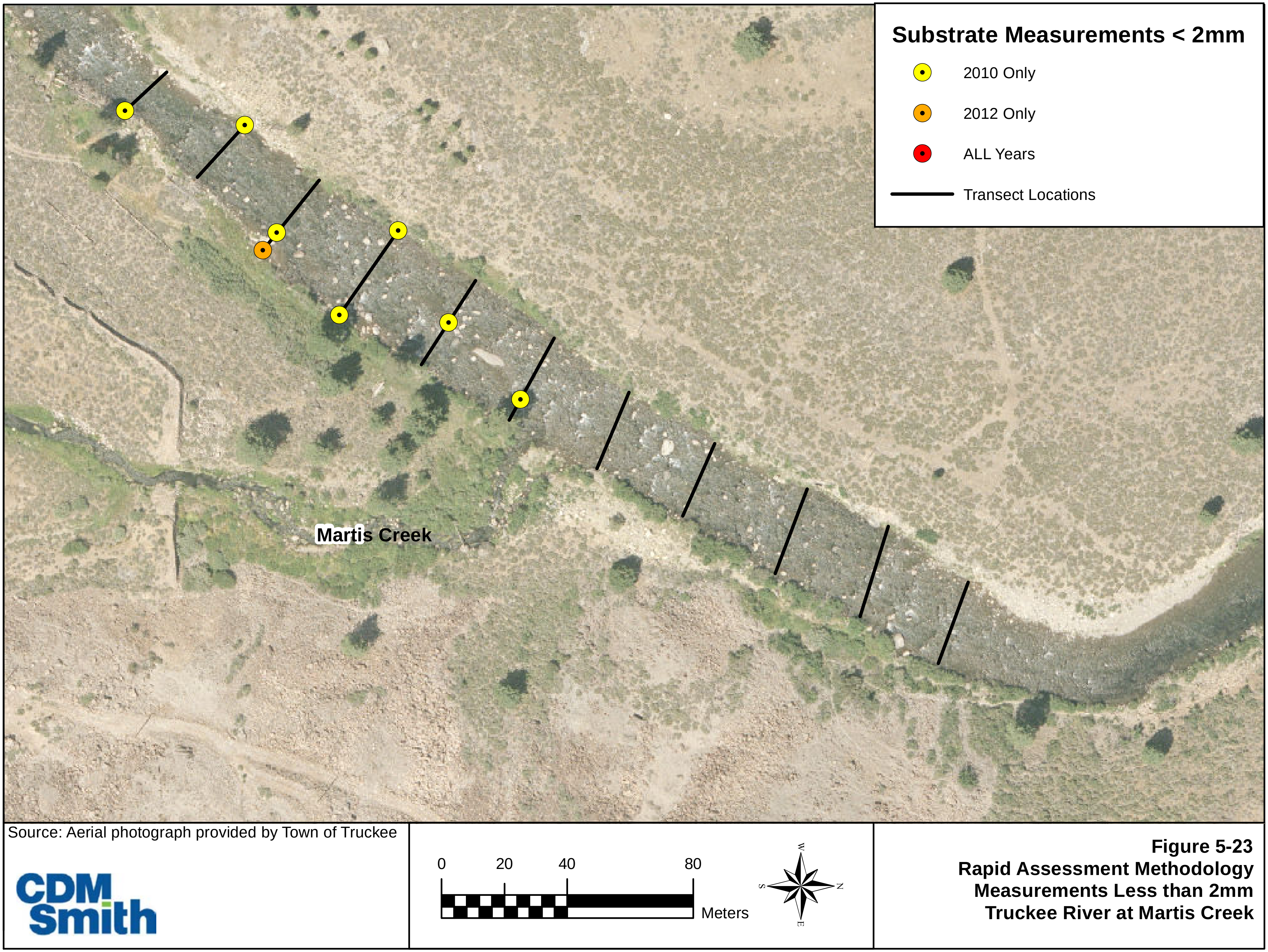
Figure 5-22
Rapid Assessment Methodology
Measurements Less than 2mm
Truckee River at SR 267



Source: Aerial photograph provided by Town of Truckee

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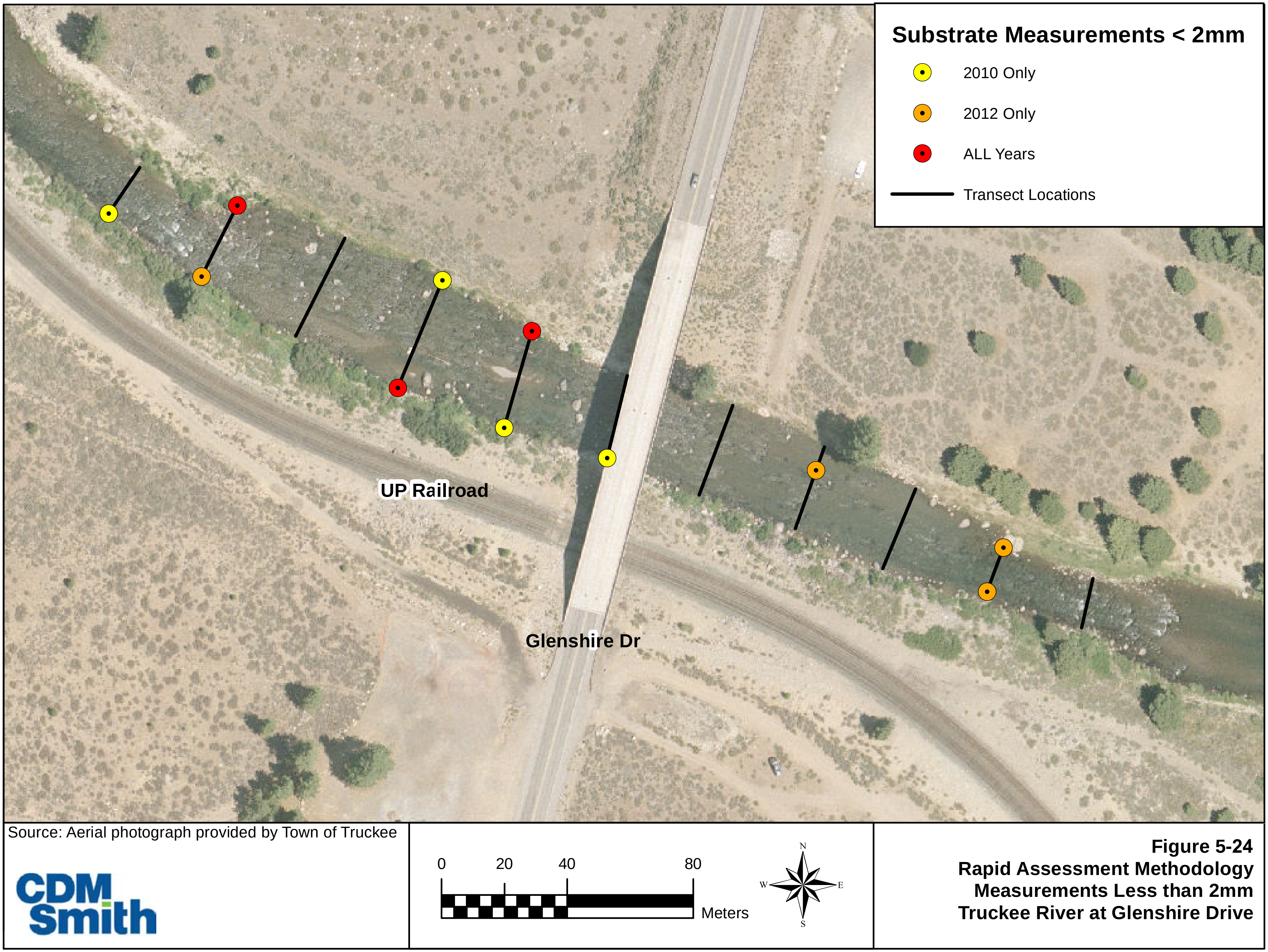
Figure 5-23
Rapid Assessment Methodology
Measurements Less than 2mm
Truckee River at Martis Creek



Source: Aerial photograph provided by Town of Truckee

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Figure 5-24
Rapid Assessment Methodology
Measurements Less than 2mm
Truckee River at Glenshire Drive

5.2 Bioassessments

Bioassessments were conducted in Squaw and Martis Creeks during the summer and fall of 2012. Squaw Creek surveys were completed in late July and Martis Creek surveys were completed in August and September. The bioassessment results are presented below beginning with a documentation of the monitoring locations.

5.2.1 Monitoring Site Locations

The stream and station descriptions where bioassessments occurred during the 2012 monitoring period are summarized in Table 5-2 and the locations are displayed graphically in Figures 5-25 and 5-26. All 2012 bioassessment monitoring locations were identical to those surveyed in 2010.

Table 5-2. Bioassessment Locations

Surface Water	Reach Length (meter)	Station ID	Reach Latitude / Longitude[1]	
			Upstream Endpoint	Downstream Endpoint
Squaw Creek	150	Bio-SC1	39° 12' 5.02" N 120° 13' 10.68" W	39° 12' 2.60" N 120° 13' 12.11" W
	150	Bio-SC2	39° 12' 18.53" N 120° 12' 56.59" W	39° 12' 17.18" N 120° 13' 1.98" W
	150	Bio-SC3	39° 12' 18.99" N 120° 12' 44.69" W	39° 12' 19.19" N 120° 12' 49.61" W
Martis Creek	150	Bio-MC2	39° 16' 17.83" N 120° 10' 14.00" W	39° 16' 22.019" N 120° 10' 14.17" W
	150	Bio-MC5	39° 17' 42.42" N 120° 8' 24.82" W	39° 17' 43.51" N 120° 8' 28.81" W
Upper Martis Creek	150	Bio-MC1	39° 16' 53.99" N 120° 7' 2.22" W	39° 16' 49.88" N 120° 7' 3.63" W
West Martis Creek	150	Bio-MC3	39° 17' 45.9" N 120° 7' 4.1" W	39° 17' 48.8" N 120° 7' 7.0" W
	150	Bio-MC4	39° 18' 7.39" N 120° 7' 16.83" W	39° 18' 5.88" N 120° 7' 22.18" W
East Martis Creek	150	Bio-MC6	39° 18' 31.34" N 120° 6' 48.84" W	39° 18' 30.26" N 120° 6' 43.47" W

[1] Coordinate System: NAD 1983 State Plane California II FIPS 0402 Feet

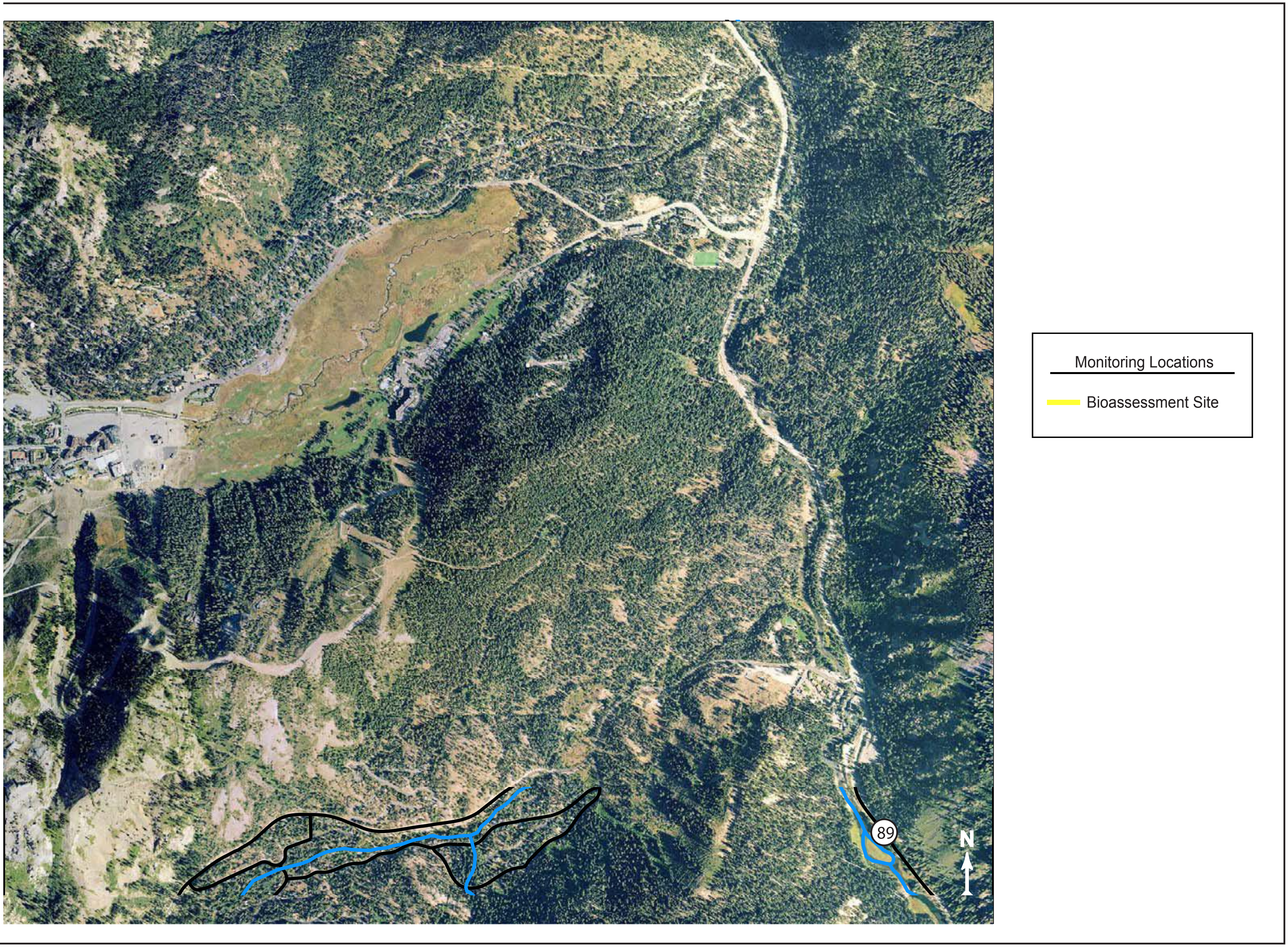
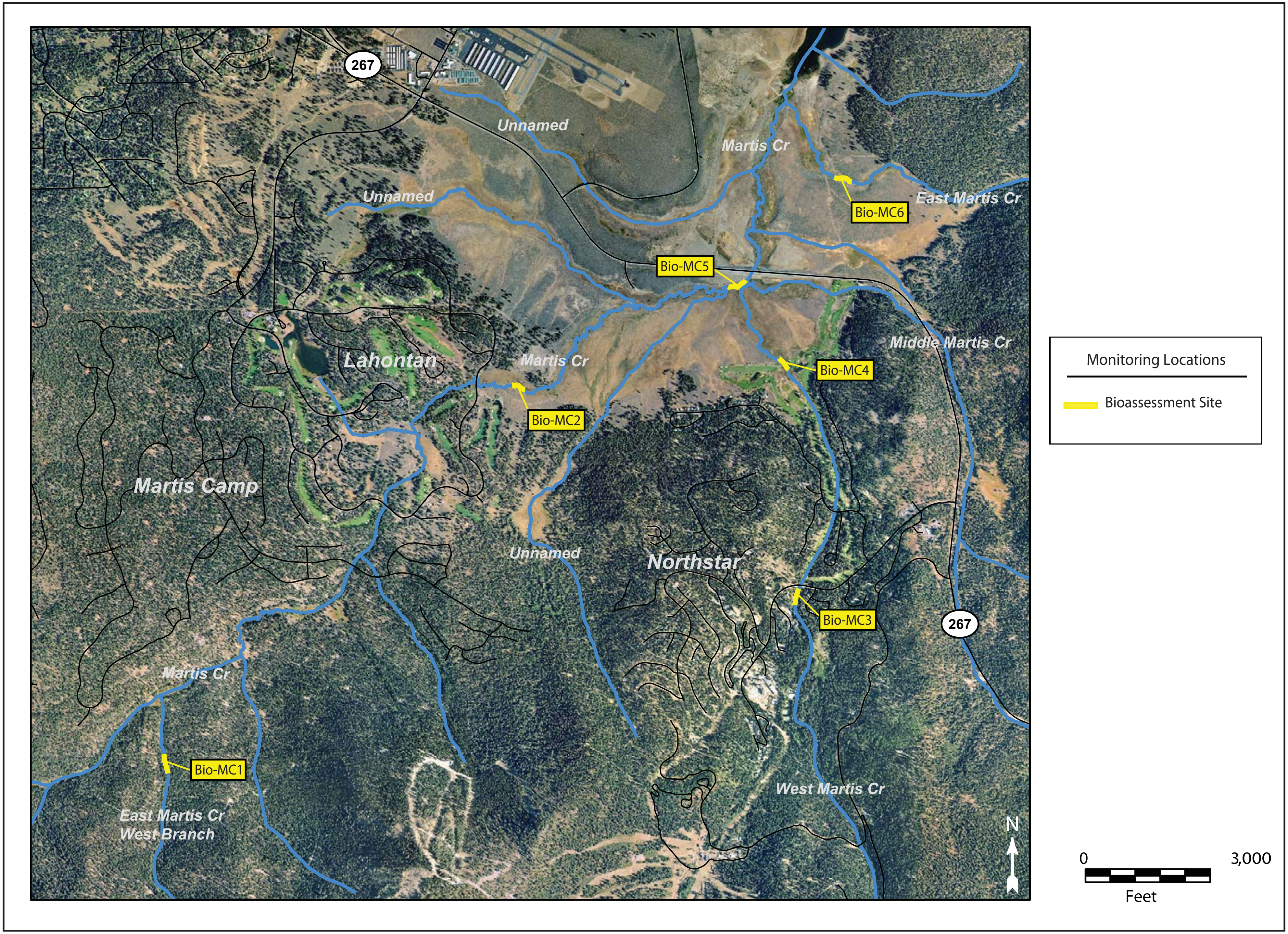


Figure 5-25
Squaw Creek Bioassessment Monitoring Locations



CDM Smith

Figure 5-26
Martis Valley Bioassessment Monitoring Locations

5.2.2 Bioassessment Results

Bioassessment results are presented in this section beginning with a discussion of field conditions and measurements and followed with the presentation of detailed laboratory results and calculations. A complete set of the original field data forms are provided in Appendix B.

Squaw Creek

Weather conditions were fair and warm during the July bioassessment surveys in Squaw Creek. Brief thundershowers occurred on one of the survey days (7/23/12). Stream temperatures ranged from 17.5 to 22.5 °C and pH ranged from 7.5 to 8.0. Conductivity ranged from 153 to 161 µS/cm and dissolved oxygen ranged from 4.3 to 10.7 milligrams/liter at 48 to 193 percent saturation.

Flows in Squaw Creek were between 0.6 and 1.8 ft^3/sec during the surveys (thundershowers increased discharge slightly during one of the three survey days). Surface flows between pool-riffle-run sequences were continuous (i.e., no intermittent flows or dry channel sections were present along the longitudinal profile). Mean wetted width was between 4.9 and 5.5 meters and mean depth was between 21 and 34 centimeters. Median particle size (D50) was between 5 and 6 millimeters. Particles less than 2 millimeters in diameter (fines and sands) comprised between 33 and 35 percent of the streambed. Cobbles were scarce, with mean cobble embeddedness between 10 and 29 percent. Filamentous algae growth was substantial, particularly along the stream margins, but not overwhelming as can be the case during lower and/or intermittent flow conditions typical of later in the year. Aquatic macrophytes were also common in depositional and lower gradient areas within the stream. Representative photos of each site are provided in Figure 5-27.

The channel in this meadow section of Squaw Creek is very low gradient (0.01% to 0.35% slope) with relatively high sinuosity (1.1 to 1.9). The channel is typically open and un-shaded (mean canopy cover was between 0% and 1%). Stream banks are lined with low herbaceous cover (grasses, sedges, etc.) and sparse willow bushes. The channel appeared incised with a high percentage of eroded stream banks (69% to 88%). Several banks had boulder rip-rap placed as protection although some of this was failing.

FIGURE 5-27a. Collecting benthic macroinvertebrate samples in Squaw Creek (7/23/12).

FIGURE 5-27b. Measuring stream discharge in Squaw Creek (7/23/12).

FIGURE 5-27c. Looking upstream from the middle of the Lower Meadow site (7/23/12).

