# APPENDIX E

# PROPOSED RESTORATION ACTIONS

# APPENDIX E

# ECOLOGICAL RESTORATION ACTIONS WITHIN THE MERCED RIVER WILD AND SCENIC RIVER CORRIDOR

## INTRODUCTION

This report presents an ecological restoration plan to support the Merced Wild and Scenic River Comprehensive Management Plan (Merced River Plan). It provides a description of sites recommended for ecological restoration. The following restoration actions protect and enhance the biological, hydrologic/geologic and cultural Outstandingly Remarkable Values (ORVs) as well as free-flowing condition and water quality, collectively referred to as River Values in the Merced River Plan. The Scenic ORVs are addressed in a separate appendix on scenic vista management actions (Appendix I). A detailed map series showing the locations and types of restoration actions proposed follows this *Proposed Restoration Actions Appendix*. Chapter 5 of the Merced River Plan describes these River Values and provides background information pertaining to the justification for the work described in this appendix.

The Biological ORV actions cover meadow and riparian habitat. These habitats are sites of exceptional ecological importance and occupy the ecotone between terrestrial and aquatic ecosystems (Mitsch and Gosselink 2007). These habitats are integral to a healthy riverine ecosystem and are connected to the river through the active floodplain. When the floodplain becomes inundated during spring snow melt, soils become saturated, nutrients are redistributed and wetland and riparian plants adapted to this dynamic environment thrive. The wide range of hydrologic conditions in this zone leads to diverse plant communities that provide food and shelter for wildlife along the river. Although riparian and meadow ecosystems occupy relatively little land area in Yosemite National Park, they comprise the most biologically diverse areas and are priorities for ecological restoration (Hall 1997). While highly productive and diverse, riparian and aquatic systems (including meadows) are the most impacted areas in the Sierra Nevada (SNEP 1996) and declining spatial extent and condition of riparian and wet meadow ecosystems is occurring throughout California at an alarming rate (SNEP 1996).

The Hydrologic/Geologic ORV actions describe ways of protecting and enhancing the meandering alluvial river system. Due to systematic removal of large wood from the channel, loss of riparian vegetation and subsequent bank erosion caused by visitor use, portions of the Merced River channel lack complexity and have become wider and shallower than would naturally occur in an alluvial system. This alters the connectivity of the river to the floodplain, sediment transport dynamics and the meadows and riparian communities that occupy these areas. The actions in this plan call for the restoration of the integral large wood component of the alluvial system, and for comprehensive riverbank restoration.

The free-flowing condition actions describe the removal of impediments to free-flow such as, riprap, revetment, bridges and other infrastructure within the bed and banks of the Merced River, as well as the associated revegetation work. Impediments to free-flow may not always be removed, because they

are necessary to protect important infrastructure. In such instances, this appendix outlines a strategy for improving the river channel complexity surrounding these impediments.

The water quality actions describe ways to reduce the amount of sediment and chemicals potentially reaching the river. While water quality is considered excellent in Yosemite's portion of the Merced River, protective measures would only enhance the Park's ability to maintain this high standard of quality. Protective measures may include reducing the amount of sediment that enters the river from erosion stemming from formal and informal trails and campsites, and removing parking in close proximity to the river.

The Cultural ORV actions include actions to protect and enhance both cultural and ethnographic resources. While seemingly natural to most, the landscape of Yosemite Valley is shaped by both natural and cultural processes. Many of the meadow and riparian species comprising the ethnographic resources are important in the history and ongoing cultural traditions of traditionally associated American Indian tribes and groups. While natural hydrologic processes have shaped the meadow complexes of the Merced River, cultural processes including American Indian burning to promote hunting and gathering have shaped the plant communities. Vista clearing to maintain views of Yosemite's iconic scenery of Yosemite Valley have contributed to the landscape as well. The International Primer on Ecological Restoration (SER 2004) acknowledges the conundrum that can take place on a landscape where natural and cultural processes have shaped the landscape, stating that – "...cultural landscapes or ecosystems have developed under the joint influence of natural processes and human-imposed organization." These systems are interconnected and interrelated. Therefore, a suite of interconnected actions that address both ecological and cultural landscape processes are presented in this appendix.

This restoration plan also addresses actions to protect archeological sites, some of the many types of important tangible resources reflecting thousands of years of cultural connections to the Merced River landscape. Archeological resources are non-renewable, and once they are gone, they are lost forever. While they cannot be restored, they can often be protected and their condition stabilized through certain management actions, such as removing informal and formal trails, campsites, rock rings and graffiti from within the site boundary. Through these means, the interconnected landscape of cultural and natural resources can continue to form touchstones for place-based human history.

## The Need for Ecological Restoration

The actions described in this plan are, at times, difficult to tease apart with regards to which river value they protect and enhance. For example, removal of riprap and subsequent revegetation would benefit free-flowing condition, water quality, biological, hydrologic/geologic and cultural river values. As described above, both natural and cultural resources are integral to the ecosystem processes that now exist on the landscape. This appendix uses the term ecological restoration to describe actions that protect and enhance river values.

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability (SER 2004). The overarching goal of

ecological restoration is not to return to a particular point in time but rather to restore ecosystem processes, structure, and composition (Falk et al. 2006).

This plan identifies ecological restoration actions that involve restoring hydrological processes and the reintroduction of fire back into the ecosystem, where possible (Madej et al. 1991, Cooper and Wolf 2008). In the river corridor, particularly in Yosemite Valley, the need for ecological restoration is apparent due to impacts to meadow function (fragmentation, trampling, and conifer encroachment), decreased meadow size, reduction in the health of California black oak communities, and loss of riparian habitat due to disruptions in both hydrological processes and cultural processes such as the cessation of burning by American Indians. These natural and cultural processes have been hindered by water diversions (such as ditches), channelization (bridges and riprap), road and bridge building, roadside parking, removal of large wood from the river channel, trampling of riverbanks and meadows, introduction of invasive plants and limited opportunities to reintroduce fire on the landscape. These actions have led to changes in hydrologic regime, channelization, river widening, decreased vegetation structural complexity and diversity, a reduction in the extent of meadows, and reduction in habitat quality.

This plan identifies both passive and active ecological restoration actions to restore these natural and cultural processes. Passive restoration actions include fencing and signing sensitive areas. They are intended to halt human impacts and allow natural processes to repair damage. Active restoration actions include brush layering, revegetation, prescribed burning, removal of abandoned infrastructure, placement of large woody debris, road removal, and removal of formal and informal trails in sensitive areas. These actions are intended to stabilize riverbanks, accelerate ecosystem recovery and promote diversity of meadow and riparian habitats, the health of ethnographic resources, and reduction in conifer encroachment in meadows.

## OVERARCHING GOAL

*Promote the ability of the Merced River to shape the landscape by reducing impediments to free flow, improving geologic/hydrologic processes, restoring floodplains and meadows, and protecting water quality.*

## ECOLOGICAL RESTORATION GOALS

Ecological restoration addresses the National Park Service mission to allow natural processes to prevail, as well as protecting scenery and historic resources; it also addresses the goals of the Wild and Scenic Rivers Act by enhancing river free-flow, water quality and physical and ecological outstandingly remarkable values. Ecological restoration actions in riparian, riverine, and meadow habitats enhance the open, scenic quality which provides a sense of place for reflection and inspiration.

In addition to the overarching goal noted above, the following are specific goals of this restoration plan:

- Restore hydrologic function and connectivity with the floodplain including meadow and wetland habitats.
- Restore overbank flooding frequency by narrowing widened channels
- Repair eroded riverbanks, restore riparian plant communities and prevent further human-caused, erosion-induced widening.
- Improve hydrologic conditions at severely restricted bridges
- Increase channel complexity by increasing the amount of large wood in the river channel
- Restore and protect the ecological processes that support riparian and meadow communities including naturally high groundwater levels and sheet flow.
- Remove impediments to natural hydrology including ditches, berms, and abandoned roadbeds in order to protect and maintain native plant communities.
- Restore and maintain the function, structure, diversity and productivity of native riparian and meadow plant communities to protect species diversity, ethnobotanical resources and wildlife habitat.
- Protect and enhance the scenic values of meadows and riparian areas, while improving visitor experience
- Protect archeological resources

## ECOLOGICAL RESTORATION ACTIONS COMMON TO ALTERNATIVES 2-6 ("ACTION ALTERNATIVES")

Multiple actions would be taken across all alternatives to restore, protect and enhance hydrologic and ecological processes, free-flowing condition, water quality, and meadows and riparian habitat. A 150 foot riparian buffer, measured from the ordinary high water mark, would be protected and enhanced, corridorwide. This riparian buffer will filter runoff and provide a transition zone between the river and human land use. This riparian buffer will reduce the magnitude and velocity of overland flow, trap sediment, and attenuate compounds such as nitrogen and phosphorous and pathogens. It will help to stabilize riverbanks through provision of root cohesion on banks and floodplains, reduce erosion, and allow surface water to infiltrate the soil. The riparian buffer vegetation will provide a source of large wood to the river and adjacent floodplain, which will dissipate river flow energy and regulate channel form. In terms of habitat, the riparian buffer will enhance important habitat for wildlife by allowing establishment of new vegetation and persistence of a complex habitat structure. The buffer will also protect aquatic ecosystems by providing organic nutrients, by supplying woody debris that will improve habitat complexity, and by moderating water temperatures by vegetative shading of the river. This riparian buffer will protect and enhance river values, and function as a setback for all future development in the corridor.

