

## Chapter 6: Basis of Restoration Approach and Design

Information and analyses presented in this report demonstrate that the watershed conditions above Highway 89 and above the lower meadow area are, in general, in good ecological condition. In stark contrast, land use activities across the portion of Meeks Creek drainage below Highway 89 have altered ecosystem function to the extent that present ecological conditions are highly degraded between the highway and the shoreline of Lake Tahoe.

The construction and configuration of the Meeks Bay Marina requires that Meeks Creek be an incised channel and the presence and design of the Highway 89 bridge directs all flow and hydraulic force to be concentrated into a single bankfull channel downstream. These changes, in conjunction with development filling of former wetland and floodplain areas, have eliminated floodplain function and floodplain marsh surfaces within the critical elevation range necessary to support wetlands. The marina has been dredged into an artificially deepened, widened, and fixed configuration, resulting in a lack of natural geomorphologic and hydraulic processes and function in the dynamic floodplain/shoreline area, and resulting in generally poor primary benthic productivity and species viability.

The SNFPA (2004) AMS goals call for restoring physical processes to riparian and meadow ecosystems as a means to create self-sustaining riparian dependent plants and wildlife species and stable wildlife populations. Floodplain and marsh function are essential for a stable channel and natural growth and sustenance of riparian and meadow vegetation. Natural erosion and sediment deposition processes are essential to stable banks, valuable habitat in shorelines, healthy substrate and aquatic habitat and cover, and positive and functional hydraulic circulation. To meet the AMS goals at Meeks, the analyses presented in this EAR indicate that major restoration efforts are needed to restore ecosystem function below the Highway 89 bridge. Limited measures are indicated for the lower meadow areas above the highway.

In this Chapter we summarize the key ecosystem functions that have either been degraded or eliminated in the Meeks Creek Watershed, and what measures are possible to restore the degraded condition. These measures are presented consistent with the key SNFPA (2004) AMS goals governing the overall restoration objectives. As noted previously in this EAR, the decision to move forward with restoration projects is subject to “site-specific analysis and planning” when potential modification of recreation facilities is involved in order to determine the degree to which AMS goals are met. Recreational considerations are preliminarily assessed at this stage of the analysis and are addressed relative to possible management actions presented in Chapter 7.

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**AMS Goal — Water Quality:** Improve water quality to meet goals of Clean Water Act and Safe Drinking Water Act.

Meeks Creek upstream of Highway 89 discharges some of the cleanest water measured in the Lake Tahoe Basin. Measurements taken at Highway 89 have led many researchers to cite Meeks Creek as the baseline of pre-disturbance water quality.

Below Highway 89, however, the degraded channel conditions have simultaneously increased fine sediment production through bank erosion and eliminated floodplain fine sediment deposition; this has likely increased fine sediment discharge into Lake Tahoe. Detection of selected metals in the Meeks Bay Marina, while generally low, indicate pollution directly related to marina use. Leaching of organic carbon from natural drift matter (e.g., leaves and woody debris) trapped and decomposing in Meeks Bay Marina results in discoloration of the water discharged into Lake Tahoe.

Stabilizing the Meeks Creek channel and restoring natural bankfull channel and floodplain morphology would restore floodplain function and filter runoff. Restoring the natural barrier beach processes and shoreline wetland vegetation would increase hydraulic residence time, increase water/vegetation contact time, and increase fine sediment and nutrient removal.

**AMS Goal — Wildlife Species Viability:** Maintain and restore habitat as a means to restore and maintain wildlife species viability.

Wildlife populations in Meeks Creek Watershed have been modified from land use activities during the last 150 years. Some species, such as the native Lahontan cutthroat trout, have been eliminated through overfishing and introduction of competitive non-native species (i.e., lake, brook, brown, and rainbow trout). Other species, such as bald eagles, have retreated due to human encroachment and loss of food sources.

Habitat quality in Meeks Creek Watershed above Highway 89 is in generally good condition, notwithstanding the loss of species due to human encroachment. Below Highway 89, however, channel incision and elimination of natural geomorphic processes have dramatically reduced riparian and meadow vegetation, as evidenced by historical aerial photographs and subsurface investigations.