FIGURE 5-27d. Looking upstream from near the top of the Middle Meadow site (7/24/12).

FIGURE 5-27e. Looking upstream from the middle of the Upper Meadow site (7/30/12).

FIGURE 5-27f. Deposition of DG sand and fine sediments along the Lower Meadow site (7/23/12).

Figure 5-27
Bioassessment Photographs – Squaw Creek

CDM Smith

Martis Creek

Weather conditions were fair during the August and September bioassessment surveys in Martis Creek. Stream temperatures ranged from 8.8 to 11.9 °C and pH ranged from 6.9 to 7.5. Conductivity ranged from 84 to 140 µS/cm and dissolved oxygen ranged from 10.3 to 11.5 mg/L at 89 to 106 percent saturation.

Generally discharge was lower in the upper portions of the watershed (e.g., 1.7 cfs in the upper West Branch [site Bio-MC3] and 1.4 cfs in the Schaeffer Branch [site Bio-MC1]) and greater in the lower portions of the watershed (e.g., 6.1 cfs in the lower mainstem). Mean wetted width was between 0.8 and 3.5 meters and mean depth was between 9 and 24 centimeters. Median particle size (D_{50}) was between 14 and 42 millimeters. Particles less than 2 millimeters in diameter (fines and sands) comprised between 13 and 30 percent of the streambed. Mean cobble embeddedness was between 4 and 19 percent. Representative photos of each site are provided in Figure 5-28.

The channel in the upstream headwater sections of Martis Creek is relatively high gradient (e.g., 4.9% slope in the upper West Branch [site Bio-MC3] and 3.1% in the Schaeffer Branch [site Bio-MC1]) with relatively low sinuosity (1.1 to 1.2). Stream gradient in the downstream meadow sections of Martis Creek is lower (between 0.4% and 2.5%) with slightly higher sinuosity (between 1.1 and 1.4). In the upper reaches, the channel is typically well shaded by alder and willow bushes and an overstory of conifers (e.g., mean canopy cover was 87% and 89% in the upper West Branch [site Bio-MC3] and the Schaeffer Branch [site Bio-MC1], respectively); whereas in the lower reaches, no overstory is present and stream banks are lined with low herbaceous cover (grasses, sedges, etc.) and some sparse willow bushes (mean canopy cover in the lower reaches was between 4% and 27%). At several locations in the lower reaches, the channel appeared somewhat incised with some eroding or vulnerable stream banks (the highest percentage of eroded banks was 86% in the middle mainstem of Martis Creek [site Bio-MC2]). The lowest percentages of eroded banks were in the upper and lower West Branch (sites Bio-MC3 and Bio-MC4) and East Branch (site Bio-MC6); at all three of these sites, zero percent of stream banks were described as eroded or vulnerable.

FIGURE 5-28a. Looking upstream from the bottom of site Bio-MC1 in the Schaeffer Branch (8/21/12).

FIGURE 5-28b. Looking upstream from the bottom of site Bio-MC2 in middle Martis Creek (8/24/12).

FIGURE 5-28c. Looking upstream from the bottom of site Bio-MC3 in the upper West Branch (9/6/12).

FIGURE 5-28d. Looking upstream from the bottom of site Bio-MC4 in the lower West Branch (9/17/12).

FIGURE 5-28e. Looking upstream from the bottom of site Bio-MC5 in lower Martis Creek (9/14/12).

FIGURE 5-28f. Looking upstream from the bottom of site Bio-MC6 in the lower East Branch (9/29/12).

Figure 5-28
Bioassessment Photographs - Martis Valley

5.2.3 Bioassessment Laboratory Results

The most common taxa collected in Squaw Creek during 2012 were aquatic earthworms (Oligochaeta), nemourid stoneflies of the genus *Zapada*, and chironomid midges of the *Orthocladius* complex and *Micropsectra*. Other abundant taxa included chironomid midges of the genus *Stictochironomus*, and mayflies of the genus *Paraleptophlebia*. Benthic density was relatively high in Squaw Creek during 2012, averaging 2,606 individuals/ft^2 for all riffle samples.

The most common taxa collected in Martis Creek during 2012 were aquatic earthworms (Oligochaeta), chloroperlid stoneflies of the genus *Sweltsa*, mayflies of the genus *Paraleptophlebia*, and chironomid midges of the genus *Micropsectra*. Other abundant taxa included flatworms of the class Turbellaria and the ubiquitous baetid mayfly *Baetis tricaudatus*. Benthic density averaged 1,049 individuals/ft^2 for 2012 Martis Creek riffle samples.

Eastern Sierra IBI scores and values for the component IBI metrics are listed in Table 5-3 for all riffle composite samples. A complete 500-fixed-count taxa list for all of these samples from Squaw Creek and Martis Creek sites is provided in Table 5-4. Generally, most sites sampled in 2012 had relatively good IBI scores, although Squaw Creek sites had slightly lower IBI scores (46 to 93 out of a possible 100) and Martis Creek sites had slightly higher IBI scores (62 to 97 out of a possible 100). Low IBI scores were typically attributable to low taxa richness (i.e., low total richness, as well as low caddisfly [Trichoptera], and mite [Acari] richness in particular), high dominance, and high weighted tolerance (i.e., high Hilsenhoff Biotic Index scores) presumably due to poor habitat conditions associated with excessive fines. The highest IBI score was from the upstream headwater site in the Schaeffer Branch (Bio-MC1) of Martis Creek (97 out of a possible 100). The lowest IBI score was from the upper meadow site (Bio-SC1) in Squaw Creek (46 out of a possible 100). The differences in survey period between Squaw Creek (sampled in July) and Martis Creek (sampled in August and September) are not likely to have contributed to the differences in IBI scores.

Biological Condition Scores for two of the three Squaw Creek sites were relatively high (25 and 27 out of a possible 35 for the middle [Bio-SC2] and lower meadow [Bio-SC3] sites, respectively). However, BCS was very low for the upper meadow (Bio-SC1) site (7 out of a possible 35).

Table 5-3. Summary of 2012 TRWQMP Bioassessment Results (Squaw Creek and Martis Creek Riffle Samples)

BIOASSESSMENT STATION ID		BIO SC1	BIO SC2	BIO SC3	BIO MC1	BIO MC2	BIO MC3	BIO MC4	BIO MC5	BIO MC6
LOCATION (Stream Reach)		Squaw Upper Meadow	Squaw Middle Meadow	Squaw Lower Meadow	Martis Schaeffer Branch	Martis Middle Mainstem	Martis Upper West Branch	Martis Lower West Branch	Martis Lower Mainstem	Martis East Branch
GENERAL	Survey Date	7/25/12	7/24/12	7/23/12	8/21/12	8/24/12	9/6/12	9/17/12	8/27/12	9/6/12
	Discharge (cfs)	0.7	0.6	1.8	1.4	4.2	1.9	0.7	6.1	1.9
	Reach Slope (%)	0.01	0.35	0.20	3.10	0.61	4.86	1.65	0.41	2.46
	Reach Sinuosity	1.9	1.1	1.2	1.2	1.2	1.1	1.4	1.1	1.1
	Mean Wetted Width (m)	5.5	4.9	5.0	1.8	2.4	1.8	0.8	3.5	1.1
	Mean Depth (cm)	34	21	28	9	21	11	9	24	18
BED	Median Particle Size (mm)	5	6	6	26	17	39	17	14	42
	% Particles < 2 mm	35	33	33	13	30	18	13	30	15
	Mean Cobble Embedded (%)	10	29	23	18	4	9	19	6	11
BANK	Stable Banks (%)	19	12	31	86	14	100	100	64	100
	Eroded Banks (%)	81	88	69	14	86	0	0	36	0
	Mean Canopy Cover (%)	1	0	1	89	27	87	7	4	8
WATER QUALITY	Survey Time (hrs)	1200	1200	1200	1130	1145	1200	1030	1100	1000
	Water Temperature (°C)	17.5	22.5	20.8	9.2	11.9	11.4	8.8	8.8	9.1
	pH	7.5	7.8	8.0	7.0	7.2	7.6	6.9	7.5	7.5
	DO Concentration (mg/L)	9.3	10.7	4.3	10.9	11.5	10.4	10.3	11.0	11.3
	DO Saturation (%)	98	193	48	95	106	96	89	95	98
	Conductivity (µS)	153	161	158	84	106	140	134	99	120
BIOLOGICAL METRICS	Total Taxa Richness	40	60	52	47	44	53	38	40	37
	Ephemeroptera Richness	5	10	10	9	7	9	5	7	9
	Plecoptera Richness	4	11	6	8	5	13	5	4	4
	Trichoptera Richness	3	6	5	7	6	5	5	4	3
	Acari Richness	1	1	1	6	3	1	2	2	0
	% Chironomidae Richness	45	30	37	6	25	23	13	33	24
	% Tolerant Taxa	18	5	10	0	9	23	11	18	19
	% Shredders	3	19	23	22	2	12	5	4	8
	% Dominant 3 Taxa	56	36	43	38	37	37	41	44	45
	Hilsenhoff Biotic Index	6.0	3.8	3.9	3.1	4.0	3.3	4.0	3.4	5.5
	Eastern Sierra IBI	46	93	90	97	78	82	72	69	62

Table 5-4. Taxa Listings for 500-Fixed-Count Samples from 2012 Squaw Creek and Martis Creek Bioassessments (Riffle Composite Samples)

SAFIT Level II Final ID	BIO SC1	BIO SC2	BIO SC3	BIO MC1	BIO MC2	BIO MC3	BIO MC4	BIO MC5	BIO MC6
Turbellaria				38	15	31	60		2
Oligochaeta	138	37	44	11	7	35	108	32	36
Hydra		2							
Ostracoda	7	2	1	5		5	1		
Hyalella									112
Pacifastacus leniusculus								1	1
Physa	1		1						
Pisidium casertanum				1		6	11		2
Atractides	5	5	9						
Hygrobates	1	1	1						
Feltria		1	1						
Protzia			1	28	3	12		3	
Lebertia	2	3	3	2	10		12	3	
Wandesia				1					
Hydryphantidae				1					
Sperchon			1	2	1		3		
Torrenticola		3	4	1					
Trimalaconothrus	2	5	2						
Ameletus						3	1	2	
Baetis tricaudatus	5	1	1	62	29	15	35	3	13
Diphetor hageni		3	1			1		3	11
Ameletus		4	7						
Caudatella heterocaudata				8					
Drunella		1	3		3				
Drunella doddsi				37	2				
Drunella flavilinea				2					
Drunella grandis		11	11	4		6	1		1
Ephemerella dorothea					8			137	2
Ephemerella tibialis				1	2	1			1
Matriella teresa					1				
Serratella	1	7	16						
Cinygma						3		1	7
Cinygmula	2	12	13	31	3	26	5	3	13
Ecdyonurus		5	2						
Ironodes				18		32			7
Rhithrogena		10	4						
Paraleptophlebia	14	36	35	11	4	13	4	34	84
Siphlonurus	4								
Capniidae	6	12	8						
Eucapnopsis brevicauda		1							
Paraperla						1			
Sweltsa	5	17	11	11	71	41	19	33	

Table 5-4. Taxa Listings for 500-Fixed-Count Samples from 2012 Squaw Creek and Martis Creek Bioassessments (Riffle Composite Samples)

SAFIT Level II Final ID	BIO SC1	BIO SC2	BIO SC3	BIO MC1	BIO MC2	BIO MC3	BIO MC4	BIO MC5	BIO MC6
Suwallia		1							
Moselia						1			
Leuctridae				2		1	3		
Malenka		7	5			6		8	13
Soyedina						1			
Visoka cataractae				1					
Zapada	6	73	99	3		1			
Zapada cinctipes				9	6	32	21	11	21
Doroneuria baumanni		2	1	13		8			
Frisonia picticeps		1							
Isoperla		4					3		
Kogotus/Rickera	2	3							
Skwala		5	5		8			22	2
Yoraperla nigrisoma				92	2	10	1		4
Calineuria californica						9			
Perlinodes aurea					1				
Perlodidae						3			
Pteronarcys princeps				5		3			
Apatania		1	1						
Amiocentrus		1	1						
Brachycentrus americanus				1	1		33		
Micrasema					32		20		
Anagapetus				5		13	1		
Glossosoma					1				
Hydroptila	1	3	4					1	2
Hydropsyche	1	28	13		17		1	19	9
Parapsyche				11					
Cryptochia						1			
Ecclisomyia						1			
Dolophilodes				3					
Rhyacophila				11	3	19	5		1
Rhyacophila arnaudi				1					
Rhyacophila brunnea group				3	1	4			
Lepidostoma		3	1					2	
Dicosmoecus		1						1	
Onocosmoecus	3								
Oreodytes scitulus scitulus	1								
Stictotarsus striatellus	3								
Optioservus quadrimaculatus		1			59		31	46	
Agabus							1		
Ochthebius					1				
Eubrianax edwardsi									2
Cleptelmis addenda							34		20

Table 5-4. Taxa Listings for 500-Fixed-Count Samples from 2012 Squaw Creek and Martis Creek Bioassessments (Riffle Composite Samples)

SAFIT Level II Final ID	BIO SC1	BIO SC2	BIO SC3	BIO MC1	BIO MC2	BIO MC3	BIO MC4	BIO MC5	BIO MC6
Heterlimnius corpulentus				26		111	1		
Lara avara				4		8			
Narpus						4			
Rhizelmis nigra						1			
Zaitzevia parvula					14		21	5	1
Sialis							1		
Atrichopogon				1					
Bezzia					1		1		
Bezzia/Palpomyia		11	5						
Dasyhelea		2							
Boreochlus						1			
Conchapelopia						1		2	1
Paramerina									1
Diamesa					2				1
Pagastia								2	
Potthastia gaedii group					1				
Brillia						1			
Chaetocladius						9			
Corynoneura	6	1	1			2			
Pagastia		1	1						
Potthastia gaedii group			1						
Conchapelopia	1	4	9						
Pentaneura	2	10	16						
Rheopelopia			1						
Thienemannimyia group	27								
Zavrelimyia	2								
Cricotopus					16			20	4
Cricotopus bicinctus group					9		5		
Cricotopus nostocicola					2			1	1
Eukiefferiella claripennis	3	1							
Eukiefferiella devonica						1		5	8
Eukiefferiella gracei					2			6	9
Georthocladius						1			
Orthocladius	55	53	64		2				
Orthocladius complex					1			4	
Parametriocnemus				2			1	1	
Rheocricotopus						2	2		
Synorthocladius								1	
Thienemanniella									
Tvetenia				5	35	1	6	13	25
Pseudochironomus richardsoni						1		1	
Heterotrissocladius marcidus	7								

Table 5-4. Taxa Listings for 500-Fixed-Count Samples from 2012 Squaw Creek and Martis Creek Bioassessments (Riffle Composite Samples)

SAFIT Level II Final ID	BIO SC1	BIO SC2	BIO SC3	BIO MC1	BIO MC2	BIO MC3	BIO MC4	BIO MC5	BIO MC6
group									
Limnophyes			1						
Nanocladius		1							
Parakiefferiella			2						
Parametriocnemus	1		5						
Psectrocladius	24	4	1						
Rheocricotopus	2	9							
Synorthocladius		1							
Thienemanniella		1							
Tvetenia bavarica group	5	10	5						
Cladotanytarsus		1							
Micropsectra	47	53	53	15	57	2	2	37	45
Microtendipes						1			
Microtendipes pedellus group	2	1	5						
Phaenopsectra	2								
Polypedilum		1	4						
Pseudochironomus	1		2						
Rheotanytarsus		6	9						
Stictochironomus	87								
Tanytarsus	3	2	5						
Paratanytarsus					1				
Rheotanytarsus					2			4	
Limnophora		3							
Muscidae		1							
Prosimulium				1					
Simulium	13	10		3	9	2	7	11	24
Simulium piperi							33	2	10
Pericoma				2	35	3	1	11	
Antocha monticola					17	1		5	
Dicranota					4		4	3	3
Hexatoma				1	1		1		
Tipula				1		1		1	
Neoplasta				2					1
Glutops				2	1	2			

The biological metrics from Squaw Creek bioassessment sites were markedly improved in 2012 over previous study years for two of the three survey locations. IBI scores at the upper, middle and lower meadow sites (Bio-SC1, Bio-SC2 and Bio-SC3) were 46, 93, and 90. The Squaw Creek specific Biological Condition Scores were 7, 25, and 27 out of a possible 35 for upper, middle, and lower meadow sites, respectively. Per the Squaw Valley TMDL, minimum target BCS values of 25 are considered to represent reasonably achievable desired conditions for benthic aquatic life that are protective of beneficial uses in Squaw Creek (LRWQCB 2008). Data from previous Squaw Creek sampling events in 2000, 2001 (see LRWQCB 2006), and 2010 indicate that this minimum BCS level had not previously yet to been attained achieved for any of the Squaw Creek meadow sites (Figure 5-29). However, 2012 data indicate that this level was attained and even exceeded at the middle and lower meadow sites this year, whereas the upper meadow site again ranked very low in terms of both BCS and IBI scores in 2012 (Figure 5-30).

Overall, higher BCS and IBI scores at two of the three Squaw Creek sites (Bio-SC2 and Bio-SC3) in 2012 were related to greater taxa richness and fewer tolerant taxa than in previous survey years (e.g., 60 and 52 total taxa at Bio-SC2 and Bio-SC3 in 2012 vs. 30 and 39 in 2010). The taxa list for these sites indicate a generally more robust benthic community present in 2012 (in terms of richness, composition, tolerance, and functional feeding group measures). It is likely that Squaw Creek may have experienced fewer disturbances associated with reduced surface flows and intermittency during the summer of 2011. Snowmelt and saturated ground conditions from the record snowpack of the 2010-2011 winter likely sustained surface flows in Squaw Creek further into the summer and fall than usual in 2011, thereby allowing a more robust benthic community to develop during this period. Furthermore, record low precipitation during the subsequent mild 2011-2012 winter produced fewer flood disturbances such that the benthic community that was sampled in July 2012 was likely more robust and well-developed than in other years when disturbances were more regular. It is suspected that lower BCS and IBI scores at the upper meadow site (Bio-SC1) in 2012 may have in part been related to the presence of a beaver dam downstream of the site that effectively reduced the local reach slope and partially backwatered some riffle habitats upstream (i.e., reducing overall amount and quality riffle habitats in the vicinity).

Bioassessment results for Martis Creek indicate that the upper tributaries with less disturbance had the highest IBI scores with values of 97 and 82 out of 100 at the Schaeffer (Bio-MC1) and Upper West (Bio-MC3) Sites, respectively. These two survey locations also had a low percentage of fine sediment on the streambed. The remaining Martis Creek bioassessment locations received IBI scores ranging from 62 at East Martis Creek (Bio-MC6) to 78 at the middle mainstem Martis (Bio-MC2).