Throughout the corridor, eroded riverbanks would be repaired through restoration and vulnerable riverbanks and riparian vegetation would be protected from trampling. Visitors would be directed to use resilient riverbanks such as low-angle sandbar beaches. The majority of riprap in Yosemite Valley would be removed to enhance free-flowing condition, natural hydrologic processes and to improve riparian habitat. The large wood management policy would be enforced and large wood would be left in the channel or incorporated into riverbanks as part of restoration to increase channel complexity and improve aquatic habitat. Please refer to *Standard Operating Procedure (SOP): Management of Fallen Trees in the Merced River in Yosemite Valley*, NPS, 2012, for additional detail.

Prescribed burning, conifer seedling removal and invasive plant removal are on-going activities occurring in the corridor that have already been analyzed in other planning documents. Prescribed burning for resource benefits would follow the Fire Management Plan. Prioritization of units to be burned would be developed using an interdisciplinary approach that addresses not only ecological restoration, but also ethnographic resource restoration or protection. Invasive plant removal would follow the guidelines of the *Invasive Plant Management Plan*.

In all alternatives, ditches in meadows would be filled, six miles of informal trails in meadows and riparian areas would be removed, and abandoned underground infrastructure would be removed. Roadside parking along meadows and associated fill material would be removed to restore meadow area and protect meadows from informal trailing. All action alternatives return ecological and cultural processes—hydrology and fire—to restore meadows and oak woodlands from currently conifer-dominated portions of the landscape. To improve riverbank condition, river channel restoration would occur in the reach between Clark's and Sentinel bridges, including placement of constructed log jams (CLJs), closure of sensitive riverbanks, and brush layering. The portion of Lower Pines campground that was damaged by the 1997 flood and subsequently removed would be restored to a mosaic of riparian, meadow and oak communities which would enhance riparian and floodplain habitat. To protect water quality and improve riparian habitat, the pack stock trail between the stables and Happy Isles road bridge would be removed and the riparian zone and restored to natural conditions. In all alternatives, campsites within 100 feet of the ordinary high water mark would be removed to protect and enhance riverbanks and the riparian zone.

Best management practices and mitigations to protect and enhance river values would be common to all alternatives (Appendix D). Restoration actions that address riprap, informal trails, ditching, and abandoned infrastructure would also be common to all alternatives. Some actions to address free flowing conditions and hydrologic processes that are common to all include large wood management, placement of constructed log jams, and other actions to restore eroded riverbanks and provide appropriate river access. Recreational river activity would be directed to designated river access points and all new development would be located at least 150 feet from the ordinary high water mark. The NPS would eliminate unnecessary development and limit the extend of new development in the river corridor, preserve viewpoints and scenic vistas along roadways and trails, and manage vegetation so that it does not interfere with the visitor's visual experience.

Cultural resources such as archeological sites are non-renewable therefore impacts can result in irretrievable loss. For this reason, most actions to protect and enhance archeological resources in the action alternatives of this plan do not have a range across the alternatives.

## All Wild and Scenic River Segments

**Riparian Buffer (RES-AS-005)** – Protect the riparian zone from new development within 150feet of the ordinary high water mark. Relocate or remove all campsites at least 100 feet away from the ordinary high water mark. The riparian buffer will protect water quality, hydrological processes, aquatic ecosystems, and riparian vegetation.

**Abandoned Infrastructure (RES-AS-001)** – In situations where abandoned underground infrastructure alters hydrology, develop case-by-case treatment strategies that ameliorate the ongoing impacts to hydrologic processes. This infrastructure includes remnants of abandoned sewer treatment facilities, sewer and water lines, and manholes. Treatment would be designed to avoid impacts to sensitive resources (including archeological sites) and may include removal, collapsing in place, plugging, or other measures. See map series at the end of this *Proposed Restoration Actions Appendix*, for known locations. Where infrastructure would be removed or relocated and restored to natural conditions, soils would be decompacted and recontoured, and the area revegetated with appropriate native plants.

**Informal Trails (RES-AS-002)** – Six miles of informal trailing through meadows would be removed and restored to natural conditions. Fencing and signage would direct visitors to less sensitive areas that can accommodate some use without compromising meadow health. Define and delineate accepted trails with closure signs, fencing, and/or other natural barriers such as rocks and logs. Remove informal trails by decompacting soils and filling ruts with native soils. Revegetate areas of denuded vegetation with appropriate native plants.

**Conifer Encroachment (RES-AS-003)** – Manually or mechanically remove conifer seedlings and saplings from meadows and under oaks with loppers, handsaws, or mowers.

**Restore eroded riverbanks (RES-AS-004)** – Revegetate areas devoid of vegetation with appropriate native plants. Protect re-vegetated areas using closure signs, fencing, and/or other natural barriers such as rocks and logs as deterrents. Stabilize eroded riverbanks using bio-engineering techniques such as brush layering of willow cuttings.

**Vulnerable riverbanks (RES-AS-006)** – Direct visitor use along the river to stable and resilient access points such as sandy beaches and low-angle slopes through delineated trails, signs, campground maps and brochures; establish fencing and signage to protect sensitive areas. Areas susceptible to erosion—steep riverbanks, and high use areas exhibiting vegetation and soil loss from compaction—would be closed and restored using bioengineering and revegetation techniques.

**Bridges and associated revetments (RES-AS-008)** – Install constructed log jams, and utilize bioengineered stabilization on riprap to improve hydrologic function, reduce bank erosion, and improve riverine habitat. Strategically placed log jams diffuse and direct high velocity flows, a property that makes them a valuable tool to mitigate altered flow regimes around bridges. Log jams, unlike traditional rock revetment reintroduces habitat complexity within the channel by creating additional bars and scour holes, and by providing cover for aquatic organisms When used in conjunction with a wood retention policy and riverbank revegetation, log jams form part of a comprehensive restoration and mitigation strategy designed to improve the hydrologic function of the Merced River.

**Revetments (RES-AS-009)** – Remove riprap where possible to restore natural river processes. Replace riprap with native riparian vegetation, using bioengineering techniques if riverbank stabilization is still necessary for infrastructure protection.

**Large wood (RES-AS-010)** – Manage large wood according to a management policy, *Standard Operating Procedure (SOP): Management of Fallen Trees in the Merced River in Yosemite Valley,* NPS, 2012, leaving large wood that does not compromise visitor safety or infrastructure. Incorporate large wood into riverbanks to provide structure for highly eroded riverbanks and increase habitat quality. In developed areas where standing hazard trees must be removed for safety, rather than cutting and removing these trees, fall them into the river. Add engineered log jams in severely widened river reaches.

**Trails through sensitive habitat (NO CODE)** – Re-route trails out of sensitive habitats or install boardwalks through wetlands. New trail routes should avoid wetlands and special status habitat.

## Segment 1

**Special status plants: trail impacts (RES-1-004)** – Relocate sections of trail through wetlands in Echo Valley and mineral spring outflow between Merced Lake and Washburn Lake to less sensitive areas. Re-surface the wet sections of the Mist trail to avoid trail widening. Prevent trail creep along the John Muir Trail using fencing and boardwalks. Hand tools will be used by trail and restoration crews during the late summer and fall and work will occur for up to eight weeks.

**Triple Peak Fork: braided trail through meadows (RES-1-005)** – Reroute the trail to upland area where possible Hand tools will be used by trail and restoration crews during the late summer and fall and work will occur for up to eight weeks.