In order to restore and encourage sustainable habitat for wildlife, the reach below Highway 89 would have to be modified to restore geomorphic process and function. Restoring the creek function would initiate the natural geomorphic stability and lower floodplain processes that allow

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for colonization of native vegetation communities and form the basis for naturally sustained wildlife habitat. However, the continued human presence along the shoreline would discourage use by certain species such as the bald eagle.

**AMS Goal — Plant and Animal Community Diversity:** Maintain and restore species composition and structural diversity of plant and animal communities in riparian and meadow settings and provide desired habitats and ecological functions.

The diversity of plants and animals in Meeks Creek Watershed is in generally good condition above Highway 89, but very poor below the highway and in the shoreline zone. This difference is related to the presence of favorable natural geomorphic function above Highway 89, and unstable and unnatural (highly disturbed) conditions below Highway 89. With the exception of the invasion of lodgepole pines into meadows above Highway 89, native vegetation diversity and wildlife habitat is generally high in the lower meadow area. Below Highway 89, conditions are much less diverse and valuable, a direct result of human encroachment and past land use activities and disturbances.

The present conditions below Highway 89 would require substantial modification to restore natural geomorphic processes and hydrologic conditions in order to achieve sustained plant and animal diversity.

**AMS Goal — Special Habitats:** Provide self-sustaining habitat for species dependent upon unique habitat areas, such as springs, seeps, vernal pools, and fens.

The Shoreline Zone at Meeks Bay constitutes special habitat status under the AMS, as this habitat is not only rare in Lake Tahoe, but has been highly degraded or lost entirely due to collective land use activities and disturbances since 1850, and particularly since the early 1900's. The original wetland ecosystem documented in historical photographs show a unique and highly-productive wetland system which has subsequently been eliminated by fixed developments involving dredging and landfilling activities, and resulting in undesired channel incision. The shoreline wetlands were likely important habitat areas for rearing native fish and for waterfowl and amphibians.

To restore self-sustaining habitat in the shoreline zone at the mouth of Meeks Creek to its original conditions, it will be necessary to restore geomorphic processes of sediment deposition, and marsh, meadow, and riparian vegetation development. This requires recontouring the former wetland area by removing anthropogenic fill and restoring the topography that existed prior to

1960, which supported the hydrology of wetlands. In addition, in order to achieve long term channel stability and minimum maintenance requirements, the incised condition of the streambed longitudinal profile must be raised to its original elevation where it discharges to the lagoon/lake system (i.e., vicinity of the current marina).

**AMS Goal — Watershed Connectivity:** Maintain and restore connectivity within and between watersheds to provide for unobstructed movement for survival, migration, and reproduction of wildlife species.

Connectivity of wildlife habitat in Meeks Creek has been disrupted by the constricted Highway 89 crossing and elimination of the shoreline wetland at Meeks Bay. This area originally provided an important connection between Lake Tahoe and the lower and upper watersheds and their wildlife habitats. In contrast, Highway 89 and the current bridge structure constrict connectivity between the lower meadow and the shoreline area and present a barrier to fish migration.

Replacing the Highway 89 bridge with a wider structure and removing the fish passage barrier are both important steps to restoring aquatic habitat connectivity between Lake Tahoe and Meeks Creek. Restoration of the shoreline wetland at the mouth of Meeks Creek, along with replacement of a wider Highway 89 bridge, would provide for an improved migration corridor for aquatic and terrestrial wildlife.

**AMS Goal — Floodplains and Water Tables:** Maintain and restore the connections of floodplains, channels, and water tables to distribute flood flow and sustain the diverse habitats that result from flooding processes.

Above Highway 89, most of Meeks Creek has good channel/floodplain connectivity, and shallow groundwater and good soil moisture conditions needed to sustain wetlands, meadow areas, and riparian vegetation.