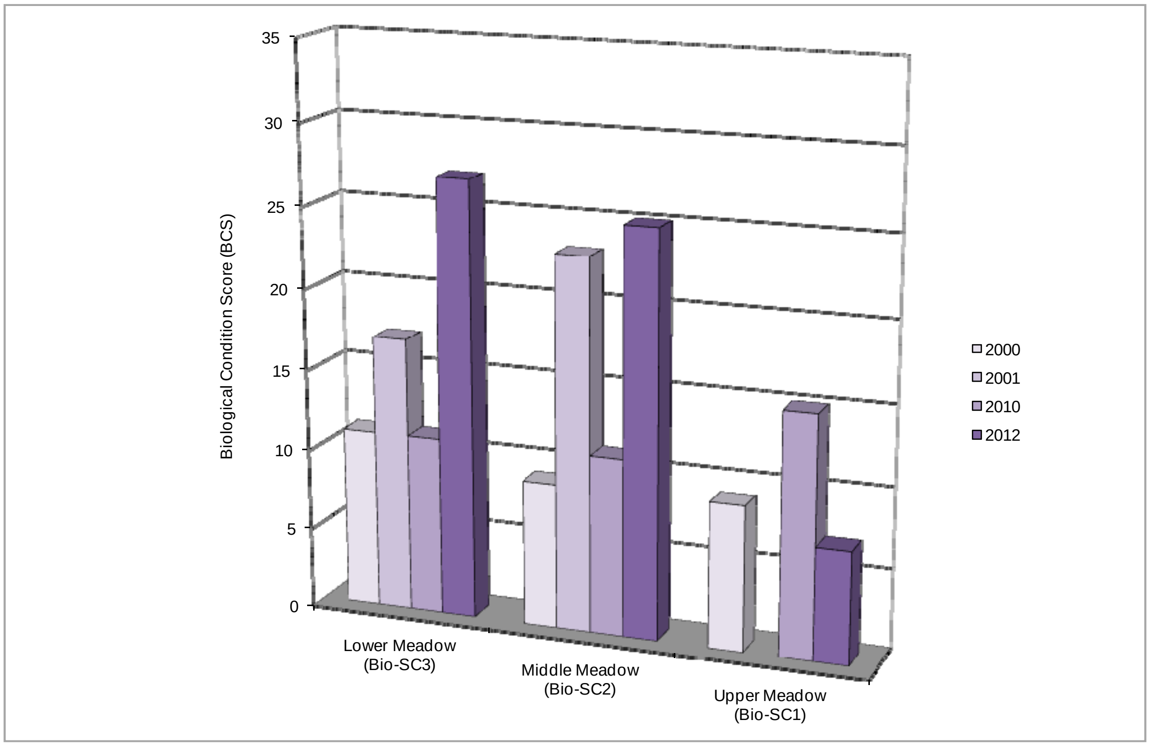


Figure 5-29
Biological Condition Scores for Squaw Creek

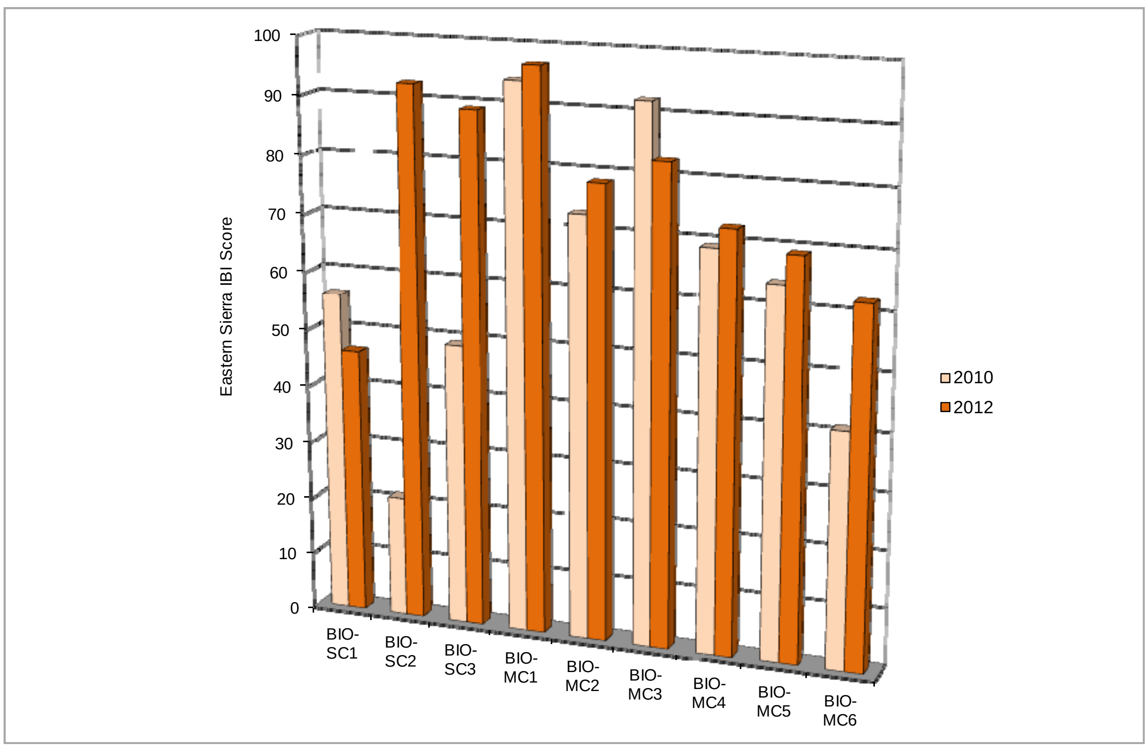


Figure 5-30
Eastern Sierra IBI Scores

5.2.4 Laboratory Quality Assurance

Ten percent of benthic macroinvertebrate samples processed (2 samples each from Squaw Creek and Martis Creek) have been sent to CDFG's Aquatic Bioassessment Laboratory for a QA/QC check of taxonomic and enumeration accuracy. The QA/QC check is performed to provide a secondary review of taxonomy and enumeration. If significant errors or other problems are identified through this process, they will be reported separately.

5.3 Community Level Water Quality Monitoring

This section describes the monitored community level runoff events and then presents the water quality data with a statistical analysis and the QA/QC results.

5.3.1 Monitored Events

During WY 2012, discrete stormwater runoff samples were collected from the two County and nine Town sites described in Section 4. Seventeen separate runoff events were monitored between October, 2011 and August, 2012. Five samples were collected at each site, except for: the Town Airport site (DSC-MC1) where three samples were collected, the County Lahontan site (DSC-MC2) where eight samples were collected, and the Town Bridge St NW site (DCS-TT4) where 6 samples were collected. Monitoring at the Airport site (DSC-MC1) was ceased with the addition of six new Town sites (DSC-DC1, DSC-TC2, DSC-TT2 through DSC-TT5) in February, 2012. At the County Northstar site (DSC-MC3), the large infiltration basin and pervious drainage area contributed to lower flow rates and frequencies, especially from snowmelt events at this site. A summary of the monitored runoff events during WY 2010 through WY 2012 are presented in Table 5-5.

The antecedent dry time is the period without measurable precipitation prior to each monitored event. While longer antecedent periods can allow more pollutants to accumulate and wash off with stormwater runoff, larger runoff events in the mid-winter also result in increased pollutant loads due to factors such as increased deicer and abrasives applications and greater energy flows. The high frequency of storm events during WY 2011 generally reduced dry periods between sampling events. During WY 2012, longer dry periods occurred at the beginning and end of the water year.

Table 5-5. 2010, 2011, & 2012 Water Years Community Level Water Quality Monitoring Event Summary

				Samples Collected										
				Town	Town	County	County	Town	Town	Town	Town	Town	Town	Town
Event Date	Event Type[1]	Antecedent Dry Time (Days)	Total Precip (inches)	Donner Creek (DSC DC1)	Airport (DSC MC1)	Lahontan (DSC MC2)	Northstar (DSC MC3)	Trout Creek SE (DSC TC1)	Trout Creek NW (DSC TC2)	Brickelltown (DSC TT1)	Bridge St SW (DSC TT2)	Bridge St SE (DSC TT3)	Bridge St NW (DSC TT4)	West River (DSC TT5)
Water Year 2010														
2/5/2010	S	0	NA							X				
2/24/2010	M	2	0.6					X		X				
2/26/2010	M	1	0.9					X		X				
3/12/2010	M	2	1.2							X				
3/29/2010	R	4	1					X		X				
4/22/2010	S	0	NA					X		X				
4/27/2010	R	5	0.5					X		X				
5/10/2010	M	12	0.6							X				
5/25/2010	R	3	0.2					X						
Water Year 2011														
10/4/2010	R	42	0.8		X			X						
10/24/2010	R	5	4.9		X			X		X				
12/14/2010	M	7	1.3		X	X	X	X		X				
12/18/2010	M	2	3			X	X	X						
12/28/2010	M	3	1.3					X						
1/17/2011	S	4	NA			X				X				
2/22/2011	S	4	NA					X						
3/2/2011	M	4	0.3		X	X				X				
3/6/2011	M	2	0.3		X			X						
3/10/2011	M	3	0.2			X								
3/14/2011	S	0	NA			X	X	X		X				
3/28/2011	S	1	NA		X					X				
3/31/2011	S	4	NA			X	X			X[2]				
4/11/2011	S	3	NA		X									
4/17/2011	M	4	0.1				X							
4/20/2011	M	3	0.2							X				

Table 5-5. 2010, 2011, & 2012 Water Years Community Level Water Quality Monitoring Event Summary

				Samples Collected										
				Town	Town	County	County	Town	Town	Town	Town	Town	Town	Town
Event Date	Event Type[1]	Antecedent Dry Time (Days)	Total Precip (inches)	Donner Creek (DSC DC1)	Airport (DSC MC1)	Lahontan (DSC MC2)	Northstar (DSC MC3)	Trout Creek SE (DSC TC1)	Trout Creek NW (DSC TC2)	Brickelltown (DSC TT1)	Bridge St SW (DSC TT2)	Bridge St SE (DSC TT3)	Bridge St NW (DSC TT4)	West River (DSC TT5)
5/25/2011	R	6	0.8		X	X				X				
6/6/2011	M	2	0.5				X							
Water Year 2012														
10/5/2011	R	21	0.75		X		X			X				
1/20/2012	M	23	1.8			X		X		X				
1/21/2012	S	2	NA		X									
1/25/2012	S	2	NA			X								
1/26/2012	S	3	NA		X					X				
3/1/2012	S	0	NA								X		X	
3/2/2012	S	1	NA											X
3/5/2012	S	4	NA			X							X	X
3/8/2012	S	2	NA								X			
3/13/2012	M	7	0.5			X			X		X		X	X
3/15/2012	M	0	0.6	X										
3/16/2012	M	0	1.8	X		X	X	X	X	X	X	X	X	X
3/21/2012	S	3	NA			X	X	X	X				X	
3/28/2012	M	1	0.8	X		X		X	X	X	X	X	X	X
4/12/2012	S	1	NA	X					X			X		
4/26/2012	R	11	0.8	X		X	X	X				X		
8/14/2012	R	23	0.8				X					X		
			Total	**5**	**11**	**16**	**11**	**19**	**5**	**21**	**5**	**5**	**6**	**5**

[1]M = Mixed Snow/Rain, R = Rain, S = Snowmelt.
[2]TPH grab sample. Sample not analyzed for standard constituent list.

5.3.2 Water Quality Results

Tables containing the complete analytical results for the community level water quality monitoring are presented in Appendix C. The results for TSS, turbidity, total nitrogen, and total phosphorus are also presented graphically in Figures 5-31, 5-32, 5-33, and 5-34, respectively. Figure 5-31 includes the six new Town monitoring sites and shows all 11 sites side by side to allow for direct visual comparisons. Data from the five original monitoring locations are plotted side by side for comparisons in Figures 5-32, 5-33, and 5-34. The figures indicate that samples from the Brickelltown site (DSC-TT1) contained the highest mean concentrations of each constituent and samples from the Lahontan site (DSC-MC2) had the lowest mean concentrations. The six new Town sites all had relatively high concentrations of TSS, second only to Brickelltown (DCS-TT1).