**Merced Lake Shore Meadow: informal trails (RES-1-003)** – Remove informal trails, decompact soils, fill ruts with native soils, and revegetate denuded areas with native plants Hand tools will be used by trail and restoration crews during the late summer and fall and work will occur for up to eight weeks.

## Segment 2

**Ditching in Meadows (RES-2-001)** – Fill 2,155 ' of ditches not serving current operational needs using adjacent berm material or pond and plug techniques. (see Map Series for precise locations). A mini excavator, skid steer, dozer, dump truck, and loader would be used when water table is low, in the fall season. Work would last up to 8 weeks.

**Road improvements over meadows (RES-2-017)** – Mitigate effects of roads on meadow hydrology with culverts or other engineered solutions that allow unimpeded groundwater flow. Use wide box culverts or other design components such as rolling dips, permeable subgrade, etc. to improve surface water flow. Examples include Southside Drive through Sentinel Meadow and Northside Drive through Cook‘s and El Capitan Meadows. Work would occur any time after peak flow when the area is not flooded. Heavy equipment including a skid steer, excavator, loader, and dump truck and would take an estimated 6 weeks.

**Informal trails (RES-2-012):** Remove and restore six miles of informal trailing through meadows to natural conditions (Figure 1; map series). Use fencing and signage to direct traffic to less sensitive areas that can accommodate some use without compromising meadow health. Define and delineate accepted trails with closure signs, fencing, and/or other natural barriers such as rocks and logs. Remove informal trails by decompacting soils and filling ruts with native soils. Revegetate areas of denuded vegetation with appropriate native plants. Work would occur for up to 6 weeks in the summer and fall.

**Figure 1:** The park has successfully removed networks of informal trailing in meadows. In this example before (left) and after (right) restoration of Stoneman Meadow, high visitor use was mitigated by adding fencing to direct people to a new boardwalk, which allowed access to the meadow without the associated impacts.

**Valley Meadows: Conifer Encroachment, loss of meadow extent (RES-2-002) –** Improve condition of plant communities at specific locations in Yosemite Valley (targeted 67 potential acres) by restoring the mosaic of meadow, riparian deciduous vegetation, black oak, and open mixed conifer forest. Management actions may include re-vegetation, prescribed fire, mechanical removal of conifers, and re-design of infrastructure. These actions will enhance scenic vistas and maintain the cultural landscape, as well as enhance the condition of the Merced River ecosystem by sustaining the diverse mosaic of interconnected plant communities.

**Revetments (RES-AS-007) –** Under all alternatives, 3,400 feet of riprap would be removed and revegetated with riparian species where needed. An additional 2,300 feet would be removed but replaced with bioengineered riverbank stabilization (see map series for precise locations). Work would occur in late summer or fall during low flow. Heavy equipment including a skid steer, excavator, loader, and dump truck and would take an estimated 16 weeks.

**Leidig Meadow: Bike Path (RES-2-015)** – Replace a 1,000 foot section of paved trail that passes through the ordinary high water mark. Heavy equipment (excavator, skid steer, loader, dump truck) would remove asphalt path, fill material, and any plant salvage needed. Work would be done in late summer or fall for approximately six weeks.

**Valley Loop Trail: delineation and river access (RES-2-029)** – Reconstruct trail and designate river access, such as at Housekeeping Camp, Sentinel Beach, Cathedral Beach, Swinging Bridge, in the southwest area of the former River's Campground, and South of Slaughterhouse Meadow.

Re-establish the Valley Loop Trail at Curry Village where it ends. Work would occur in summer or fall. Heavy equipment including a skid steer, excavator, loader, and dump truck and would take an estimated 4 weeks.

**Roadbridge at Happy Isles: free flowing condition (RES-2-058)** – Place large wood in the channel and riverbank to lessen the scouring from the bridge. Use brush layering and place a constructed log jam. Heavy equipment including a skid steer, excavator, loader, and dump truck. Work would be done in late summer or fall for approximately six weeks.

**Sentinel Bridge: free flowing condition (RES-2-059)** – Place large wood in the channel and riverbank to lessen the scouring from the bridge. Use brush layering and place a constructed log jam. Work would be done in late summer or fall for approximately six weeks. Heavy equipment including a skid steer, excavator, loader, and dump truck would be used during late summer and fall.

**Swinging Bridge: free flowing condition (RES-2-060)** – Place large wood in the channel and riverbank to lessen the scouring from the bridge. Use brush layering and place a constructed log jam. Work would occur in late summer and fall and last 3 weeks. Heavy equipment including a skid steer, excavator, loader, and dump truck would be used during late summer and fall.

**Superintendent's Bridge, footbidge, and associated revetments (RES-2-160)** – Install constructed log jams, and utilize bioconstructed stabilization on riprap to improve hydrologic function. Work would be done in late summer or fall for approximately six weeks. Heavy equipment including a skid steer, excavator, loader, and dump truck would be used during late summer and fall.

**Clark's Bridge: free flowing condition (RES-2-054)** – Place large wood to lessen the scouring from the bridge. Use brush layering of willows to stabilize banks and place a constructed log jam in the area. Heavy equipment including a skid steer, excavator, loader, and dump truck would be used and would take an estimated 6 weeks during the late summer or fall.

**Pack stock trail from concessioner stables to Happy Isles (RES-2-143)** – Remove 3,800 feet of pack stock trail proximate to the riverbank. Remove residual asphalt and other fill material with an excavator and skid steer, decompact hardened surfaces, recontour surfaces and plant riparian vegetation where needed (Figure 2). Work would occur any time after peak flow when the area is not flooded. Heavy equipment including a skid steer, excavator, loader, and dump truck and would take an estimated 6 weeks, and revegetation would require an additional two weeks.

**Figure 2:** Stock trail in Happy Isles reach passes through riparian habitat. Its hardened surface affects natural hydrologic processes by preventing sediment transport and capture.

**River channel at Lower and North Pines campgrounds** – Repair eroded riverbanks at Lower and North Pines campgrounds with

bioengineering techniques such as brush layering (Figure 3). Allow vegetation to accrete sediment to rebuild the banks. The erosion at North Pines campground is farther advanced and continuous. In such cases, plant willows further out into the river channel than currently established vegetation using a hydro drill. This project would be implemented in the fall during low flow conditions with duration of up to six weeks. Excavator, skid steer, loader, and dump truck would be used during late summer and fall.

**Figure 3:** Divot caused by river access at Lower Pines Campground where the riverbank is highly vulnerable to erosion at (left). Active restoration by brush layering will stabilize the riverbank, capture sediment to rebuild the bank over time and improve riparian habitat.

**Lower Pine Loop within the bed and banks (ONA-2-007)** – Remove Lower Pine Loop between sites 60 and 62, because it is within the bed and banks of the river. Work would occur any time after peak flow and when the area is not flooded. Revegetation would occur in late summer or fall and take 2 weeks. Heavy equipment including a skid steer, excavator, loader, and dump truck would be used during late summer and fall.

**River reach between Clark's and Sentinel Bridges: highly impacted riverbanks (RES-2-062)** – To address river widening and low channel complexity, build eight constructed log jams (CLJs) in the channel between Clark's and Sentinel Bridges. Locations of CLJs are shown in the map series that follows this *Proposed Restoration Actions Appendix*. Logs would be gathered locally including naturally fallen or salvaged hazard trees when available. Coniferous trees with exposed roots along the bank in proximity to the log jam may be pushed over into the river to be incorporated in the constructed log jam. These trees with the root ball still attached at the bank would help to anchor the log jam to the bank. Burying ends of logs into the bank would also be used to anchor the log jam. Localized riverbank erosion would be repaired through brush layering and revegetation of the bank. Heavy equipment such as excavator, dozer, loader, and skid steer would be used to place and secure large wood. Work would occur in the fall during low flow and last for up to twelve weeks. Heavy equipment would access the riverbank from nearby roads, paved bike paths, and former campgrounds with already compacted soils and would not pass through wetlands.

**Swinging Bridge River Access (RES-2-155)** – Remove river access upstream, river-right of Swinging Bridge. Add fencing along bike trail to connect to bridge and revegetate 2,000 square feet of denuded area with riparian species and native grasses. Direct visitor use to a large sandbar directly downstream

of the bridge (Figure 4). Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would take place in late summer or fall for 4 weeks.

**Figure 4:** Current river access point at Swinging Bridge (left) leads to denuded riverbank. River access would instead be directed to the adjacent sandbar (right), which is naturally resilient to visitor use and provides a nice beach for visitor enjoyment.