Below Highway 89, Meeks Creek is in a highly degraded condition due to channel incision. Channel incision, induced by the dredging of Meeks Bay Marina in 1960 and anthropogenic filling, has eliminated channel/floodplain connectivity and function. This was demonstrated rather dramatically when the record flood of January 1, 1997 did not overflow the incised channel banks. The presence of fixed structures and marina dredging combined with placement of up to four feet of fill over former marsh areas, exacerbated channel incision which has lowered groundwater and soil moisture levels to the point where former wetland and marsh areas support only upland vegetation and limited diversity. The original pre-marina shoreline supported highly-productive wetlands and marsh and riparian vegetation when the functional geomorphic and hydrologic conditions and good channel floodplain connectivity were present.

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In order to recover flood plain function and establish water table conditions needed to support wetlands and plant and wildlife diversity, major modification to the marina, creek reach, and Highway 89 would be necessary. This would include removal of anthropogenic fill, raising of the channel profile, and revegetation.

**AMS Goal — Watershed Conditions:** Maintain and restore favorable soil and vegetative conditions to absorb and filter precipitation and regulate runoff to sustain favorable streamflow conditions.

Soil and vegetative conditions in the Meeks Creek Watershed are in generally good condition upstream of Highway 89. The configuration of the Meeks Creek valley has a broad flat area over which runoff is dispersed over well-vegetated areas and Meeks Creek flows through several expansive meadow areas. Meeks Creek discharges some of the cleanest water found in the Lake Tahoe Basin when measured at Highway 89. In contrast, the reach below Highway 89, including Meeks Bay Marina, is in a highly degraded condition where sediment is released from bank erosion and water discoloration apparently results from the release of dissolved organic carbon from decaying organic matter that is trapped in the marina basin.

The watershed conditions of Meeks Creek above Highway 89 are some of the most pristine in the Lake Tahoe basin, and limited actions are needed for that portion of the watershed. However, the reach between Highway 89 and the shoreline is highly degraded and is discharging discolored water into Lake Tahoe. Substantial modification to Meeks Creek below Highway 89 would be required to take full advantage of the pristine conditions above Highway 89 and to restore watershed conditions critical for water quality and ecological function in the lower portion of the drainage and shoreline area.

**AMS Goal — Streamflow Pattern and Sediment Regime:** Maintain and restore streamflow sufficient to sustain desired conditions for riparian, aquatic, wetland, and meadow habitats and keep sediment regimes as close as possible to those with which aquatic and riparian biota evolved.

The streamflow pattern and sediment regime in Meeks Creek above Highway 89 is in good condition for ecosystem function, and the available streamflow is unregulated and natural. It supports a variety of riparian, meadow, and marsh vegetation areas and habitats. The available sediment supply supports formation of gravel riffles in many locations where geomorphic function has not been disrupted.

Streamflow volume is not affected below Highway 89, however hydraulic conditions below Highway 89 are deficient because too much flow is concentrated in the channel causing erosion, channel bed incision, and instability. Replacing the bridge with a wider span would allow for

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natural hydraulics, allow for fish passage and reduce erosion. Restoring the channel from the bridge to the lake, including reconfiguring to natural morphology and raising channel bed elevation, would achieve long term stability.

**AMS Goal — Streambanks and Shorelines:** Maintain and restore the physical structure and conditions of streambanks and shorelines to minimize erosion and sustain desired habitat diversity.

Streambanks in Meeks Creek are in good condition above Highway 89. Streambanks are well vegetated and there are few, if any, areas of accelerated erosion. The geomorphic processes are favorable for well vegetated streambanks and development of excellent shoreline habitat.

Below Highway 89, Meeks Creek is highly degraded with steep, eroding banks supporting only sparse shoreline vegetation with limited diversity. Shoreline habitat also is of poor quality and without diversity. The reach of Meeks Creek within the Meeks Bay Marina has steep, linear, uniform, and barren banks with a flat and unnaturally wide streambed.

Historical photographs show a natural and highly-productive marsh/lagoon system behind the barrier beach at Meeks Bay, including meadow and riparian vegetation bounding a natural channel between the marina and Highway 89. The lagoon area prior to marina dredging had diverse shorelines and complex bathymetry and vegetation. Restoring these conditions would require substantial modification of the lower drainage area including channel profile raising and other measures described above to reestablish the dynamic geomorphic and hydrologic function of the lower floodplain and shoreline setting.