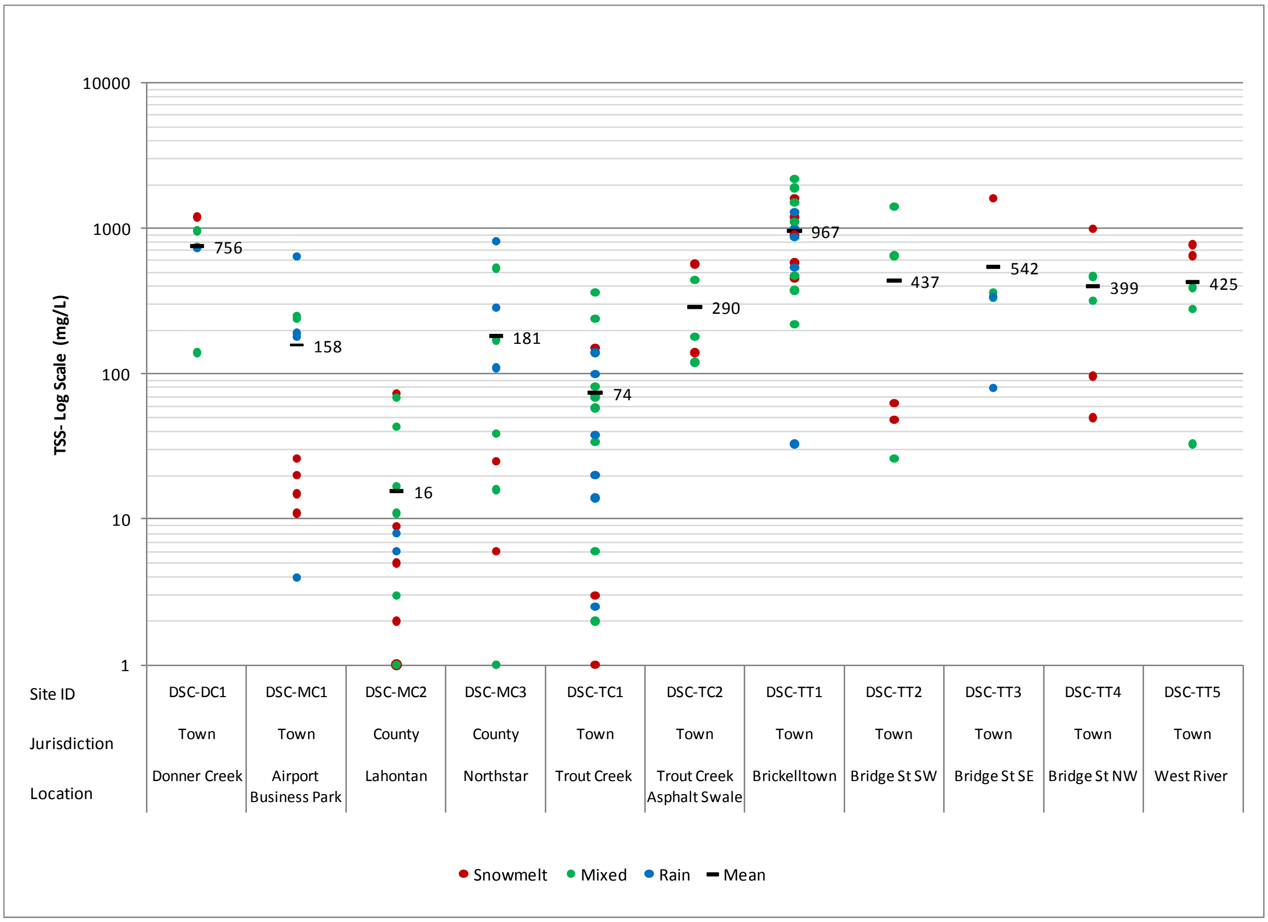


Figure 5-31
Site Comparisons – TSS

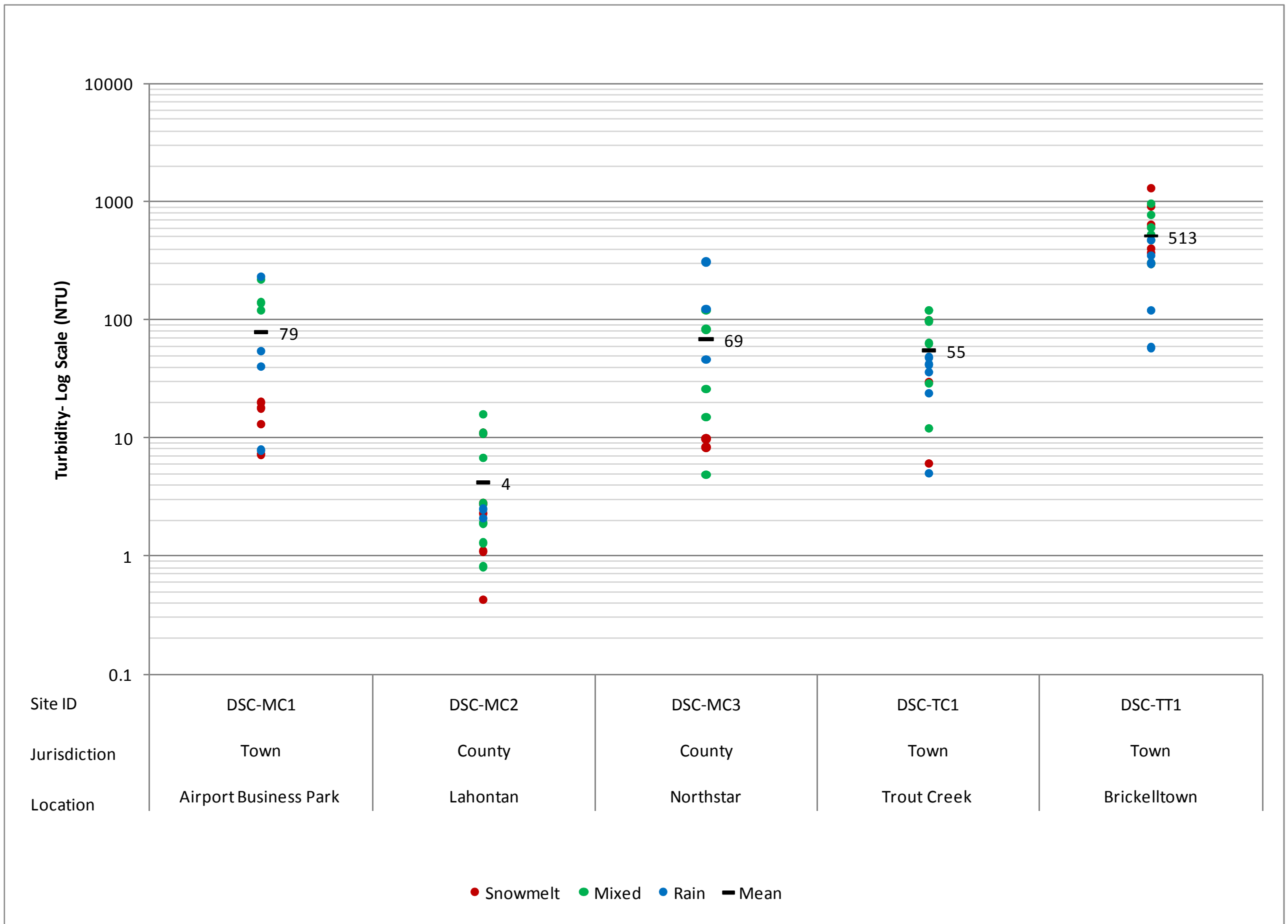


Figure 5-32
Site Comparisons – Turbidity

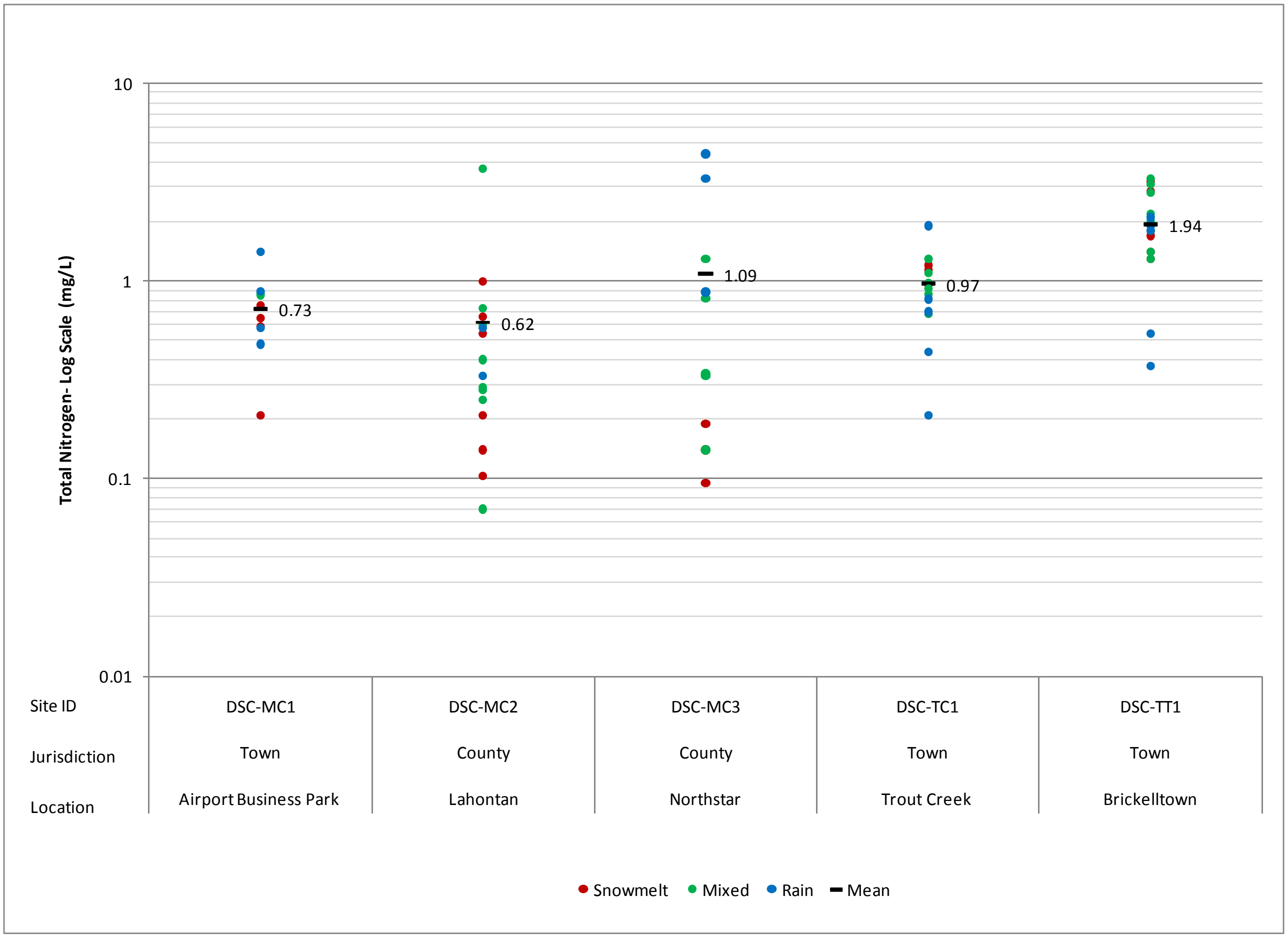


Figure 5-33
Site Comparisons – Total Nitrogen

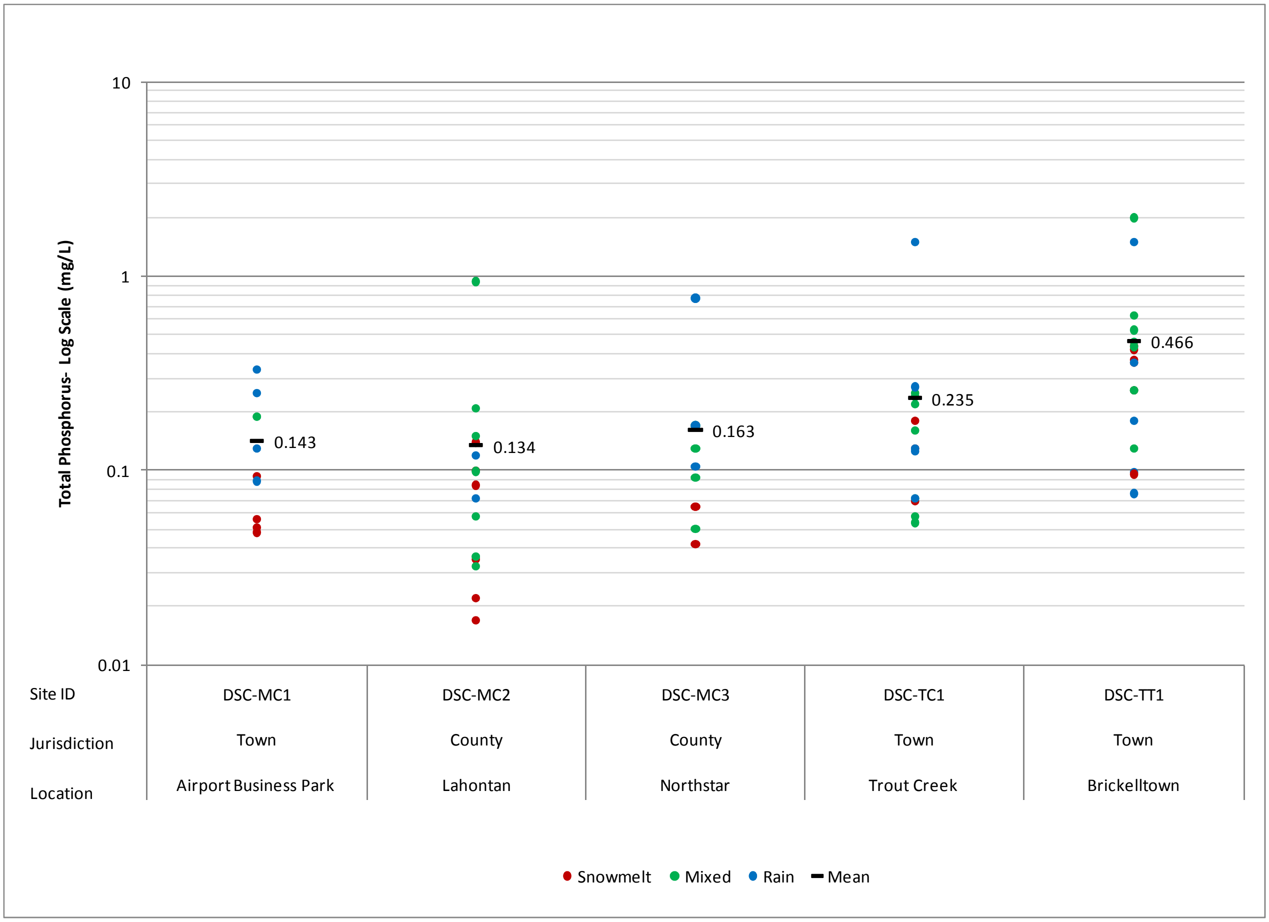


Figure 5-34
Site Comparisons – Total Phosphorus

5.3.3 Statistical Analyses

Statistical analyses were performed to further evaluate the community level monitoring results. These analyses consisted of summary statistics, t-tests at the 95 percent confidence level, and Mann-Kendall trend analyses.

5.3.3.1 Summary Statistics

Summary level statistics were generated to characterize and summarize the data set for each site and are presented below in Tables 5-6 thru 5-11. The summary statistics tables include: the number of samples, percent of samples with detected pollutant concentrations, minimum, maximum, mean and median concentrations and the standard deviation and coefficient of variation (CV). The only constituent collected for new sites was total suspended solids (TSS). Therefore, Table 5-11 includes TSS summary statistics for all old and new sites.

An evaluation of the summary statistics show that nitrogen species (nitrate, nitrite, ammonia and TKN) had the highest number of non-detectable concentrations. Samples with non-detectable concentrations of TSS were also collected at the Lahontan site (DSC-MC2) and the Northstar site (DSC-MC3). The coefficient of variation (CV) values are high at all sites indicating a large amount of variability in the data.

Table 5-6. Airport Business Park Community Level Summary Statistics (Site DSC-MC1)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	CV
				Min	Max				
Combined 2011 & 2012 Water Years									
Total Suspended Solids	mg/L	10	100%	4	640	157.6	103	197.6	1.25
Turbidity	NTU	11	100%	7.3	230	79.1	40	84.8	1.07
Nitrate as N	mg/L	11	82%	0.01	0.59	0.27	0.24	0.15	0.58
Nitrite as N	mg/L	11	9%	0.01	0.03	NC	0.01	NC	NC
Total Kjeldahl Nitrogen (TKN)	mg/L	10	100%	0.06	1.4	0.48	0.41	0.39	0.82
Total Nitrogen as N	mg/L	10	100%	0.21	1.4	0.73	0.70	0.31	0.43
Total Phosphorus	mg/L	10	100%	0.05	0.33	0.14	0.11	0.10	0.67

Notes
mg/L =milligrams per liter, NTU = nephelometric turbidity units.
n = Number of samples
Total Nitrogen is the sum of nitrite (as N), nitrate (as N) and total Kjeldahl nitrogen
NC = Not calculated; insufficient number of detections to generate statistics
The robust regression on order statistical (ROS) method was used for datasets containing detectable concentrations
Percent Detection = percent of samples that were detected above the reporting limit
CV = coefficient of variation

Table 5-7. Lahontan Golf Club Community Level Summary Statistics (Site DSC-MC2)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	CV
				Min	Max				
Combined 2011 & 2012 Water Years									
Total Suspended Solids	mg/L	16	75%	1	73	15.5	5.5	24.1	1.6
Turbidity	NTU	16	100%	0.43	16	4.2	2.4	4.5	1.1
Nitrate as N	mg/L	16	69%	0.01	0.39	0.10	0.04	0.11	1.16
Nitrite as N	mg/L	16	0%	0.01	0.03	NC	0.01	NC	NC
Ammonia as N	mg/L	16	19%	0.05	0.08	0.04	0.05	0.02	0.44
Total Kjeldahl Nitrogen (TKN)	mg/L	16	94%	0.05	3.7	0.52	0.28	0.87	1.65
Total Nitrogen as N	mg/L	16	94%	0.07	3.7	0.62	0.37	0.86	1.40
Dissolved Phosphorus as P	mg/L	16	100%	0.01	0.96	0.10	0.03	0.23	2.29
Dissolved Orthophosphate as P	mg/L	16	94%	0.01	1.1	0.10	0.03	0.27	2.60
Total Phosphorus as P	mg/L	16	100%	0.02	0.94	0.13	0.08	0.22	1.65

Notes
mg/L =milligrams per liter, NTU = nephelometric turbidity units.
n = Number of samples
Total Nitrogen is the sum of nitrite (as N), nitrate (as N) and total Kjeldahl nitrogen
NC = Not calculated; insufficient number of detections to generate statistics
The robust regression on order statistical (ROS) method was used for datasets containing detectable concentrations
Percent Detection = percent of samples that were detected above the reporting limit
CV = coefficient of variation

Table 5-8. Northstar Community Level Summary Statistics (Site DSC-MC3)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	CV
				Min	Max				
Combined 2011 & 2012 Water Years									
Total Suspended Solids	mg/L	11	91%	1.00	810	181.3	39	264.8	1.5
Turbidity	NTU	11	100%	4.90	310	68.8	26	91.6	1.3
Nitrate as N	mg/L	11	55%	0.01	0.81	0.10	0.01	0.24	2.53
Nitrite as N	mg/L	11	18%	0.01	0.05	0.01	0.01	0.02	2.60
Ammonia as N	mg/L	11	27%	0.05	0.17	0.045	0.05	0.06	1.40
Total Kjeldahl Nitrogen (TKN)	mg/L	11	100%	0.10	3.6	0.99	0.34	1.25	1.27
Total Nitrogen as N	mg/L	11	100%	0.10	4.4	1.09	0.34	1.44	1.33
Dissolved Phosphorus as P	mg/L	11	100%	0.01	0.41	0.08	0.04	0.12	1.47
Dissolved Orthophosphate as P	mg/L	11	91%	0.01	0.58	0.09	0.03	0.17	1.82
Total Phosphorus as P	mg/L	11	100%	0.04	0.77	0.16	0.10	0.21	1.27

Notes
mg/L =milligrams per liter, NTU = nephelometric turbidity units.
n = Number of samples
Total Nitrogen is the sum of nitrite (as N), nitrate (as N) and total Kjeldahl nitrogen
NC = Not calculated; insufficient number of detections to generate statistics
The robust regression on order statistical (ROS) method was used for datasets containing detectable concentrations
Percent Detection = percent of samples that were detected above the reporting limit
CV = coefficient of variation

Table 5-9. Trout Creek SE Community Level Summary Statistics (Site DSC-TC1)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	CV
				Min	Max				
Combined 2010, 2011, & 2012 Water Years									
Total Suspended Solids	mg/L	19	100%	1.00	360	74.1	38	93.7	1.3
Turbidity	NTU	15	100%	5.1	120	55.3	42	41.1	0.74
Nitrate as N	mg/L	15	100%	0.02	1.6	0.46	0.36	0.46	1.01
Nitrite as N	mg/L	15	13%	0.01	0.07	0.01	0.01	0.02	2.05
Total Kjeldahl Nitrogen (TKN)	mg/L	15	100%	0.18	1.2	0.49	0.42	0.28	0.56
Total Nitrogen as N	mg/L	15	100%	0.21	1.9	0.97	0.96	0.40	0.41
Total Phosphorus	mg/L	15	100%	0.05	1.5	0.24	0.13	0.36	1.52

Notes
mg/L =milligrams per liter, NTU = nephelometric turbidity units.
n = Number of samples
Total Nitrogen is the sum of nitrite (as N), nitrate (as N) and total Kjeldahl nitrogen
NC = Not calculated; insufficient number of detections to generate statistics
The robust regression on order statistical (ROS) method was used for datasets containing detectable concentrations
Percent Detection = percent of samples that were detected above the reporting limit
CV = coefficient of variation

Table 5-10. Brickelltown Community Level Summary Statistics (Site DSC-TT1)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	CV
				Min	Max				
Combined 2010, 2011, & 2012 Water Years									
Total Suspended Solids	mg/L	21	100%	33	2200	967	900	567.9	0.59
Turbidity	NTU	19	100%	58	1300	513.5	470	306.0	0.60
Nitrate as N	mg/L	18	100%	0.03	0.79	0.20	0.15	0.18	0.86
Nitrite as N	mg/L	18	44%	0.01	0.33	0.04	0.01	0.08	2.19
Total Kjeldahl Nitrogen (TKN)	mg/L	19	100%	0.21	3	1.68	1.7	0.80	0.47
Total Nitrogen as N	mg/L	19	100%	0.37	3.3	1.94	1.80	0.83	0.43
Total Phosphorus	mg/L	19	100%	0.08	2	0.47	0.36	0.49	1.04

Notes
mg/L =milligrams per liter, NTU = nephelometric turbidity units.
n = Number of samples
Total Nitrogen is the sum of nitrite (as N), nitrate (as N) and total Kjeldahl nitrogen
NC = Not calculated; insufficient number of detections to generate statistics
The robust regression on order statistical (ROS) method was used for datasets containing detectable concentrations
Percent Detection = percent of samples that were detected above the reporting limit
CV = coefficient of variation

Table 5-11. Community Level Summary Statistics for TSS at All Sites

Jurisdiction	Site ID	Site	Water Year(s)	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	CV
							Min	Max				
Town	Donner Creek	DSC-DC1	2012	mg/L	5	100%	140	1200	756	750	393.4	0.52
Town	Airport Business Park	DSC-MC1	2011, 2012	mg/L	10	100%	4	640	157.6	103	197.6	1.25
County	Lahontan	DSC-MC2	2011, 2012	mg/L	16	75%	1	73	15.5	5.5	24.1	1.55
County	Northstar	DSC-MC3	2011, 2012	mg/L	11	91%	1	810	181.3	39	264.8	1.46
Town	Trout Creek SE	DSC-TC1	2010, 2011, 2012	mg/L	19	100%	1	360	74.1	38	93.7	1.26
Town	Trout Creek NW	DSC-TC2	2012	mg/L	5	100%	120	570	290	180	202.7	0.70
Town	Brickelltown	DSC-TT1	2010, 2011, 2012	mg/L	21	100%	33	2200	967	900	567.9	0.59
Town	Bridge St SW	DSC-TT2	2012	mg/L	5	100%	26	1400	437.4	63	598.5	1.37
Town	Bridge St SE	DSC-TT3	2012	mg/L	5	100%	80	1600	542	340	602.4	1.11
Town	Bridge St NW	DSC-TT4	2012	mg/L	6	100%	50	1000	399.3	390	343.5	0.86
Town	West River	DSC-TT5	2012	mg/L	5	100%	33	770	424.6	390	293.9	0.69

Notes
mg/L =milligrams per liter
n = Number of samples
The robust regression on order statistical (ROS) method was used for datasets containing detectable concentrations
Percent Detection = percent of samples that were detected above the reporting limit
CV = coefficient of variation

5.3.3.2 Statistical Comparisons

Statistical comparisons (t-tests at the 95 percent confidence level and Mann-Kendall trend analyses) were conducted on select data groups to determine whether observed spatial or temporal differences in water quality were significant. The results of the individual trend analyses are included in Appendix D, and are summarized in Table 5-12. The new community sites monitored for the Town are not included in these analyses because of the limited amount of data available. The results of the trend analysis are very sensitive to the more extreme values in this limited dataset and are not clearly indicative of changes/activities in the watersheds. Since data is limited, individual high or low concentrations can have significant impacts on the results. As the program continues, these tests will become more reliable in determining if long-term trends exist. If long-term trends are identified, correlations between these results and changes to the conditions or management in the watersheds will be investigated.

The statistical analyses allowed for the following conclusions to be made:

- The results of the t-tests indicate that samples collected at the Brickelltown site had statistically higher mean concentrations than samples from Trout Creek, Lahontan, Airport Business Park, and Northstar sites for all four parameters compared (TSS, turbidity, total nitrogen, and total phosphorus). Brickelltown also had a significantly higher mean TSS concentration than the Trout Creek site, but was not significantly higher than the remainder of the new Town sites. All of the new Town sites, with the exception of the new Trout Creek site, had significantly higher mean TSS concentrations than the Trout Creek, Airport Business Park, Lahontan, and Northstar sites.

- The samples collected at the Lahontan site had statistically lower mean concentrations than samples from the Brickelltown and the Trout Creek sites for all four constituents. The mean TSS concentration at the Lahontan site was significantly less than the mean at all other community sites, and the mean turbidity value was significantly less than the means at the Northstar and Airport Business Park sites.

The differences among mean concentrations at the remaining sites are not as large and statistical differences cannot yet be discerned with the limited amount of data collected to date. The number of additional samples required to determine significance increases if the mean values between the two groups are similar and there is large variability in the individual data points.

Table 5-12. Statistical Trends of Constituents of Concern at Community Monitoring Sites

		TSS	Turbidity	Total Nitrogen	Total Phosphorus	Diss. Phosphorus
Placer County	DSC-MC2 Lahontan			Increasing	Slightly Increasing	
	DSC-MC3 Northstar		Slightly Increasing			
Town of Truckee	DSC-TC1 Trout Creek SE			Increasing		
	DSC-TT4 Bridge St NW	Slightly Decreasing				
	DSC-TC2 Trout Creek NW	Slightly Increasing				

Note: Mann-Kendall (MK) Trend Analyses used to determine significance. See Appendix D for detailed results.

Only site with statistically significant trends are included. A blank cell signifies no discernible trends or insufficient data.

5.3.4 Community Level Discussion

A summary of the community level discrete water quality sampling results is presented in Table 5-13. This table compares the mean TSS, turbidity, total nitrogen, and total phosphorus concentrations at each of the monitoring sites and provides a ranking of the sites in order of increasing mean pollutant concentration. Consistent with previous findings, the Lahontan site had the lowest concentrations, while Brickelltown had the highest concentrations for all four constituents. Aside from Brickelltown, the newly established Town sites all had higher mean TSS concentrations than the other locations.

To put this results into a regional context, the event mean concentrations (EMCs) developed for the Lake Tahoe Total Maximum Daily Load (TMDL)(LRWQCB and NDEP, 2008) for TSS, total nitrogen, and total phosphorus in stormwater runoff from various land use categories are provided in Table 5-14 for comparison with the community level results. Overall the community level results are consistent with the Tahoe TMDL values. The TSS concentrations in runoff from the downtown Truckee area are consistent with EMCs for primary roadways and commercial areas. The Total Nitrogen and Total Phosphorus concentrations from the community level sites are slightly lower than the EMCs for comparable landuses used in the Tahoe TMDL.

Discussions regarding the results from each individual community level water quality monitoring site are presented below. The discussions focus on watershed characteristics and how they may relate to water quality results for the key constituents (TSS, turbidity, total phosphorus, and total nitrogen).

Table 5-13. Community Level Site Rankings Based on Mean Pollutant Concentrations

Sites		Jurisdiction	Mean TSS (mg/L)	Mean Turbidity (NTU)	Mean Total Nitrogen (mg/L)	Mean Total Phosphorus (mg/L)
Lahontan	DSC-MC2	County	16	4	0.62	0.13
Airport Business Park	DSC-MC1	Town	158	79	0.73	0.14
Trout Creek SE	DSC-TC1	Town	74	55	0.97	0.24
Northstar	DSC-MC3	County	181	69	1.09	0.16
Brickelltown	DSC-TT1	Town	967	513	1.94	0.47
Trout Creek NW	DSC-TC2	Town	290	--	--	--
Bridge St NW	DSC-TT4	Town	399	--	--	--
West River	DSC-TT5	Town	425	--	--	--
Bridge St SW	DSC-TT2	Town	437	--	--	--
Bridge St SE	DSC-TT3	Town	542	--	--	--
Donner Creek	DSC-DC1	Town	756	--	--	--

Notes: A ranking of 1 equals the lowest mean value, a ranking of 2 equals the second lowest mean value, and so on.