**Sentinel Beach Picnic Area (RES-2-031)** – Redesign the picnic area to better manage visitor use, and designate the area as a formal river access point, fence off sensitive areas, re-direct use to more resilient areas and reestablish riparian vegetation. Crews would work for four weeks in late summer and fall.

**Indian Creek drainage (RES-2-007)** – Create a buffer zone for the creek by pulling parking and residential yard use back 50 feet. Restore native riparian vegetation and protect with restoration fencing. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would take place in late summer or fall for 4 weeks.

**El Capitan Meadow (RES-2-009)** – Reroute climber use trails on north side of road from meadow habitat to an appropriate upland route (a few meters to the east). Remove informal trails through meadow and oak woodland. Protect re-vegetated areas with fencing or other natural barriers and sign the area to reduce trampling of sensitive meadow vegetation. As opportunities arise through maintenance or restoration projects, improve hydrologic flow and meadow connectivity by extending the permeable road base across the entire segment of Northside Drive through El Capitan Meadow and add additional box culverts with bottom elevations equal to the meadow surface elevation. Remove encroaching conifer saplings (< 10 inches diameter at breast height) using loppers, handsaws, or mowers. Heavy equipment including excavator, skid steer, loader, and dump truck would be used to remove ditches and recontour natural topography. Work would take place in late summer or fall for 10 weeks.Other restoration treatments at El Capitan Meadow vary depending on alternative.

**Sentinel Beach Picnic Area to El Capitan Moraine: Channel complexity (RES-2-061)** – To enhance channel complexity in the river reach upstream of the El Capitan moraine to the Sentinel picnic area, localized restoration would include willow planting, brush layering, uninhibited accumulation and strategic placement of large wood. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would take place in late summer or fall for 4 weeks.

**Stoneman Meadow** – Slightly expand fenced area to protect wetlands on north end of meadow near Lower Pines Campground. Remove invasive non-native species and encroaching conifers. Remove ditch, fill with native soils, and revegetate. A mini excavator, skid steer, dump truck, and loader would be used when water table is low, in the fall, for eight weeks.

**Bridalveil Meadow: stream headcutting and absence of willows (RES-2-010)** – Address headcuts in stream on west edge of meadow by planting willow cuttings in the impacted area, along riverbank, and adjacent meadow. Reestablish the riparian shrub layer. Manually remove encroaching conifer saplings with loppers, hand saws, or mowers. Restoration would require four weeks crew time, with planting occurring in fall when willow are heading into dormancy or prior to bud swell in the springtime.

**Cook's Meadow roadbed: abandoned infrastructure (RES-2-011) –** Remove fill of a former road bed north of Northside Drive between the Ranger Club and the three-way stop. Revegetate with native meadow species. Heavy equipment including excavator, skid steer, loader, and dump truck would be used.

**Cook's Meadow: Informal shoulder parking (RES-2-012) –** Roadside parking along meadow (along both Northside Drive and Sentinel Drive) would be removed and the area restored to meadow conditions (Figure 5). Remove approximately 1,800 cubic feet of fill and revegetate with native seed and transplanted native plants. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used. Work would take six weeks in the late summer or fall.

**Figure 5:** Roadside parking along Cook's meadow encroaches on meadow. Vegetation is crushed, soils compacted and net area of meadows reduced. All alternatives eliminate informal parking along meadows.

**Leidig Meadow: Informal trailing (RES-2-013) –** Remove informal trails that incise or fragment meadow habitat. Decompact soils and revegetate trampled areas with seed collected from local native meadow plants. Work would occur in late summer or fall over a period of six weeks and a skid steer may be used along with hand tools.

**Rocky Point Sewage Plant: abandoned infrastructure (RES-2-014) –** Remove abandoned infrastructure occupying 9.5-acres at Eagle Creek Meadow. Remove remains of the abandoned Rocky Point Sewage Plant including a two-unit reinforced concrete Imhoff settling tank (55 feet x 78 feet) and remaining asphalt left from the demolition of the concrete sludge drying bed, and circular reinforced chlorinating structure. Any remaining utility pipes would be removed. Re-establish natural landscape contours, including the distribution of ephemeral stream channels. Backfill with native soil and/or rehabilitate disturbed soils and plant with native plant species. This is a phased project with demolition and removal of abandoned infrastructure taking 12 weeks, fill removal, contouring and planting four weeks. Heavy equipment would be used including excavator, loader, dozer, dump truck, and skid steer. Project would be implemented after peak flooding; summer or fall.

**Royal Arches Meadow: abandoned infrastructure (RES-2-016) –** Remove abandoned tiles, pipes and abandoned road. Decompact soils, remove conifers and revegetate with riparian species. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used. Work would last eight weeks in the late summer and fall.

**Sentinel Meadow: Trampling (RES-2-018) –** Add a 150 foot section to the existing boardwalk in order to accommodate visitors and reduce meadow trampling. Substantial trampling is evident along river's edge at north section of the boardwalk. Work would be accomplished in six weeks using a skid steer.

**Western portion of former Lower Pines Campground loop: abandoned infrastructure (RES-2-019)** – Restore 20 acres of the former Lower Pines campground to natural conditions. Remove any remaining asphalt (Figure 6) and decompact soils of former roadbed and campsite footprint using an excavator and loader. Treat invasive plants (velvet grass). Manually thin conifer saplings and trees to allow for a mosaic of deciduous riparian species including alder and cottonwood. Remove tree stumps with an excavator and tub grinder. Restore channel topography using the 1919 maps as a guide. This work would occur over 12 weeks during summer months using heavy equipment including: excavator, dozer, skid steer, loader, dozer, and dump truck.

**Figure 6:** Asphalt remains in former Lower Pines Campground floodplain.

**Devil's Elbow: riverbank erosion (RES-2-020) –** Relocate parking from Devil's elbow to the east of the current parking lot, and delineate a trail to access the large sandbar to the east of the "elbow", river right. Remove informal trails and restore to meadow conditions through soil decompaction and revegetation. Designate river access with appropriate signage. This work would occur up to 12 weeks during summer months using heavy equipment including: excavator, dozer, skid steer, loader, dozer, and dump truck.

**Eagle creek drainage: channelization (RES-2-025) –** Remove berm and parking lot abutting Eagle Creek. Add culverts to allow more dispersed water delivery to the Eagle Creek Meadow. Revegetate with native upland species. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used. Work would last eight weeks in the late summer and fall.

**El Capitan Bridge: River access (RES-2-026) –** Redirect visitors accessing the river near El Capitan Bridge to sandbars. Fence and revegetate eroded areas. This would occur in the summer and /or fall seasons and take two weeks for crew and equipment such as the skid steer.

**Swinging Bridge: Riparian impacts (RES-2-027) –** Delineate picnic area by fencing and revegetating the river terrace along the riparian zone approximately 50 feet from the ordinary high watermark to reduce soil erosion. Fence off sensitive areas and reestablish riparian vegetation. Revegetate denuded

area with riparian species and native grasses. Remove riprap and use bioengineering techniques to rebuild riverbank. Re-direct visitors to access the large sandbar on the north and downstream side of Swinging Bridge and designate the area as the river access point. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used. Work would last eight weeks in the late summer and fall.

**Valley Swinging Bridge river access (RES-2-155) –** Remove river access upstream, river-right of Swinging Bridge. Add fencing along bike trail to connect to bridge and revegetate 2,000 square feet of denuded area with riparian species and native grasses. Direct visitor use to a large sandbar directly downstream of the bridge (Figure 4). A skid steer would be used and fencing constructed in two weeks time and could occur anytime of the year. Revegetation would occur in fall for a period of two weeks.

**Valley Campgrounds: River Access (RES-2-028) –** Direct visitors staying in Lower and North Pines Campgrounds to resilient sandy beaches through signage and campground maps and brochures. There are four sandy beaches in the vicinity of the campgrounds (Figure 7). Fence off vulnerable steep slope and provide signs directing visitors to current access. This would occur in the summer or fall and require four weeks of crew time with the use of a skid steer.

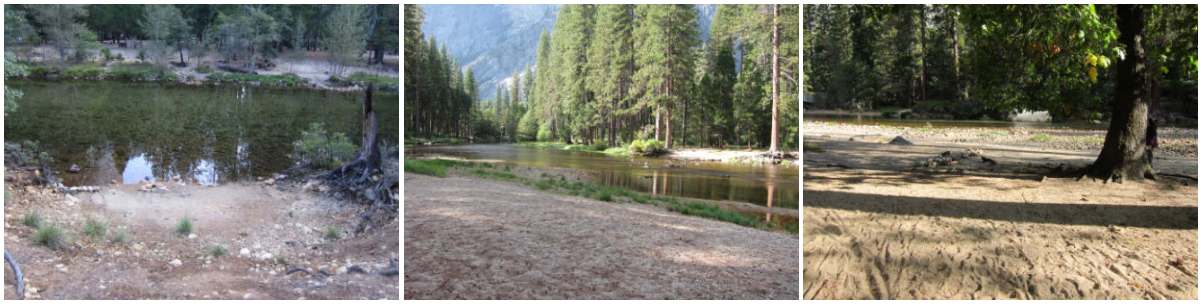


**Figure 7:** Use of the riverbank at the current river access in Lower Pines Campground has caused vegetation trampling and heavy erosion of this highly susceptible riverbank (left). Use will instead be directed to resilient sandbars such as these, located a short walk downstream (middle and right).

**Yosemite Lodge: former lodge cabin area and volunteer center abandoned infrastructure (RES-2-030)** – Restore 4.5 acres of riparian ecosystem at the site of the former Yosemite Lodge units and cabins, and Wellness Center located in the western portion of the Lodge complex (those that were damaged by the 1997 flood and subsequently removed). Remove fill, decompact soils and plant riparian plant species. Restoration of this area would be completed at low river flow and would require eight weeks of crew time. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used.

**Sentinel Beach Picnic Area: Riparian impacts (RES-2-031) –** Redesign the picnic area to better manage visitor use and designate the area as a formal river access point, fence off sensitive areas, redirect use to more resilient areas and re-establish riparian vegetation. Restoration of this area would be completed at low river flow during summer and fall and would require eight weeks of crew time. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used.

**Bridalveil Sewer Plant (RES-2-050) –** Remove or demolish buried structures including a 200 foot long and 5 foot deep concrete chlorine contact chamber, aeration tanks, sludge digesters, and drying beds. Backfill with native soil and revegetate with native plants. Remove pipe leading to Black Springs. This work would take place in late summer and fall and would include the use of heavy equipment such as excavator, dozer, skid steer, dump truck, and loader. This work would take place for two seasons for up to eight weeks each year.

**Footings at the former Happy Isles footbridge (beyond gage): free flowing condition (RES-2-056) –** Remove former Happy Isles footbridge footings and former river gage base (steel re-enforced concrete and wet and dry wall masonry).Revegetate denuded areas and improve way-finding between Happy Isles and the Mist Trail from the shuttle stop. Break concrete and masonry into movable pieces using an excavator-mounted jackhammer. Move material offsite with front-end loaders and dump trucks. Recontour and decompact soils and plant appropriate riparian vegetation in all denuded areas. Work would be performed by a contractor at low flow, in the fall, and would take four weeks.

**Pohono Bridge: Infrastructure within the bed and banks (RES-2-057)** – Move the gauging station north of the river outside of the bed and banks of the river. Revegetate denuded areas. Work would occur for one week in the fall and include the use of heavy equipment such as an excavator, dump truck, loader, and skid steer.

**Clarks Bridge to El Capitan Bridge: Large Woody Debris management (RES-2-063) –**Manage large wood according to the management plan, *Standard Operating Procedure (SOP): Management of Fallen Trees in the Merced River in Yosemite Valley*, NPS, 2012. Trees that fall into the river will be retained in the river. Large wood may be minimally manipulated to protect critical infrastructure, to ensure visitor safety, and to prevent unnatural accumulation of wood near bridges.

**Upper Pines: recreational vehicle dump station (RES-2-144) –** Relocate the recreational vehicle dump station from its site proximate to the river to a site between Curry parking and the campgrounds entrance (see Map Series 1). Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used.

**Cathedral Beach: picnic area (RES-2-145) –** Designate area as a formal river access point, fence off sensitive areas, and direct use to most resilient areas. Remove parking in the riparian zone, decompact soils, plant appropriate native vegetation and delineate river access. Remove infrastructure (toilets, parking and picnic tables) in the 10-year floodplain, decompact soils, and revegetate. Work can occur any time after peak flow in the upland areas and during low flow of late summer or fall where the water table remains high. Four weeks of crew and equipment time would be needed. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used.

**Yosemite Lodge: Beach Access (RES-2-149) –** Direct visitors to the sandbar at Swinging Bridge. Fence the riparian area at Yosemite Lodge. Fence construction directing use from the Lodge to Swinging Bridge would take one week with the use of a skid steer.

**Ahwahnee Meadow: Former golf course and tennis court (RES-2-151) –** Restore the impacted portion of Ahwahnee Meadow to natural meadow conditions, while allowing special functions, such as weddings to continue on the lawn. Remove the tennis courts from the California black oak

woodland. Restore topography by removing abandoned irrigation lines and fill, filling in ditches, and revegetating with native meadow vegetation. Reconnect currently disjunct portions of Ahwahnee Meadow by removing conifers to return approximately 5.65 acres to meadow habitat. Heavy equipment including excavator, dozer, skid steer, loader, dozer, and dump truck would be used.

**Ethnographic ORV: Impacts to traditionally used plant populations (RES-2-045) –** The ecological restoration actions associated with this planning effort implemented in concert with the existing invasive plant management program will address impacts to some traditionally used plant populations in some locations. Conifers that are overtopping black oaks would also be considered for removal.

**Pohono Bridge to Big Oak Flat Road Junction: River Access (RES-2-065) –** Pave and formalize 5 roadside pull-outs for river access between Pohono Bridge and the intersection of the Big Oak Flat Road. Install curbing along pull-outs and along El Portal Road to prevent further encroachment towards the river and associated resource damage. Completely remove one pullout that is not protective of resources. In the areas that require ecological restoration following parking and river access formalization, decompact soil and revegetate with riparian species including willow. Install drainage improvements and head walls at 11 locations. Excavator and skid steer may be used over a period of eight weeks during low water in the fall.

**CA-MRP-0046/47/74 (RES-2-032) –** Reroute stock trail and formal trail off sensitive area, remove graffiti from rock art boulder.

**CA-MRP-0052/H (RES-2-033) –** Delineate or reroute bridle path away from site.

**CA-MRP-0055/H (RES-2-034) –** Remove informal trails and parking pullout. Increase law enforcement and archeology monitoring to protect rock shelter/rock art (best management practices).

**CA-MRP-0057 (RES-2-036) –** Remove graffiti in rock shelter and remove informal trails. Increase law enforcement and monitoring of rock shelter (best management practices).

**CA-MRP-0062 (RES-2-037) –** Remove the logs, graffiti, and informal trails and ecologically restore to natural conditions. Relocate the parking area away from the site.

**CA-MRP-0076 (RES-2-038) –** Remove informal trails, restore to natural condition, and prohibit climbing.

**CA-MRP-0080 (RES-2-039)** - Remove campsite 208 and bear box; reroute bathroom foot traffic away from milling feature and fence off.

**CA-MRP-0082/H (RES-2-040) –** Remove climbing bolts from rockshelter boulder and prohibit climbing. Increase interpretation, education, and outreach efforts for climbers (best management practices).

**CA-MRP-0158/309 (RES-2-041) –** Remove informal trails, restore to natural condition, and prohibit climbing on rock art boulder. Increase interpretation, education, and outreach effort for climbers (best management practices).

**CA-MRP-0190/191 (RES-2-042)** – Delineate trail/bike path to limit shoulder access within site.

**CA-MRP-0240/303/H (RES-2-043)** – Fence off/close access to milling feature next to trail.

**CA-MRP-0902/H (RES-2-152)** – Remove informal trails and restore to natural condition.

## Segment 3

**Cascades picnic area: abandoned infrastructure (RES-3-001)** – Remove abandoned infrastructure including cement block, surface concrete and asphalt and imported rock with skid steer and dump truck. Work would take three weeks in late summer or fall.

## Segment 4

**Old El Portal: Soil compaction around Valley oaks from parking (RES-4-002)** – Restore the rare floodplain community of valley oaks in Old El Portal through implementation of mitigation measures related to invasive species removal, overwatering, tree pruning, and prohibiting grading and parking in the dripline. Designate oak recruitment areas in the Odger's fuel storage area (to be removed from the river corridor in Alternatives 2-6) and the parking lots adjacent to this area. Prohibit new building construction within the oak recruitment area. Remove non-native fill and decompact soils (after development removal); plant appropriate native understory plant species; treat invasive plants. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

**El Portal: river confined by rip-rap and road (RES-4-006)** – Develop best management practices for revetment construction and repair throughout the river corridor. Vertical walls should be used wherever possible. Provide CalTrans with best management practices recommendations when repair/replacement is necessary in Segment 4.