Ranking of 1 =
Ranking of 2 =
Ranking of 3 =
Ranking of 4 =
Ranking of 5 through 11 =

Table 5-14. Tahoe TMDL Event Mean Concentrations

Land Use Category	TSS (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Vegetation/Turf	12	4.88	1.50
Single Family Residential	56	1.75	0.47
Multi-Family Residential	150	2.84	0.59
Commercial/Institutional/ Communications/Utilities	296	2.47	0.70
Primary Roads	952	3.92	1.98
Secondary Roads	150	2.84	0.59

Airport Business Park (DSC-MC1)

Much of the Airport Business Park drainage area consists of newer development which incorporates infiltration and settling basins, vegetated swales, and sediment traps. However, the drainage area also includes paved roadways with moderate traffic that are directly connected to the outfall with little to no treatment (see Figure 5-35). The low to moderate pollutant concentration levels observed at this site correlate well with the landuses and water quality improvements at this site.

Figure 5-35
Airport Business Park Drainage Area on October 24, 2010

The water quality at the Airport Business Park site is also influenced by groundwater that infiltrates into the drainage system when the water table elevation rises. The groundwater appears to be very clean, and likely dilutes the stormwater runoff that is sampled (Figure 5-36). The groundwater is at its lowest rate in the fall, and the flow increases throughout the winter and spring. Monitoring at this site has been discontinued.

Figure 5-36
Airport Business Park Groundwater Intrusion on November 5, 2012

Lahontan Golf Club (DSC-MC2)

Two years of data at this site indicate it has the lowest mean values for TSS, turbidity, total phosphorus, and total nitrogen. The drainage area consists of modern development that includes a golf course and residential area with minimal impervious area. This community also includes facilities that treat stormwater runoff prior to discharge including a long vegetated channel. The sampling location is within a drainage channel that experiences a large amount of continuous baseflow in the winter and spring as shown in Figure 5-37. The baseflow appears to be very clean, and likely dilutes the stormwater runoff that is sampled. In the summer and fall when no baseflow exists, runoff tends to infiltrate prior to reaching the sampling location unless the event is very large (Figure 5-38).

Unusually high nutrient concentrations were observed during one large event on January 20, 2012 when no baseflow existed. This could be attributed to the amount of decaying vegetation that existed in the channel at this time (Figure 5-38) or possibly by fertilizer applications on the upstream golf course.

Figure 5-37
Baseflow at the Lahontan Site on March 14, 2012

Figure 5-38
Dry Conditions at the Lahontan Site on January 18, 2012

Northstar (DSC-MC3)

The site receives runoff from multiple land uses including a large ski area parking lot, a dirt road, a paved residential road, natural wooded upland areas, and residential homes. The large parking lot for Northstar ski resort incorporates sediment traps in the drainage inlets and a large infiltration/ sedimentation basin which is shown in Figure 5-39. This basin must fill completely before runoff from the parking lots is conveyed downstream to the sample location. During large events, runoff is conveyed down a steep hill where erosion has been observed as shown in Figure 5-40. The runoff then travels along an unpaved road where loose soil is present prior to being conveyed in an earthen channel that leads to the sample location. Groundwater seepage occurs in the earthen channel during the winter and spring which dilutes the stormwater runoff being sampled. The residential and roadway runoff at the Northstar site does not receive treatment prior to reaching the sample collection point.

Mean concentrations increased at this site with the incorporation of data from WY 2012 and this site ranked in the mid to higher mean concentration levels when compared to other community sites. This is in large part attributed to one intense Thunderstorm event that was sampled on August 14, 2012. This sample had the highest concentrations of pollutants observed to date. During this event, the upstream infiltration basin filled completely, and high flow rates were observed on the residential street (Skidder Trail) as shown in Figure 5-41.

Figure 5-39
Infiltration/Sedimentation Basin at Northstar

Figure 5-40
Erosion Downstream of Infiltration/Sedimentation Basin

Figure 5-41
High Flow Rates at Northstar Site during Thunderstorm on August 14, 2012

Trout Creek SE Outfall (DSC-TC1)

The Trout Creek drainage area includes portions of the oldest parts of downtown Truckee and includes a high percentage of impervious area with commercial and residential activities and large parking areas. Most of these areas drain to a stable vegetated channel (Figure 5-42) and then through a stormwater treatment vault prior to discharging to Trout Creek. Localized sheet flow from a portion of Donner Pass Road enters a similar vegetated channel on the opposite side of the roadway where flow has been observed to be minimal. The combination of these factors explain the relatively low TSS and turbidity concentrations observed in the samples from this site. Field observations also indicate that the vegetated swale infiltrates a significant portion of the runoff. Some samples have contained higher nutrient concentrations which may be a result of decomposing vegetation in the earthen channel, fertilizer use for landscaping, and wildlife (raccoons) which have been observed in the storm drain system upstream of the sample location. One unusually high total phosphorus concentration was observed during a large rain event on October 4, 2010.

Figure 5-42
Vegetated Channel Draining Towards the Trout Creek SE Outfall (DSC-TC1)

Trout Creek NW Outfall (DSC-TC2)

This site was installed in March 2012 and monitored for TSS, turbidity, pH, and conductivity only. TSS was laboratory analyzed, but the other constituents were measured using field instruments. The catchment area for this site includes the recent Stoneridge multifamily development, a Caltrans maintenance station and high traffic roads and intersections that receive frequent traction sand treatment during winter months. Runoff travels through a series of earthen and paved swales with no treatment prior to discharging to Trout Creek. A steep rocky channel conveys flows from Jiboom Street onto the asphalt shoulder of Donner Pass Road where it is conveyed to the outfall (Figures 5-43 and 5-44).

Five samples have been collected to date. The mean TSS concentration at this site was in the intermediate range when compared to other sites. When comparing this site to only the new Town sites, it had the lowest mean TSS concentration which was unexpected due to the surrounding land uses. It is possible that with additional sampling, a more representative dataset could show higher TSS concentrations at this location. Field observations have indicated large sediment loads entering Trout Creek at this location.

Figure 5-43
Asphalt Swale Leading to Trout Creek

Figure 5-44
Steep Channel above Trout Creek NW Site

Brickelltown (DSC-TT1)

The Brickelltown site had higher mean values of TSS, turbidity, total phosphorus, and total nitrogen than all of the other community level sites. The Brickelltown drainage area represents older development with high imperviousness and little or no water quality controls. It also includes multiple high traffic roadways and unpaved parking lots that are directly adjacent to the drainage inlets (Figure 5-45). These roads receive frequent traction sand applications during winter months and vehicle traffic tracks additional road sand from Interstate 80 as well as from pulling in and out of the unpaved parking areas. Snow removal operations frequently disturb soils which later erode during snowmelt or stormwater runoff events. This site also has trace levels of petroleum hydrocarbon contamination based on visual observations of sheen and the results of a grab sample collected during WY 2011. No groundwater intrusion has been observed coming into the drainage system at this site.

In November of 2011 the drainage system upstream of the sampling point was cleaned by Town maintenance crews. Four samples were collected at the site after the cleaning operations which did not indicate a clear improvement in water quality but this may be due to the limited amount of data.

Figure 5-45
Runoff from Unpaved Parking Lots in Brickelltown Catchment Area

Bridge Street SW Outfall (DSC-TT2)

This site was installed in March 2012 and monitored for TSS, turbidity, pH, and conductivity only. TSS was laboratory analyzed, but the other constituents were measured using field instruments. Five samples have been collected to date. The mean TSS concentration measured at this site was higher than most of the community level sites. Runoff for this site originates from Brockway Road and the Hilltop development. A spring also discharges into the drainage area which likely dilutes the runoff being sampled at this site. Traction sand is frequently applied to this portion of Brockway Road and erosion is occurring on the cut slope above the site as shown in Figure 5-46. The results at this site were highly variable ranging from 26 mg/L to 1400 mg/L, both of which were from mixed rain and snow events. In this case, the higher concentration was from a larger precipitation event (1.8 inches versus 0.8 inches).

Figure 5-46
Sediment Accumulations on Brockway Road Draining to DSC-TT2

Bridge Street SE Outfall (DSC-TT3)

This site was installed in March 2012 and monitored for TSS, turbidity, pH, and conductivity only. TSS was laboratory analyzed, but the other constituents were measured using field instruments. Five samples have been collected to date. This site had the third highest TSS mean concentration after the Donner Creek and Brickelltown sites. This site has a small drainage area consisting of a section of Brockway Road that receives significant amounts of traction sand during the winter months as shown in Figure 5-47. A large stormwater vault just upstream of the sampling point provides treatment prior to discharge. Small runoff events typically do not discharge from the outfall as a result of this vault. A very high TSS concentration was observed during an April 12, 2012 snowmelt event, and a low value was observed during an August 14, 2012 rain event. This was likely due to the amount of traction sand present on the roadway at the time of the event.

Figure 5-47
Sediment Accumulations on Brockway Road Draining to DSC-TT3

Bridge Street NW Outfall (DSC-TT4)

This site was installed in March 2012 and monitored for TSS, turbidity, pH, and conductivity only. TSS was laboratory analyzed, but the other constituents were measured using field instruments. Five samples have been collected to date. The mean TSS concentration at this site was in the middle of the range when compared to all other sites. This site receives runoff from historic downtown Truckee with little upstream stormwater treatment. The results at this site were also variable ranging from 50 mg/L to 1000 mg/L, both for snowmelt events. A photograph of the downtown drainage area during a rain event is provided in Figure 5-48.

Figure 5-48
Catchment Area Draining to the Bridge Street NW Outfall (DSC-TT4)

West River Street Outfall (DSC-TT5)

This site was installed in March 2012 and monitored for TSS, turbidity, pH, and conductivity only. TSS was laboratory analyzed, but the other constituents were measured using field instruments. Five samples have been collected to date. The mean TSS concentration at this site was in the middle to high range Relative to other sites. It receives runoff from commercial areas on West River Street as well as from West River Street itself. The commercial areas contain a large area of dirt open space that appears to be a major source of TSS at this site (Figure 5-49). The runoff from West River Street is conveyed to the outfall via an earthen channel where erosion is evident as shown in Figure 5-50. The culvert crossing under the road at this site is approximately 50 percent full of sediment. The two samples with the highest TSS concentrations at this site were from snowmelt events.

Figure 5-49
Catchment Area Draining to the West River Street Outfall (DSC-TT5)

Figure 5-50
Earthen Channel Upstream of the West River Street Outfall (DSC-TT5)

Donner Creek Outfall (DSC-DC1)

This site was installed in March 2012 and monitored for TSS, turbidity, pH, and conductivity only. TSS was laboratory analyzed, but the other constituents were measured using field instruments. Five samples have been collected to date. This site had the second highest mean concentration of TSS after Brickelltown. This was the only site not to have a single event concentration below 100 mg/L. The drainage area for this site includes a section of Highway 89, West River Street, and a portion of the Donner Creek Trailer Park. This is a very high traffic area that receives traction sand treatment during winter storms. Runoff is conveyed to the site via an earthen channel which shows signs of erosion (Figure 5-51). This site discharges to Donner Creek just above the confluence with the Truckee River. A sediment plume is often visible at this confluence (Figure 5-52).

Figure 5-51
Earthen Channel Leading to the Donner Creek Outfall

Figure 5-52
Sediment Plume at the Donner Creek/Truckee River Confluence

5.3.5 Field Parameters

Additional community level field measurements were collected in WY 2012 for Brickelltown (DSC-TT1), Trout Creek SE (DSC-TC1), and the six new Town sites. Portable water quality meters were used to measure turbidity, pH, and conductivity of the samples prior to sending to the lab. Field parameter data was collected as a screening type assessment tool and QA/QC check for lab data. Tables containing the results of the field measurements are presented in Appendix C, and can be identified by the "Field" label in the sample type column.

In general, higher TSS concentrations in the lab data corresponded to higher turbidity field measurements. pH values were typically between 7.0-8.75 which is considered typical for stormwater runoff. Electrical Conductivity is often used as an indicator for dissolved solids such as road deicing salt. The highest EC values were measured at the Bridge St. SE Outfall (DSC-TT3) and Trout Creek NW (DSC-TC2), both areas were salt is frequently applied to steep roadways and intersections during winter months.

5.3.6 QA/QC Results

Upon receipt from the laboratory, each analytical report was thoroughly reviewed and the data evaluated to determine if the data met the project objectives. Data reviewed included storm water samples. Initially, the data were screened for the following major items:

- A 100 percent check between electronic data provided by the laboratory and the hard copy reports;
- Conformity check between the chain-of-custody forms, compositing protocol, and laboratory reports;
- A check for laboratory data report completeness; and,
- A check for typographical errors on the laboratory reports.

After performing the aforementioned data screening, the laboratory was notified of any deficiencies, if any, detailing the problems encountered during the initial screening process.

Following the initial screening, a more complete QA/QC review was performed, which included an evaluation of method holding times, method blank contamination, and accuracy and precision. Accuracy was evaluated by reviewing MS, MSD, and LCS recoveries; precision was evaluated by reviewing field duplicate, spike duplicate and laboratory sample duplicate RPDs.

A total of 607 constituents were measured among 107 samples (including field QC samples). Data quality assessment was based upon review of holding times, laboratory blanks, laboratory control samples, laboratory duplicates, matrix spikes and matrix spike duplicates, reporting limits, and field duplicates. Based on the data review, none of the constituent results were rejected. Appendix E provides the detailed descriptions of specific items that were evaluated during the QA/QC review process and data that were qualified as estimated due to laboratory QC exceedances.

5.4 Tributary Level Discrete Water Quality Monitoring

In this section the results of the WY 2012 tributary level water quality monitoring are presented including a description of the monitored events, the water quality results, a statistical summary and analysis and a discussion of the QA/QC Results.

5.4.1 Monitored Events

During WY 2012, tributary level discrete samples were collected from all six of the monitoring locations described in Section 4. A summary of the events that were successfully monitored during WY 2012 is presented in Table 5-15. An effort was made to collect the tributary samples during the rising limb of an event, when possible, to provide data for "worst-case-scenarios." After the samples were collected, the stage data from the Martis Creek gauging station (Station GS-MC1) was reviewed to determine whether the samples were collected during the rising limb of an event. Figures 5-53 thru 5-59 illustrate when the samples were collected in relation to stream stage. These figures show that six of the seven events were sampled during the rising limb or near the peak stage of the runoff event.

Table 5-15
2010 & 2012 Water Years Tributary Level Water Quality Monitoring Event Summary[1]

Event Date	Event Type[2]	Antecedent Dry Time (Days)	Total Precip (inches)
2011 Water Year			
12/14/2010	M	6	1.6
12/18/2010	M	1	2
3/15/2011	M	4	1.3
4/1/2011	S	6	NA
5/5/2011	S	10	NA
6/6/2011	M	1	1.5
6/29/2011	R	20	0.4
2012 Water Year			
1/21/2012	M	23	1.8
3/14/2012	M	7	0.7
3/16/2012	M	1	2.1
3/21/2012	S	3	NA
4/20/2012	S	7	NA
4/23/2012	S	10	NA
4/26/2012	R	11	0.9

1. A sample was collected at all six sites for every event
2. M = Mixed Snow/Rain, R = Rain, S = Snowmelt.
NA = not applicable