**El Portal NPS Maintenance and administrative complex roadside parking (RES-4-007)** – Restore to natural conditions the informal roadside parking, which is southeast of the dirt parking area, between Foresta Road and the Merced River. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

**Trailer court: Restore 150 foot riparian buffer** – Remove asphalt and imported fill to restore 9.3 acres in the 150 foot riparian buffer; recontour and plant native riparian species and oaks. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Greenmeyer sandpit: flood and riparian plant impacts from fill material (RES-4-005)** – Restore hydrologic function to 1.8 acres of floodplain and re-establish riparian habitat (Figure 8). Excavate 4,000 cubic feet of angular imported rock, concrete, asphalt and soil which is capping the site to return a floodplain elevation of a 20-50 year flood. Restore upland areas to natural topography, utilizing some

**Figure 8:** Greenmeyer Sandpit current conditions (left) and target braided channel and riparian habitat conditions (middle and right).

of the fill soils which would reduce the amount need to move off-site. Recontour topographic features. Reestablish native vegetation through propagation and planting of local native plants, including *Sambuccus mexicanus* (blue elderberry). Retain road for utilities and to allow for river access. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. This is a twelve week project to be performed at low river flow conditions during summer and fall.

**CA-MRP-0250/H (RES-4-003) –** Remove informal trails and non-essential roads.

**CA-MRP-0251/H (RES-4-004) –** Remove informal trails.

**CA-MRP-0181/H (RES-2-049) –** In recognition of the high cultural significance of CA-MRP-0181/H for traditionally associated American Indians, the site will be protected from any further development. A plan of action for addressing the abandoned infrastructure on the site will be developed in consultation with traditionally associated American Indian tribes and groups. Any solution(s) developed will also include a recommended approach for deterring visitor use within the site.

## Segment 5

**CA-MRP-0218 (RES-5-001) –** Remove informal trails and charcoal rings.

## Segment 6

**Wawona Impoundment: effects to free-flowing condition (RES-6-001) –** Retain current water collection and distribution system, implementing the water conservation plan related to the minimum flow analysis for the South Fork.

**Wawona: arch district impacts (RES-MS-001) –** Increase monitoring frequency for affected sites, Increase management protection designed to counteract or minimize impacts, crafted to individual site specifications. At the district-wide level, amend National Register of Historic Places nomination to reflect district changes and impacts.

## Segment 7

**South Fork side channels: Abandoned infrastructure (RES-7-005)** – Remove abandoned metal pipes that dewater the terrace using skid steer, excavator, dump truck and loader for one week.

**Wawona Campground: septic system (RES-7-006)** – Develop a waste water collection system. Build a pump station above the Wawona Campground to connect the facility to the existing waste water treatment plant. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Wawona dump station: proximity to river (RES-7-007)** – Relocate the dump site to the Wawona Campground away from the river. Design and construct RV dump station on a new sewer line near the campground entrance, at least 150 feet away from the river's ordinary high water mark. After the existing dump station is removed, revegetate the area with native plants. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately three weeks.

**South Fork Wawona picnic area: river access and water quality (RES-7-008)** – Delineate picnic area and a path to the river to encourage visitors to use more resilient areas. One week crew time at low flow would be needed.

**Wawona picnic area: river access and water quality (RES-7-009)** – Harden the three steep river access points using rockwork or staircase construction to prevent further erosion. If needed, place fencing to direct visitors to these hardened access points. Add path to river that encourages visitors to walk in the more resilient areas. Work would be performed for two weeks after peak water flow with an excavator and skid steer.

**Wawona Maintenance yard: Riparian Impacts (FAC-7-001)** – Remove staged materials, abandoned utilities, vehicles, and parking lot from the riparian buffer and restore a native ecosystem. Provide a 150-foot wide restoration buffer. Work would be performed for two weeks after peak water flow with an excavator and skid steer.

**CA-MRP-0374 (RES-7-001)** – Remove informal trail, delineates access road, and reduce hazard fuels.

**CA-MRP-0008/H (RES-7-002)** - Remove informal trails. Relocate camp sites out of archeological site. Also, relocate the campground to the Wawona Stables.

**CA-MRP-0171172/254/516/H (RES-7-012)** - Remove informal trails and shoulder and off-road parking.

**CA-MRP-0168/0329/H (RES-7-003)** – Remove 7 campsites from Wawona Campground that cause potential impacts to the archeological site.

**Wawona: arch district impacts (RES-MS-001)** – Increase monitoring frequency for affected sites, Increase management protection designed to counteract or minimize impacts, crafted to individual site

specifications. At the district-wide level, amend National Register of Historic Places nomination to reflect district changes and impacts.

## ECOLOGICAL RESTORATION ACTIONS WITHIN ALTERNATIVES

There is a varying degree of ecological restoration associated with the removal of infrastructure such as roads and bridges within the range of action alternatives (see Table E-1 below). In Alternative 6, all roads and bridges would be retained and their impacts on hydrology and free-flowing condition are addressed through engineered solutions such as placing culverts under roads that bisect meadows and placing engineered log jams adjacent to bridges to ameliorate scour pool formation. In Alternative 5, Sugar Pine Bridge, the bridge causing the greatest hydrologic restriction, would be removed. In Alternatives 2, 3, and 4, Sugar Pine and Ahwahnee Bridges and the berm connecting them would be removed, greatly enhancing free-flowing condition and hydrologic function of this river reach. Stoneman Bridge would be removed in addition to Sugar Pine and Ahwahnee Bridges in Alternatives 2 and 3 to further enhance free-flowing conditions. In Alternative 5, further study would be undertaken to assess the potential costs and benefits of removal of the road segment through Stoneman Meadow. No permanent structures would be built that would preclude a future reroute of this road to the south of the meadow. Alternative 4 would remove the road segment that bisects Stoneman Meadow, but retains the segment of road that bisects Ahwahnee Meadow. Alternatives 2 and 3 would remove the road through Stoneman Meadow and Ahwahnee Meadow to restore 2.7 acres of wet meadow and restore hydrologic connectivity to the meadows. Roads through other meadows such as El Capitan, Cook's and Sentinel would not be rerouted but rather improvements in the road made, such as placement of additional culverts and addition of permeable road base to better connect hydrologic flow.

**TABLE E-1: AREA (ACRES) OF ECOLOGICAL RESTORATION PROPOSED AS ACTIONS COMMON TO ALL ALTERNATIVES (CTA) AND BY ALTERNATIVE (ACREAGE REPORTED IN EACH ALTERNATIVE INCLUDES ACTIONS COMMON TO ALL)**

| Alt | CTA | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Meadow, Riparian and Floodplain Restoration | 164 | 347 | 302 | 223 | 203 | 170 |

The site of the former Upper and Lower Rivers Campgrounds has a range of restoration options within the action alternatives. Alternatives 2 and 3 would provide for the greatest degree of ecological restoration, fully restoring the area to a mosaic of riparian, floodplain, meadow and oak woodland habitat. In these alternatives, the road bisecting the area and Ahwahnee Meadow is removed, allowing for maximum potential for the river to reshape the landscape, unimpeded. Natural topography, including side channels, would be restored to natural conditions. In Alternatives 4, 5, and 6, the road would remain and camping and day use added. The riparian buffer outside of the campground would be restored to natural conditions in Alternatives 2-6.

The greatest need for river channel restoration occurs in the vicinity of the campgrounds and Housekeeping Camp where the greatest channel widening has occurred. Because riverbanks along the

former Upper Rivers Campground are not resilient river access points, they need protection from trampling. The lower number of visitors in Alternatives 2 and 3 due to lack of road access and camping would be protective of these riverbanks. In Alternatives 4, 5, and 6, riverbanks would be closed, fenced and signed to prevent vegetation damage and riverbank erosion. River use would be directed across the road, to the large sandbar beach at Lower Rivers. In Alternatives 5 and 6, river access would also be available across from the Ahwahnee Bridge, which would remain in place under these alternatives.

Current parking at Yosemite Village Day Use Parking (Camp 6) and the Curry Orchard Parking Area are re-evaluated in this plan. There are two options within the Alternatives for restoration at Camp 6. In Alternatives 4, 5 and 6, the footprint of the current parking lot would be pulled back from the river at least 150 feet from the ordinary high water mark, allowing for riparian restoration and future protection. In Alternatives 2 and 3, all parking and roads would be moved out of the 10-year floodplain, which would allow for riparian restoration as well as restoration of the active floodplain and allow future potential for the river to reshape the land. These alternatives ecologically restore a larger portion of this dynamic floodplain area. Storm run-off mitigations would be used in all alternatives to protect water quality. Actions at the Curry Orchard Parking Area range from major ecological restoration to minimal change. In Alternatives 5 and 6, the area would remain designated parking and limited restoration would occur. In Alternative 3 and 4, most of the parking lot would remain while the northern portion would be restored to natural conditions. In Alternative 2, the parking footprint at this location remains similar to existing conditions, but areas to the north and east are restored when road segments are removed. In all alternatives, the apple trees would be removed to mitigate human-bear encounters and these areas would be revegetated with native species.

There is a range of options within the alternatives for restoring riparian and floodplain habitat at Housekeeping Camp. In Alternatives 5 and 6, 34 structures that are within the modeled ordinary high water mark are removed and riparian habitat restored. Under Alternative 4, 166 structures—those within the observed high water of 2010 and 2011—are removed, resulting in a larger area for restoration. A much larger riparian zone would be restored and channel complexity restored in the active floodplain. Day use in this area increases in this alternative and visitors would be directed to the sandbar beaches. Alternatives 2 and 3 provide for the greatest restoration opportunity with the removal of all lodging units. Riparian habitat and the 10-year floodplain would be restored allowing the greatest level of unimpeded river processes. Alternative 2 and 3 retain a restroom and a small parking lot in the highest elevations to provide for day use picnicking. In all alternatives, current access on the steep, eroding slope on the eastern side would be closed and restored and all river access directed to the sandbar on the western side or to the north side of Housekeeping Bridge.

Campsites in close proximity to the river in Wawona and Yosemite Valley are also addressed in Alternatives 2-6. In Alternatives 5 and 6, sites within 100 feet of the river are removed and riparian habitat restored. In Alternatives 3 and 4, the setback is 150 feet. All sites in the 100-year floodplain are removed and restored to natural conditions in Alternative 2. This entails removal of all of North Pines campground and full restoration of a dynamic floodplain.

At the Yosemite Lodge complex, areas west of the lodge where former lodging units were removed following damage from the 1997 flood would be restored to natural condition. This action is common to Alternatives 2-6. Much of this area is frequently flooded and supports riparian vegetation. In

Alternative 3, 4 buildings in the floodplain are removed and the area restored to natural conditions. Alternative 2 removes all infrastructure in the 100-year floodplain and restores the greatest area of floodplain habitat.

## Alternative 2

This alternative was designed to restore much of the 100-year floodplain. Roads over meadows and bridges impacting free-flowing condition are removed and restored to natural conditions. This alternative includes restoration of more than 347 acres of riparian, meadows and upland habitat within the river corridor. It removes development including campsites, informal trails, and non-essential roads from sensitive areas.

### *Segment 1*

**Merced Lake Ranger Station Meadow: grazing (RES-1-002)** – Remove the meadow from grazing permanently. Require all administrative pack stock passing through the Merced Lake area to carry pellet feed.

### *Segment 2*

**Ahwahnee Row and Tecoya Housing: 100-yr. floodplain (RES-2-007) –** After removal of housing, decompact soils, recontour topography (using 1919 maps as a guide) and plant native meadow vegetation. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used for eight weeks in the late summer and fall.

**Yosemite Lodge: buildings in the 100-year floodplain (RES-2-024) –** Restore 28 acres of floodplain and riparian habitat after removal of all Yosemite Lodge buildings in the 100-year floodplain. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used for eight weeks in the late summer and fall.

**Ahwahnee Meadow: Northside Drive and bike path impact hydrology and meadow extent (RES-2-004) –** Remove the road from Camp 6 intersection to Southside Drive to restore 0.9 acre of wet meadow and improve meadow hydrology and 0.7 acres of California black oak habitat. Remove 12,500 cubic yards of asphalt and imported fill material and recontour to natural topography and restore natural hydrology. Revegetate meadow through propagation and seeding with native meadow species. Revegetate California black oak and floodplain understory with appropriate plants. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used. Revegetate with willows, cottonwoods and other riparian species. Crews would work 12 weeks during the fall for two years.

**El Capitan Meadow: bisected by road, informal trails, conifer encroachment (RES-2-009) –** Remove all informal trails and areas of bare compacted soils and restore to native plan communities. Disperse and reduce roadside parking along the meadow through alternative pavement striping (approximately 30 spaces removed). Retain some roadside parking for SAR and other administrative

traffic. Use restoration fencing and signing where necessary to further protect the meadow from trampling. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately three months.

**Stoneman Meadow and Orchard parking lot: Road through meadow and parking lot (RES-2-008)** – Remove the road through Stoneman Meadow to restore 1.9 acres of wet meadow and improve hydrology to entire meadow. Remove 7,260 cubic yards of asphalt and imported fill material, recontour to natural topography and restore natural hydrology. Revegetate through propagation and seeding with native meadow species. Remove apple trees. Remove imported fill, decompact soils and recontour using the 1919 maps as a guide. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Revegetate with willows, cottonwoods and other riparian species. Crews would work 12 weeks during the fall for two years.

**Housekeeping Camp: riparian restoration and river access (RES-2-023)** – Remove all infrastructure and riprap at Housekeeping Camp and restore 16.8 acres of floodplain and riparian ecosystem to natural conditions. Convert area to day use river access (raft put-in) and picnicking. Focus river access to resilient locations. This work would be phased over the course of two seasons and would occur between midsummer and early winter, depending on weather and soil moisture. All work within the bed and banks of the river would be done at low river flow conditions. Phase 1(year 1) would take 14 weeks and would concentrate on the removal of all infrastructure including lateral utilities, concrete structures, revetment and, when hauling is complete, removal of imported fill material. Native sand and gravel fill may be retained on site. Phase 2 (year 2), would include additional grading and contouring, decompaction of soils, fence construction and planting and would take six weeks. Heavy equipment including excavator, skid steer, loader, and dump truck would be used.

**Upper and Lower Rivers Campground: abandoned infrastructure (RES-2-021)** – Restore topography of 35.6 acres of impacted floodplain to support a mosaic of riparian, meadow and California black oak woodland at the former Rivers campgrounds site. Remove any remaining asphalt, decompact soils of former roads and campsites and re-establish seasonal channels and natural topography that have been graded flat. Develop a planting plan for restoring native plant communities and restoring soils to support them. Mechanically remove ponderosa pine and incense cedar saplings and mature trees that are infringing on California black oaks and growing on soils that once supported meadow communities. Revegetate with native meadow grasses, sedges, and shrubs. Plant native riparian species, such as willow, alder and cottonwood along riverbanks. Remove Lower River amphitheater structure and associated fill material. Restore natural topography to original contours and revegetate with wetland plants. Fence the revegetated areas for up to 3 years to prevent trampling of young plants and seedlings. This work would be phased over two years. Excavation of former channels and roads would generate asphalt, rock and other material not suited to the ecology of the site and would moved off-site. The excavation, grading and hauling would last ten to twelve weeks. Fencing and planting would be done in an additional three weeks. Heavy equipment including excavator, skid steer, loader, dozer, and dump truck would be used. Most if not all of this work would be completed in the late summer and fall.

**Valley Campgrounds: campsites near the river (RES-2-022)** – Remove all campsites and infrastructure at all sites within the 100-year floodplain and restore 25.1 acres of floodplain and

riparian habitat. This includes all sites at North Pines and Yellow Pines campgrounds, 19 sites at Backpacker's Campground, 32 sites at Lower Pines and 22 sites at Upper Pines. Remove asphalt, base rock, fill material; decompact soils, recontour and revegetate. Erect new fencing or adjust existing fencing to protect the riparian zone. Restore topography with natural drainages. Restore a mosaic of riparian, meadow, and oak habitat. Revegetate with native species. Repair eroded riverbanks with brush layering and willow planting. Remove conifer saplings. Twenty-two weeks crew and equipment time would be needed for implementation over a three year period. Work within the bed and banks of the river would occur at low river flow while work on the terrace would occur in the summer or fall. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used.

**Revetment: free flowing condition (RES-2-051) –** In addition to the revetment removed in the Common to All Action Alternative, remove 964 linear feet of riprap adjacent to Sugar Pine, Ahwahnee and Stoneman Bridges. Excavator, skid steer, loader, and dump truck would be used. Revegetate with willows, cottonwoods and other riparian species. Crews would work 12 weeks over two years during low flow in fall.