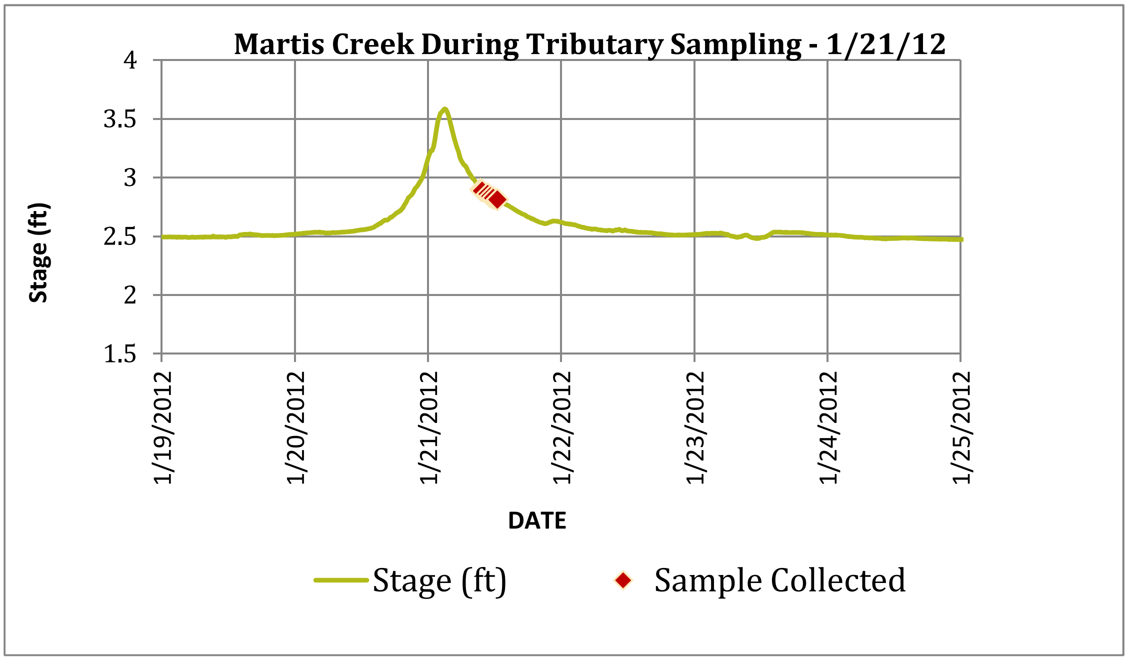


Figure 5-53
Tributary Event 1/21/2012

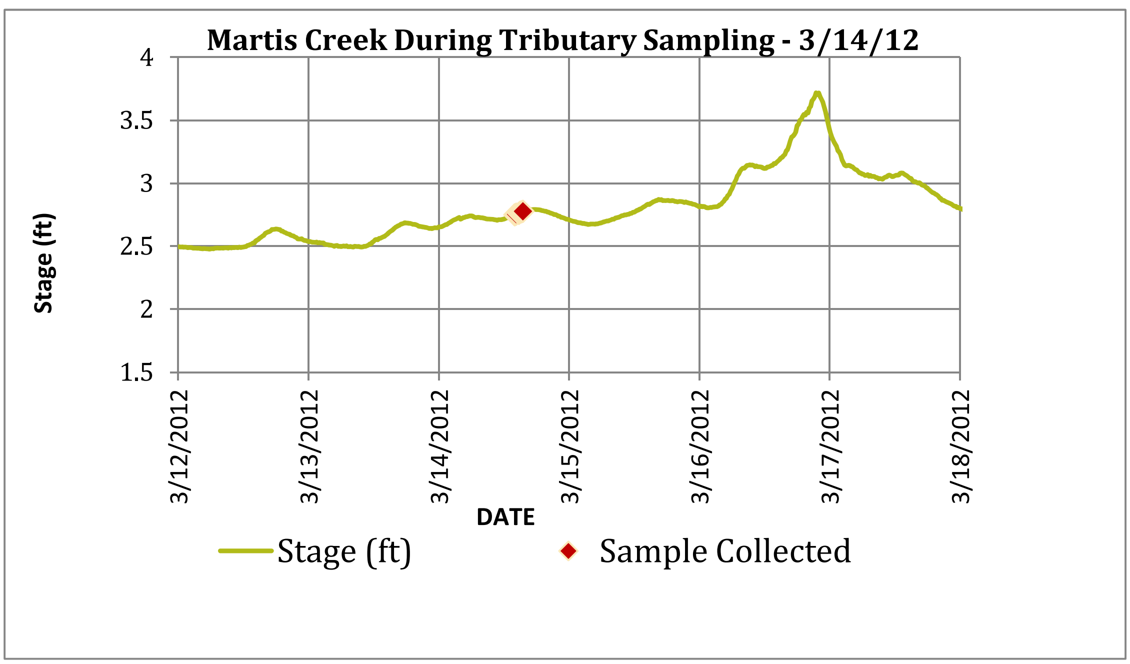


Figure 5-54
Tributary Event 3/14/2012

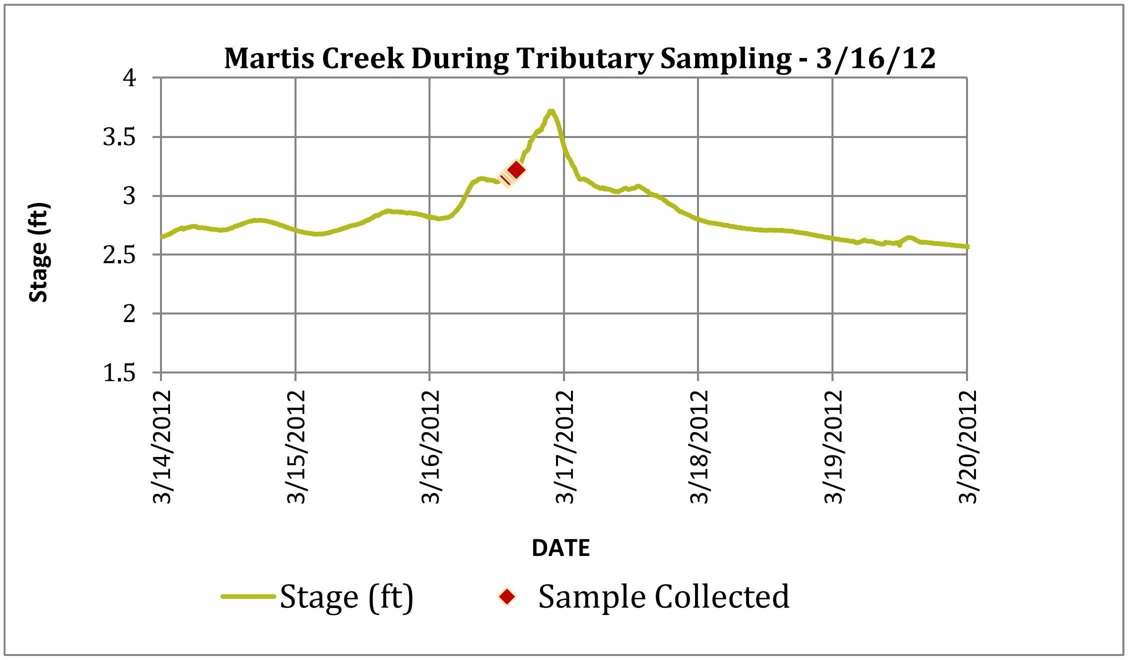


Figure 5-55
Tributary Event 3/16/2012

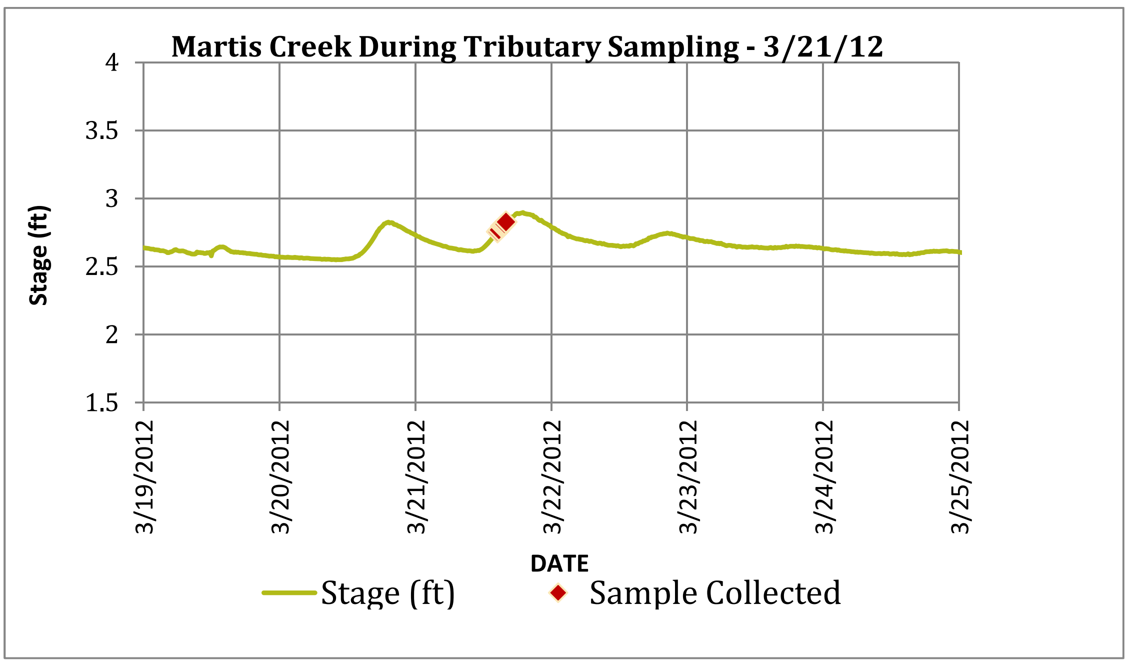


Figure 5-56
Tributary Event 3/21/2012

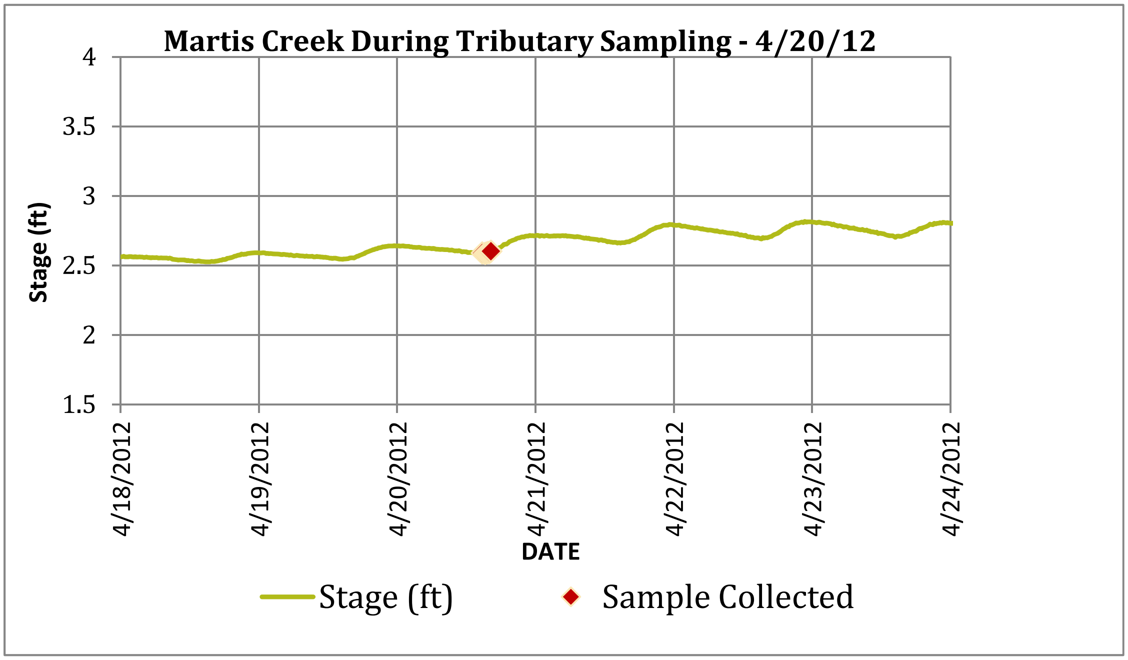


Figure 5-57
Tributary Event 4/20/2012

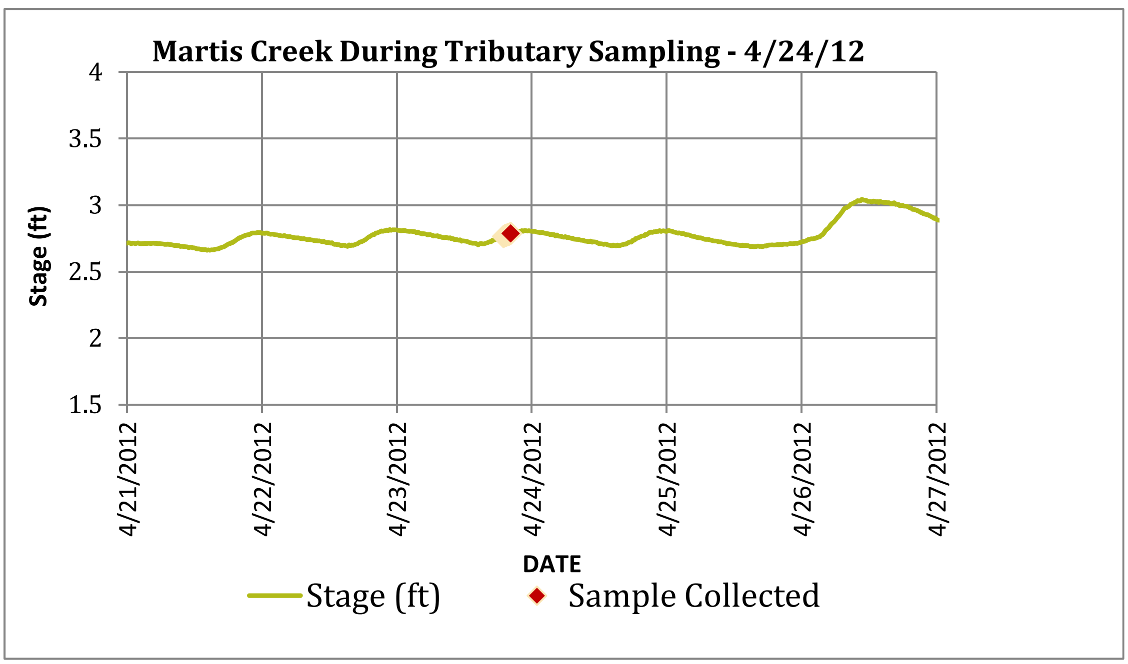


Figure 5-58
Tributary Event 4/24/2012

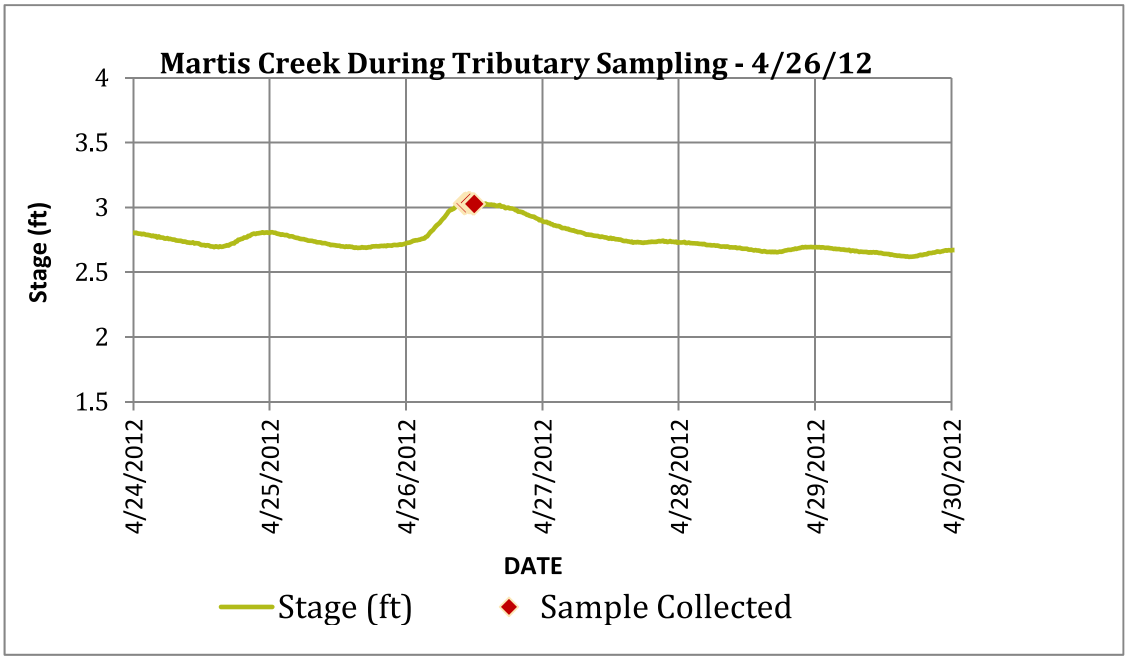


Figure 5-59
Tributary Event 4/26/2012

5.4.2 Water Quality Results

The results for TSS, turbidity, total nitrogen, and total phosphorus are also presented graphically in Figures 5-60, 5-61, 5-62, and 5-63, respectively. The figures show that the differences in mean concentrations are relatively small and no sites had consistently higher or lower mean concentrations. A review of Figures 5-53 through 5-59 indicates the largest increase in stream discharge occurred during the January 21st, March 16th and April 26th, 2012 storm events. These were either mixed rain/snow or rain events and represented the largest storms that occurred during WY 2012. As expected, pollutant concentrations were elevated during these events relative to the other smaller monitored events. The highest pollutant concentrations occurred during the January 21st event. This event had a steep increase in stream discharge, little to no snowpack in much of the tributary watershed, a large amount of precipitation (1.8 inches), and a relatively long period of dry antecedent conditions (23 days). The complete analytical results for the tributary level water quality monitoring are presented in Appendix C.

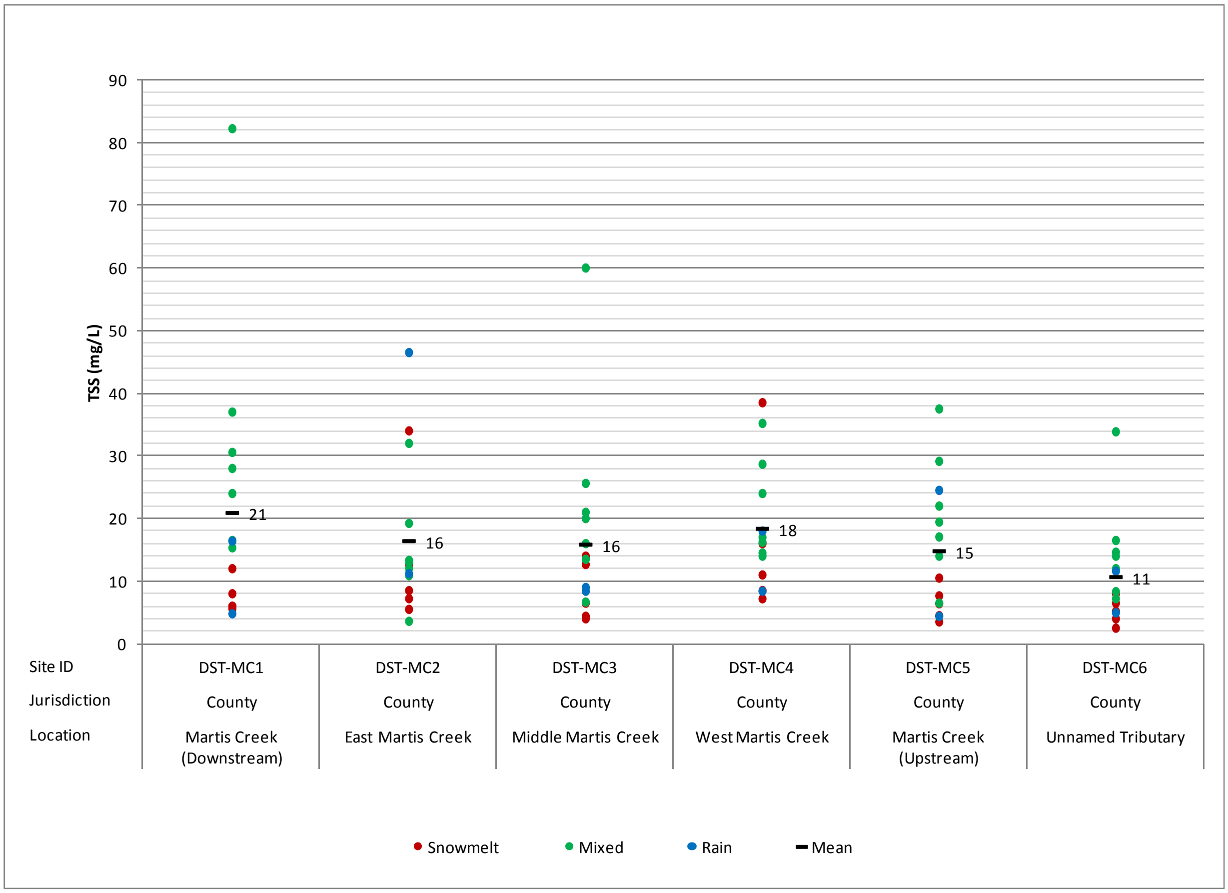


Figure 5-60
Tributary Site Comparisons – TSS

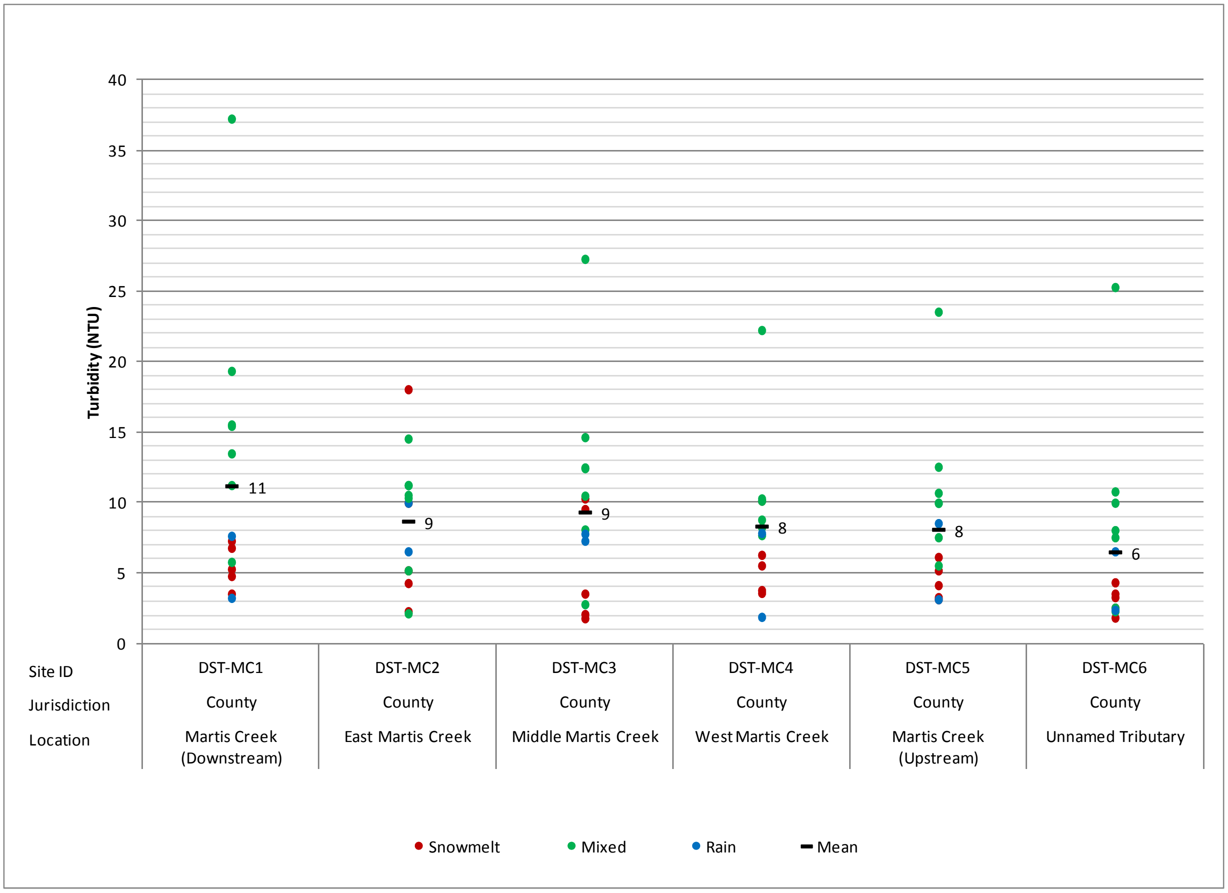


Figure 5-61
Tributary Site Comparisons – Turbidity

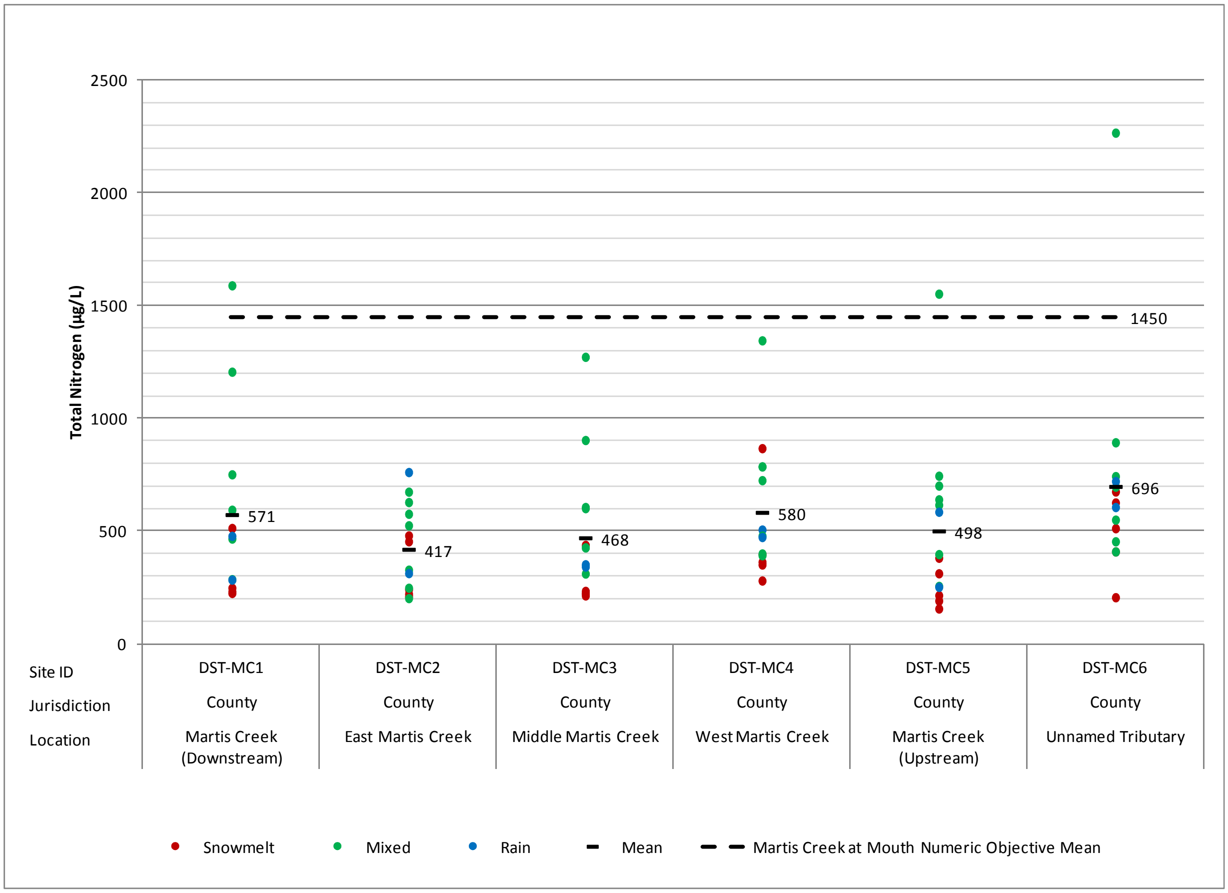


Figure 5-62
Tributary Site Comparisons – Total Nitrogen

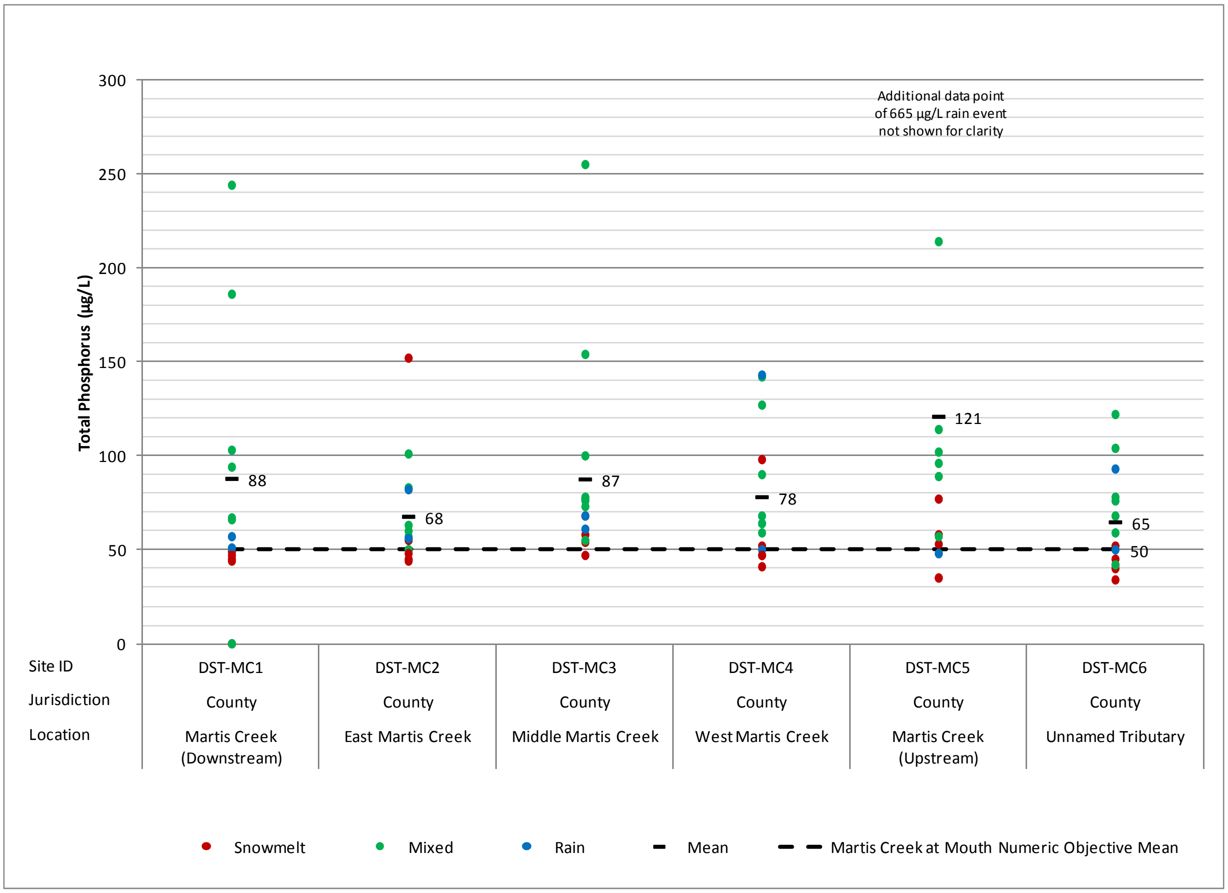


Figure 5-63
Tributary Site Comparisons – Total Phosphorus

5.4.3 Statistical Analyses

Summary level statistics (mean, standard deviation, coefficient of variation, median) are calculated from the analytical data from each monitoring site.

5.4.3.1 Summary Statistics

Summary level statistics were generated for the 2011 and 2012 monitoring seasons combined to help describe the data set for each site and are presented in Tables 5-16 thru 5-21. The summary statistics include the number of samples, percent detection, minimum, maximum, mean, median, standard deviation and CV. There were no non-detectable concentrations of the monitored constituents in any of the tributary samples. The CV values for all sites were high but less than those observed in the community level data.

Table 5-16. Water Years 2011 & 2012 Martis Creek Tributary Summary Statistics (DST-MC1)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	Coefficient of Variation
				Min	Max				
Total Suspended Solids	mg/L	14	100%	4.8	82	21	16	20	0.98
Turbidity	NTU	14	100%	3.2	37	11	7.4	9.0	0.81
Nitrate as N / Nitrite as N	µg/L	12	100%	4.0	435	88	22	133	1.5
Ammonia as N	µg/L	12	100%	1.0	6.0	3.8	4.0	1.5	0.38
Total Kjeldahl Nitrogen (TKN)	µg/L	12	100%	219	1152	483	414	305	0.63
Total Nitrogen as N	µg/L	12	100%	223	1587	571	470	426	0.75
Dissolved Phosphorus as P	µg/L	14	100%	21	153	41	33	33	0.80
Dissolved Orthophosphate as P	µg/L	12	100%	11	121	27	19	30	1.1
Total Phosphorus as P	µg/L	12	100%	44	244	88	62	64	0.72

Notes
mg/L =milligrams per liter. NTU = nephelometric turbidity units. µg/L = micrograms per liter
n = Number of samples
Total Nitrogen is the sum of nitrate (as N), nitrite (as N), and total Kjeldahl nitrogen
Percent Detection = percent of samples that were detected above the reporting limit

Table 5-17. Water Years 2011 & 2012 Martis Creek Tributary Summary Statistics (DST-MC2)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	Coefficient of Variation
				Min	Max				
Total Suspended Solids	mg/L	14	100%	3.6	47	16	12	12	0.76
Turbidity	NTU	14	100%	2.1	18	8.6	10	4.6	0.53
Nitrate as N / Nitrite as N	µg/L	14	100%	2.0	183	22	6.0	48	2.2
Ammonia as N	µg/L	14	100%	1.0	6.0	3.1	3.0	1.4	0.45
Total Kjeldahl Nitrogen (TKN)	µg/L	14	100%	192	753	395	381	180	0.46
Total Nitrogen as N	µg/L	14	100%	200	759	417	389	191	0.46
Dissolved Phosphorus as P	µg/L	14	100%	25	72	38	33	14	0.37
Dissolved Orthophosphate as P	µg/L	14	100%	12	61	21	16	14	0.66
Total Phosphorus as P	µg/L	14	100%	44	152	68	57	29	0.44

Notes
mg/L =milligrams per liter. NTU = nephelometric turbidity units. µg/L = micrograms per liter
n = Number of samples
Total Nitrogen is the sum of nitrate (as N), nitrite (as N), and total Kjeldahl nitrogen
Percent Detection = percent of samples that were detected above the reporting limit

Table 5-18. Water Years 2011 & 2012 Martis Creek Tributary Summary Statistics (DST-MC3)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	Coefficient of Variation
				Min	Max				
Total Suspended Solids	mg/L	14	100%	4.0	60	16	13	14	0.90
Turbidity	NTU	14	100%	1.8	27	9.3	8.8	6.6	0.71
Nitrate as N / Nitrite as N	µg/L	14	100%	1.0	302	35	4.5	79	2.2
Ammonia as N	µg/L	14	100%	2.0	10	4.1	3.5	2.3	0.56
Total Kjeldahl Nitrogen (TKN)	µg/L	14	100%	211	968	433	362	239	0.55
Total Nitrogen as N	µg/L	14	100%	212	1270	468	388	300	0.64
Dissolved Phosphorus as P	µg/L	14	100%	27	200	50	36	44	0.89
Dissolved Orthophosphate as P	µg/L	14	100%	13	181	34	23	43	1.3
Total Phosphorus as P	µg/L	14	100%	47	255	87	71	55	0.63

Notes
mg/L =milligrams per liter. NTU = nephelometric turbidity units. µg/L = micrograms per liter
n = Number of samples
Total Nitrogen is the sum of nitrate (as N), nitrite (as N), and total Kjeldahl nitrogen
Percent Detection = percent of samples that were detected above the reporting limit

Table 5-19. Water Years 2011 & 2012 Martis Creek Tributary Summary Statistics (DST-MC4)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	Coefficient of Variation
				Min	Max				
Total Suspended Solids	mg/L	14	100%	7.2	39	18	16	9.8	0.53
Turbidity	NTU	14	100%	1.9	22	8.3	8.0	4.8	0.58
Nitrate as N / Nitrite as N	µg/L	14	100%	16	661	132	92	161	1.2
Ammonia as N	µg/L	14	100%	1.0	15	4.6	4.5	3.5	0.75
Total Kjeldahl Nitrogen (TKN)	µg/L	14	100%	241	765	448	393	178	0.40
Total Nitrogen as N	µg/L	14	100%	278	1343	580	474	290	0.50
Dissolved Phosphorus as P	µg/L	14	100%	17	108	37	24	30	0.80
Dissolved Orthophosphate as P	µg/L	14	100%	4.0	67	21	12	20	0.97
Total Phosphorus as P	µg/L	14	100%	41	143	78	64	36	0.46

Notes
mg/L =milligrams per liter. NTU = nephelometric turbidity units. µg/L = micrograms per liter
n = Number of samples
Total Nitrogen is the sum of nitrate (as N), nitrite (as N), and total Kjeldahl nitrogen
Percent Detection = percent of samples that were detected above the reporting limit

Table 5-20. Water Years 2011 & 2012 Martis Creek Tributary Summary Statistics (DST-MC5)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	Coefficient of Variation
				Min	Max				
Total Suspended Solids	mg/L	14	100%	3.5	38	15	12	11	0.71
Turbidity	NTU	14	100%	3.1	24	8.1	6.8	5.4	0.67
Nitrate as N / Nitrite as N	µg/L	14	100%	5.0	361	74	43	98	1.3
Ammonia as N	µg/L	14	100%	1.0	8.0	3.7	3.2	2.0	0.54
Total Kjeldahl Nitrogen (TKN)	µg/L	14	100%	149	1189	424	324	279	0.66
Total Nitrogen as N	µg/L	14	100%	154	1550	498	387	364	0.73
Dissolved Phosphorus as P	µg/L	14	100%	21	603	85	36	154	1.8
Dissolved Orthophosphate as P	µg/L	14	100%	12	222	45	21	60	1.3
Total Phosphorus as P	µg/L	14	100%	35	665	121	68	163	1.4

Notes
mg/L =milligrams per liter. NTU = nephelometric turbidity units. µg/L = micrograms per liter
n = Number of samples
Total Nitrogen is the sum of nitrate (as N), nitrite (as N), and total Kjeldahl nitrogen
Percent Detection = percent of samples that were detected above the reporting limit

Table 5-21. Water Years 2011 & 2012 Martis Creek Tributary Summary Statistics (DST-MC6)

Constituent	Units	n	Percent Detection	Range		Mean	Median	Standard Deviation	Coefficient of Variation
				Min	Max				
Total Suspended Solids	mg/L	14	100%	2.5	34	10.7	8.2	7.9	0.74
Turbidity	NTU	14	100%	1.8	25	6.5	3.9	6.2	0.96
Nitrate as N / Nitrite as N	µg/L	14	100%	2.0	419	99	26	133	1.3
Ammonia as N	µg/L	14	100%	2.0	179	17	4.5	47	2.8
Total Kjeldahl Nitrogen (TKN)	µg/L	14	100%	188	1845	596	526	388	0.65
Total Nitrogen as N	µg/L	14	100%	204	2264	696	614	483	0.70
Dissolved Phosphorus as P	µg/L	14	100%	13	112	36	31	24	0.67
Dissolved Orthophosphate as P	µg/L	14	100%	5.0	78	17	11	18	1.1
Total Phosphorus as P	µg/L	14	100%	34	122	65	56	27	0.41

Notes
mg/L =milligrams per liter. NTU = nephelometric turbidity units. µg/L = micrograms per liter
n = Number of samples
Total Nitrogen is the sum of nitrate (as N), nitrite (as N), and total Kjeldahl nitrogen
Percent Detection = percent of samples that were detected above the reporting limit

5.4.3.2 Statistical Comparisons

Trends in concentrations over time are evaluated visually using time-series plots and formally using the Mann-Kendall test method. T-tests are used to determine if two groups of data have a significant difference.

The statistical outputs from the trend analyses are included in Appendix D and the results are summarized in Table 5-22 below.

Table 5-22. Statistical Trends of Constituents of Concern at Tributary Monitoring Sites

	TSS	Turbidity	Total Nitrogen	Total Phosphorus	Diss. Phosphorus
DST-MC1	Decreasing	Decreasing		Decreasing	
DST-MC2	Decreasing	Decreasing	Slightly Increasing		
DST-MC3	Decreasing	Decreasing		Decreasing	
DST-MC4	Slightly Decreasing	Slightly Decreasing			
DST-MC5	Slightly Decreasing	Slightly Decreasing			Slightly Increasing
DST-MC6	Decreasing	Decreasing			Slightly Increasing

Note: Mann-Kendall (MK) Trend Analyses used to determine significance.

A blank cell signifies no discernible trends or insufficient data points to analyze.

Table 5-22 shows a decreasing trend of TSS and turbidity values at the tributary sites, most likely a result of WY 2011 being an above average precipitation year, and WY 2012 being a below average precipitation year. Runoff rates and volumes during WY 2012 were much lower than the previous year and carried less sediment downstream.

Trends in nutrient concentrations are inconsistent and additional data is needed to improve confidence in these conclusions. The decreasing trends in total phosphorus are likely related to the decrease in sediment. The slightly increasing total nitrogen and dissolved phosphorus trends are most likely caused by a few more extreme values in the data set and any conclusions should be considered preliminary.

Based on the differences observed in Tables 5-16 thru 5-21, statistical comparisons (t-tests at the 95 percent confidence level) were conducted on select data groups. The only two sites with statistically significant differences in pollutant concentrations are DST-MC1 and DST-MC6 for turbidity and DST-MC2 and DST-MC6 for total nitrogen.

The differences among mean concentrations at all of the tributary sites are not large and, except for the two instances mentioned above, statistical differences cannot yet be discerned with the limited amount of data collected to date. The number of samples required to determine significance increases if the mean values between the two groups are similar and there is large variability in the data.

5.4.4 Tributary Level Discussion

The results for each of the tributary sites are discussed further in the sections below. The discussions focus on watershed characteristics and how they may relate to water quality results for the key constituents (TSS, turbidity, TKN, total phosphorus, and total nitrogen). Table 5-23 summarizes the tributary level results by presenting mean concentrations for TSS, turbidity, TKN, total nitrogen, and total phosphorus at each of the monitoring sites and provides a comparison to the relevant water quality objectives for the mouth of Martis Creek.

Table 5-23. Tributary Level Site Rankings Based on Mean Pollutant Concentrations

Sites		Jurisdiction	Mean TSS (mg/L)	Mean Turbidity (NTU)	Mean Total Kjeldahl Nitrogen (TKN) (µg/L)	Mean Total Nitrogen (µg/L)	Mean Total Phosphorus (µg/L)
Martis Creek at Mouth	TRWQMP Objectives		N/A	N/A	450	1450	50
Martis Creek at Mouth	DST-MC1	County	21	11	483	571	88
East Martis Creek	DST-MC2	County	16.4	8.6	395	417	68
Middle Martis Creek	DST-MC3	County	15.8	9.3	433	468	87
West Martis Creek	DST-MC4	County	18	8.3	448	580	78
Martis Creek (Upstream)	DST-MC5	County	14.8	8.1	424	498	121
Unnamed Tributary	DST-MC6	County	11	6	596	696	65

Notes: A ranking of 1 equals the lowest mean value, a ranking of 2 equals the second lowest mean value, and so on.

Ranking of 1 = (dark green)
Ranking of 2 = (light green)
Ranking of 3 = (yellow)
Ranking of 4 = (orange)
Ranking of 5 = (red)
Ranking of 6 = (dark red)

DST-MC1 (Martis Creek at Martis Creek Lake)

This monitoring site is located at the mouth of Martis Creek, and is downstream of all tributary confluences. The larger flows produced by rain and mixed events at this site (Figure 5-64) produced the highest concentrations at this location relative to the smaller snowmelt induced flows. This site had the highest levels of TSS and turbidity and the concentrations of TKN, total nitrogen, and total phosphorus were all in the higher range when compared to the other tributary sites. The mean concentrations of TKN and total phosphorus exceeded the established water quality objectives at this location while the total nitrogen concentrations where below the water quality objective.

Figure 5-64
Sampling at Site DST-MC1

DST-MC2 (East Martis Creek)

This site is located on East Martis Creek approximately 0.5 mile upstream of its confluence with the main stem. The sub-watershed for this site consists of 100 percent pervious, upland meadow and forest with some dirt roads. This site had the lowest mean concentrations for TKN and total nitrogen and the second lowest mean concentration of total phosphorus. The mean TSS and turbidity concentrations at this site ranked in the middle to higher levels when compared to the other sites. The higher particulate concentrations at this site are somewhat unexpected given the minimal development in the sub-watershed. A photograph of sampling at this site is presented in Figure 5-65.

Figure 5-65
Sampling at the DST-MC2 during 4/26/12 Rain Event

DST-MC3 (Middle Martis Creek)

This monitoring site is located on Middle Martis Creek approximately 250 feet upstream of its confluence with the main stem. The sub-watershed for this site consists of upland forest and meadow with some dirt roads as well as an approximately four mile section of SR 267. This portion of SR 267 includes a steep grade to Brockway Summit where traction sand is applied. Caltrans installed a series of new sand traps on SR 267prior to WY 2012. During the spring snowmelt, the stream sometimes overtops its banks upstream of the monitoring location and a portion of the stream flow bypasses the site (Figure 5-66). During this time period, flows travel along preferential paths formed by previous overflow conditions at this location. Most of the flow from the breach returns to the main channel upstream of the monitoring site, but some flows into the main stem of Martis Creek just downstream of the monitoring location. The mean concentrations of TSS, turbidity, TKN, and total phosphorus were all in the mid to higher levels relative to other tributary level sites.

Figure 5-66
Middle Martis Creek Bypass

DST-MC4 (West Martis Creek)

DST-MC4 is located on West Martis Creek approximately 0.25 miles upstream of its confluence with the main stem. West Martis Creek originates within the Northstar ski resort and flows through the Northstar residential development and golf course (Figure 5-67). The mean concentrations of TSS, turbidity, TKN, total nitrogen, and total phosphorus were all in the mid to higher levels when comparing this site to the other tributary sites.

Figure 5-67
Site DST-MC4 Looking Upstream Towards Golf Course and Northstar

DST-MC5 (Martis Creek)

This site is located on the main stem of Martis Creek approximately 100 feet downstream of an unnamed tributary that receives flow from a portion of the Lahontan development and access road. This site was relocated downstream following the first monitored event in 2011 due to a breach in the unnamed tributary that caused a significant portion of the flow to bypass downstream of the original monitoring location (Figure 5-68). This site is located upstream of all major tributary confluences, and its sub-watershed consists of a portion of the Northstar ski resort, upland forest and meadow with some dirt roads, and the developed residential areas of Lahontan Golf Club and Martis Camp. This site has a large sub-watershed and receives more flow than the other tributary sites (except for DST-MC1). This site had the second lowest mean concentration for TSS, turbidity, and TKN. The mean concentration for total phosphorus went from the lowest value in WY 2011 to the highest value in the combined WY 2011 and WY 2012 data. This increased average is likely due to a mix event on January 21, 2012 and a rain event on April 26, 2012 which produced total phosphorus concentrations at this site of 214 and 665 µg/L, respectively, each much higher than any WY 2011 events.

Figure 5-68
Unnamed Tributary Breaching its Banks near Site DST-MC5

DST-MC6 (Unnamed Tributary)

This site is located on an unnamed tributary of Martis Creek approximately 100 feet downstream of Martis Lake Road. This site had the lowest flow rates of all of the tributary sites due to its relatively small sub-watershed which consists of commercial development, a portion of the Truckee Tahoe Airport and open meadow areas. After discharging from the developed areas, runoff flows through a meadow where infiltration and treatment can occur as shown in Figure 5-69. This site had the lowest mean concentrations for TSS, turbidity, and total phosphorus. The mixed snow and rain event on January 21, 2012 produced an unusually high concentration of total nitrogen which also caused the site to have the highest mean concentrations for total nitrogen and TKN.

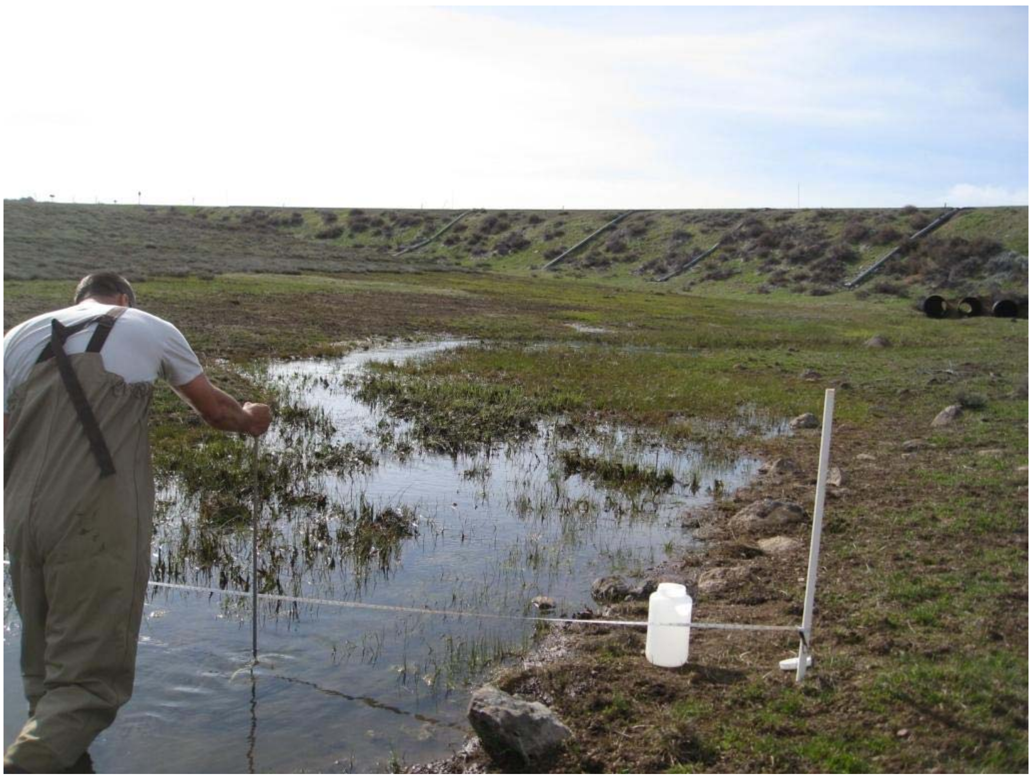


Figure 5-69
Low Flow Snowmelt Event at Site DST-MC6

5.4.5 QA/QC Results

All results were evaluated against a set of predefined quality control criteria. In the 2012 dataset, one triplicate sample was collected and analyzed to assess field precision. The field triplicate was collected from the DST-MC5 site on March 16, 2012. All results met the field precision criteria presented in Table 4-6.

The QA/QC review of analytical results found all the data to be of acceptable quality and usable for the intended purposes. For a detailed explanation of QA/QC procedures and results, refer to Appendix E.

5.5 Stream Gauging Station

The 2012 stream discharge monitoring results from the Martis Creek gauging station (GS-MC1) are presented below. The gauge was installed in November of 2011 and has been operated continuously since that time.

5.5.1 Site Operations

Field visits to the site were performed throughout WY 2012 to continue rating curve development, download data and maintain the equipment. Typical field visit tasks included measuring flow velocities, downloading the data from the pressure transducer and comparing current transducer stage readings to staff gauge readings located at the site.

5.5.2 Rating Curve Development

Due to the interfering effects of a beaver dam downstream of the stream gauge, development of the stream rating curve was continued during WY 2012 (Appendix F). During the first week of July 2011, a beaver dam/pond approximately 600 ft downstream of the Martis Creek stream gauge increased the water level at the stream gauge location. This rendered the initial rating curve developed during WY 2011 inaccurate for the time period after the dam's establishment.

Several alternatives were considered to address the problem including installing a pond leveler device, and relocating the stream gauge. After evaluating the alternatives, it was decided to continue collecting velocity measurements to develop a revised rating curve for the new condition.

The beaver dam remained stable throughout the high flow periods in WY 2012, then began to deteriorate at the end of April, 2012 causing stage measurements to decrease again. It is not clear why the dam is deteriorating but no new beaver activity was observed during the summer of 2012. Water levels in the pond did fluctuate during the summer including some increases that did not correspond to precipitation events so some beaver activity could still be occurring. It is also possible that other changes in the watershed, such as changes in groundwater pumping, could be affecting water levels at the gauging station.

5.5.3 Annual Discharge

The two rating curves developed to date were applied to the pressure transducer stage data to produce a semi- continuous record of discharge at the Martis Creek gauging station for WY 2011 and WY 2012 which is presented in Figure 5-70. The difference between the two years is readily apparent due to the large differences in precipitation amounts received. The total discharge volume in WY 2011 was almost four times as large as in WY 2012. The maximum measured stage during the entire monitored period was 4.3 feet which correlates to a discharge of approximately 420 cfs. This occurred on March 16, 2011 after nearly 4 inches of precipitation fell over a 72 hour period. The temperatures during this storm cycle were relatively warm which elevated snow levels and increased runoff. The lowest stage at the gauging station was 1.1 feet which correlates to a discharge of approximately 0.5 cfs. This occurred on August 9, 2012. In general, the discharge was greatest during the spring snowmelt cycles and was lowest during the late summer and fall.

The discharge rates shown in the graph are estimated for the periods of instability caused by the beaver dam construction or deterioration processes. During these time periods the water levels in the pond were changing and the rating curves are not applicable. Flows values were estimated by interpolating between the manual measurement points. This is apparent in the graph during the spring and summer months in both years.

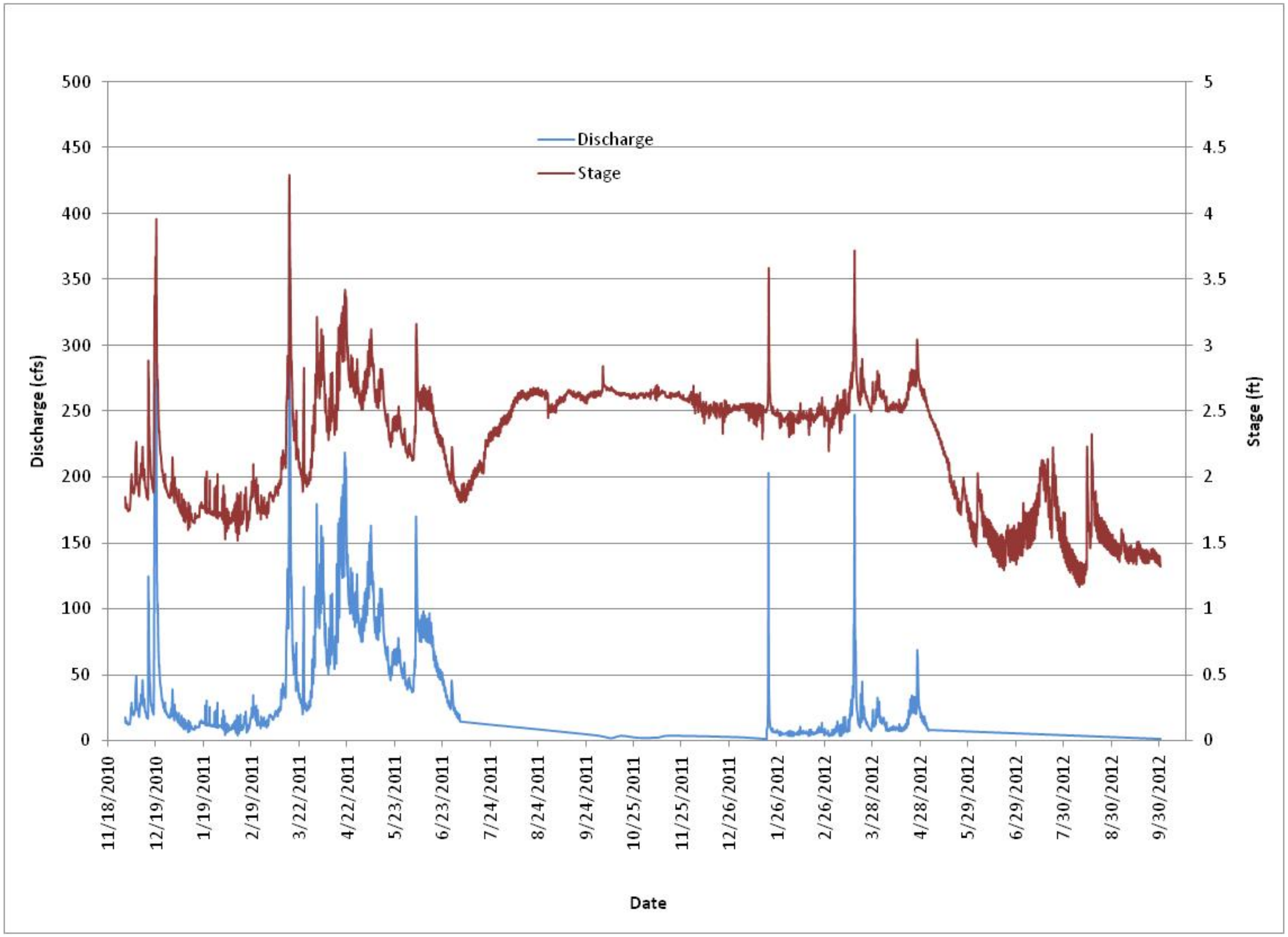


Figure 5-70
Water Years 2011 & 2012 Stage and Discharge

5.5.4 Load Estimates

Annual pollutant loads in the Martis Creek tributaries for WY 2011 and WY 2012 were estimated using the total discharge at each tributary site and the mean concentrations for each constituent. The annual discharge at each tributary sampling location was estimated based on the measured discharge at the Martis Creek gauging station (Site GS-MC1) and the size of each tributary's sub-watershed as a percentage of the total watershed size. This approach requires the assumption that the precipitation, and runoff response in the tributaries, was uniform over the entire watershed. Although differences in elevation, impervious area, land use, and other factors, likely caused variation in the amount of runoff produced in each watershed, this assumption is considered to be reasonable for the purpose of developing initial, relative annual load estimates. Future monitoring activities will include discharge measurements at two of the tributary level monitoring stations and will improve the understanding of discharge from the different Martis Creek tributaries. A map displaying the location of each tributary sampling location and their corresponding sub-watersheds is presented in Figure 5-71.

The tributary areas and relative discharge volumes for each of the Martis Creek sub-watersheds is presented Table 5-24 and the pollutant load estimates are presented in Table 5-25. The total load at each site is dependent on both the mean concentration from sampled runoff events and the discharge of the tributary. The load differences between the two years are mostly due to the differences in stream discharge volumes. Pollutant concentrations were higher in some cases, especially nutrients, but this was not enough to offset the effect of discharge volume on loads. It is also important to note that the mean constituent concentrations used in the load calculations were developed from samples of worst case scenario runoff events and therefore likely overestimate the annual loads. Future monitoring should consider sampling some lower flows, and presumably lower concentrations, to more accurately represent the full range of conditions in the stream for the annual load estimates.

In Table 5-25, site DST-MC1 had the largest loads because it receives flow from the entire Martis Creek sub-watershed. Each of the other tributary sites only receives a portion of this total flow. The pollutant loads at each tributary site generally correlated with each site's total annual discharge with the exception of sites DST-MC3 and DST-MC4 for WY 2011. Site DST-MC4 (West Martis Creek) had a slightly larger watershed than site DST-MC3 (Middle Martis Creek) and therefore also had a greater total discharge volume; however, the loads for TSS and total phosphorus were greater at site DST-MC3 due to higher mean concentrations. Pollutant load totals did correlate with each sites total annual discharge for WY 2012.

A comparison of the total pollutant load per acre of watershed (the summation of TSS, total phosphorus, and total nitrogen) for WY 2011 through WY 2012 shows DST-MC5 (65 pounds) and DST-MC6 (72 pounds) both had the lowest values per acre. Sites DST-MC3, DST-MC2, and DST-MC4 had totals of 99, 91, and 91 pounds per acre, respectively.

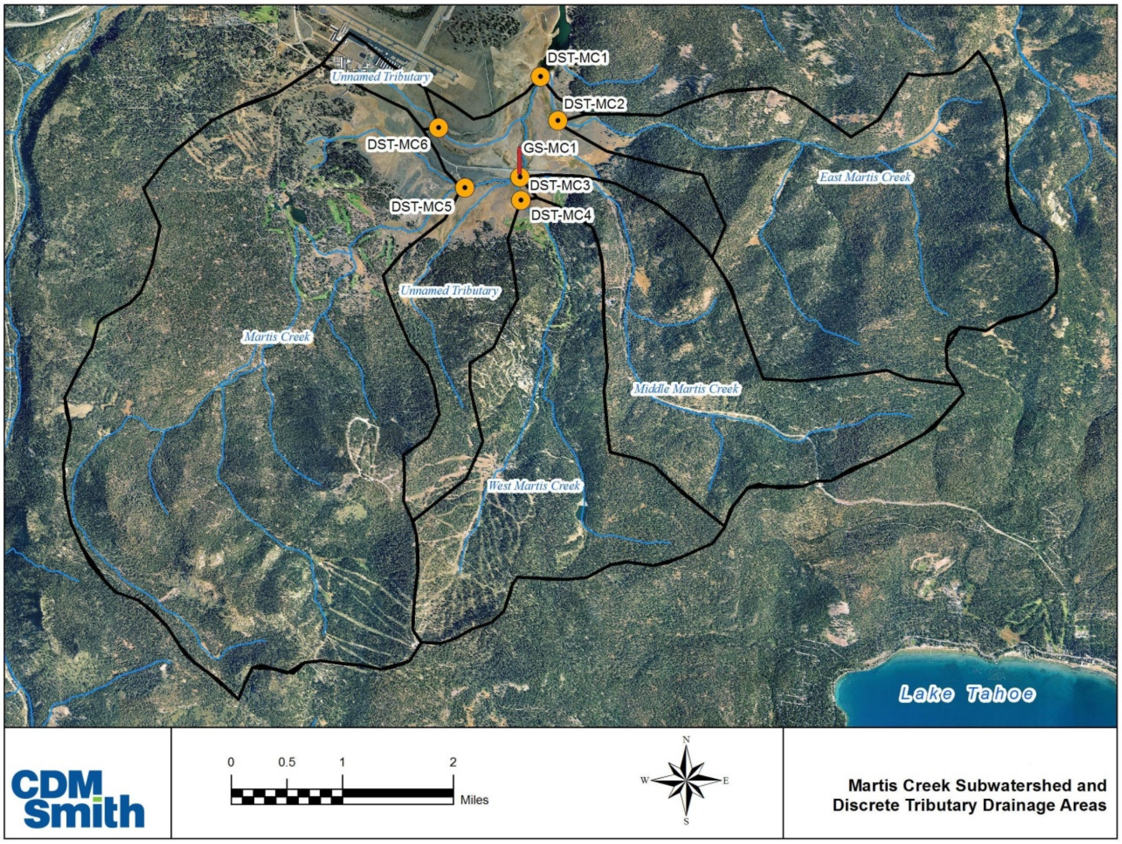


Figure 5-71
Martis Creek Tributary Monitoring Sites and Sub-Watersheds

Table 5-24. Martis Creek Tributary Annual Discharge Volumes

Station ID	Drainage Area (ac)	Percent of Martis Creek Sub watershed	WY 2011 Total Flow (acre ft)	WY 2012 Total Flow (acre ft)
DST-MC1	21,900	100%	31,334	8,370
DST-MC2	4,550	21%	6,510	1,739
DST-MC3	3,000	14%	4,292	1,147
DST-MC4	3,200	15%	4,578	1,223
DST-MC5	8,800	40%	12,591	3,363
DST-MC6	200	1%	286	76
GS-MC1	16,250	74%	23,426	6,211

Table 5-25. Total Tributary Loads

WY 2011						
	TSS		Total Nitrogen		Total Phosphorus	
Station ID	Mean (mg/L)	Load (lb)	Mean (µg/L)	Load (lb)	Mean (µg/L)	Load (lb)
DST-MC1	27	2,271,315	493	42,032	85	7,220
DST-MC2	19	339,236	324	5,732	72	1,270
DST-MC3	22	258,832	407	4,747	85	996
DST-MC4	18	218,995	450	5,599	66	824
DST-MC5	14	467,802	365	12,496	62	2,122
DST-MC6	14	10,706	539	420	64	50
WY 2012						
DST-MC1	15	344,423	679	15,460	92	2,095
DST-MC2	14	64,550	510	2,411	63	300
DST-MC3	10	29,662	529	1,650	90	279
DST-MC4	19	63,729	711	2,364	90	299
DST-MC5	16	145,909	631	5,771	180	1,644
DST-MC6	8	1,574	852	177	65	14