**Stoneman Bridge: free flowing condition (RES-2-053) –** Remove Stoneman Bridge, asphalt, and other imported material. Salvage native river gravel from the berm and place in cut-off channel. Salvage other native soils for use in restoration. Revegetate with riparian species. Implementation would take 10 weeks with all work except asphalt removal occurring at river low flow conditions. Excavator, skid steer, dozer, and dump truck would be used.

**Sugar Pine Bridge and Ahwahnee Bridge and Road Berm: free flowing condition (RES-2-052) –** Remove Sugar Pine and Ahwahnee Bridges and the causeway between Sugar Pine and Ahwahnee Bridges and associated berm. Remove asphalt and other imported material. Salvage native river gravel from the berm and place in cut-off channel. Salvage other native soils for use in restoration. After bridge removal, allow channel to reconfigure on its own. Revegetate with riparian species. Implementation would take 15 weeks with all work except asphalt removal occurring at river low flow conditions. Reroute the multiple use trail to the north bank of the river. Excavator, skid steer, loader, and dump truck would be used.

**Concessioner stables to Happy Isles: pack stock trail (RES-2-143) –** Remove trail and restore to natural conditions (see actions common to all).

**Camp 6: Water Quality, proximity to the River, and fill material within the 5-to 10-year floodplain. (RES-2146) –** Restore 10.8 acres of riparian and floodplain habitats at Camp 6 up to the 10-year floodplain: remove unnatural fill identified in soil studies. Remove construction-generated boulders remaining from use as staging area. Plant riparian and wetland species appropriate to the habitat after fill removal. Allow seasonal flooding to re-work remaining topography. Revegetate eroded riverbanks and increase signage to avoid continued impacts (Figure 9). Heavy equipment including excavator, skid steer, dozer, loader, and dump truck would be used.

**Figure 9:** Healthy herbaceous riparian vegetation growing on the riverbank (left) contrasts with trampled and eroded riverbank adjacent the Camp 6 Day Use Parking Lot.

**Valley Meadows: Valley Loop Trail impacts through meadows (RES-2-005)** – Reroute trail through Slaughterhouse Meadow out of wetlands to an upland area. Move the 780 feet of the trail through Bridalveil Meadow to the toe of the fill slope of Southside Drive. Decompact, recontour and revegetate the abandoned sections of trail with native meadow species. Because trail reroute would be located in the upland, work may occur at any time of year and would take three weeks crew time. Removal of existing trail and replanting of meadow would take three weeks in the fall. Heavy equipment including excavator, skid steer, loader, dozer, and dump truck would be used.

**Ahwahnee Meadow oxbows: trail impacts (RES-2-003)** – Reroute the trail so it does not pass through wetlands; consolidate use with trail to Housekeeping Footbridge where possible. Remove asphalt and fill material from abandoned section of trail and revegetate with native wetland plants. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Former Yosemite Lodge cabins (Pine and Oak) area (RES-2-154)** – Restore 10.9 acres of riparian ecosystem at the site of the former Yosemite Lodge units and cabins (area commonly known as the Oak and Pine cabins, which were removed after being damaged by the 1997 flood). Remove riprap from Yosemite Creek and plant willows along stream bank. Remove informal trails throughout the eastern end of the lodge near Yosemite Creek and formalize one trail through the area. Delineate one service road to the well house and parking. Remove excess service roads. Remove fill, decompact soils and plant riparian plant species. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used.

## *Segment 4*

**Old El Portal: parking and development in valley oaks (RES-4-002)** – Restore the rare floodplain community of valley oaks in Old El Portal through implementation of mitigation measures related to invasive species removal, overwatering, tree pruning, and prohibiting grading and parking in the dripline (see Appendix D). Also, create a valley oak recruitment area of 2.25 acres in Old El Portal in the vicinity of the current Odger's bulk fuel storage area, including adjacent parking lots. Decompact

soils, plant appropriate native understory plant species, and treat invasive plants. Prohibit new building construction within the oak recruitment area. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

### *Segment 7*

**Wawona golf course (RES-7-004) –** Remove the golf course and restore meadow ecosystem. Recontour to natural topography. Remove any imported fill material. Remove non-native plants and restore native meadow plant communities through propagation, seeding, and planting. Remove channelization of creek and restore natural hydrology. Continue to use the area as a spray field. This would occur with large heavy equipment over a three year period working three months per year. Heavy equipment including excavator, skid steer, loader, and dump truck would be used.

**Wawona Campground: campground activity near river (ONA-7-001) –** Remove 32 campsites in Wawona Campground that are in the 100-year floodplain or in culturally sensitive areas to restore 8.2 acres of riparian and floodplain ecosystem. Decompact soils and plant with riparian vegetation. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month. Wawona Stock Camp (RES-7-011): Two stock use campground sites relocated from sensitive resource area to Wawona Stables. The sites will then be recontoured, soil decompacted and revegetated. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

## Alternative 3

This alternative provides for significant restoration within 150 feet of the river. This alternative targets restoration strategically throughout the corridor, removing infrastructure such as campsites, roads, bridges, informal and formal trails from sensitive areas. It restores targeted areas such as the 10 year floodplain near Camp 6, the former Upper and Lower Rivers Campgrounds, the 100 year floodplain at Housekeeping Camp, and the Wawona Golf Course. In total, it restores 302 acres to natural conditions within the river corridor.

### *Segment 1*

**Merced Lake Ranger Station Meadow: grazing (RES-1-002) –** Develop preliminary grazing capacities for the Merced Lake East Meadow. When the meadow recovers, allow administrative grazing at established capacities. Monitor annually for five years, adapting use levels as needed.

### *Segment 2*

**Yosemite Lodge: buildings in the 100-year floodplain (RES-2-024) –** Remove 4 buildings in the 100-year floodplain and restore floodplain and riparian habitat. Heavy equipment including excavator,

skid steer, loader, and dump truck would be used. Work would occur during the summer or fall and take approximately one month.

**Ahwahnee Meadow: Northside Drive and bike path impact hydrology and meadow extent (RES-2-004) –** Same as Alternative 2.

**El Capitan Meadow: bisected by road, informal trails, conifer encroachment (RES-2-009) –** Remove all informal trails from the meadow that incise, promote habitat fragmentation, or are located in sensitive and frequently inundated areas, and restore to natural condition. Use restoration fencing and signing to designate appropriate meadow access points. Revegetate with native meadow species. Boardwalks would not be used as an action within this alternative. Remove ditches and restore natural hydrology. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during the summer or fall and take approximately one month.

**Stoneman Meadow and Orchard parking lot: Road through meadow and parking lot (RES-2-008) –** Remove the road through Stoneman Meadow as in Alternative 2. Remove some asphalt from the Curry Orchard parking and revegetate with native plants. Remove apple trees to mitigate human-bear encounters. Remove imported fill, decompact soils and recontour where road and parking is removed. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during the summer or fall and take approximately two months.

**Housekeeping Camp: riparian restoration and river access (RES-2-023) –** Remove all lodging infrastructure and riprap at Housekeeping Camp and restore 16.8 acres of floodplain and riparian ecosystem to natural conditions. Convert area to day use river access (raft put-in) and picnicking, while focusing river access to the sandbar across from Housekeeping Bridge. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately two months.

**Upper and Lower Rivers Campground: abandoned infrastructure (RES-2-021) –** Same as Alternative 2.

**Valley Campgrounds: campsites near the river (RES-2-022) –** Remove sites at Backpacker's Camp, Lower Pines and North Pines Campgrounds that are within 150' of the ordinary high water to restore 12 acres of riparian habitat (Figure 9). Remove asphalt, base rock, fill material; decompact soils, recontour and revegetate. Erect new fencing or adjust existing fencing to protect the riparian zone. Harden river access point at North Pines campground by using pinned logs back filled with native gravel. Fence sensitive areas and brush layer with willows to repair eroded riverbank and revegetate denuded areas. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Revetment: free flowing condition (RES-2-051) –** In addition to actions common to all, an additional 435 linear feet of riprap would be removed and the river banks revegetated. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the fall and take approximately four months.

**Stoneman Bridge: free flowing condition (RES-2-053) –** Same as Alternative 2.

**Sugar Pine Bridge and Ahwahnee Bridge and Road Berm: free flowing condition (RES-2-052) –** Same as Alternative 2.

**River reach between Clark's and Sentinel Bridges: highly impacted riverbanks (RES-2-062) –** Same as Alternative 2.

**Concessioner stables to Happy Isles: pack stock trail (RES-2-143) –** In addition to the actions described in common to all, re-route stock trail north along the road where it meets up with the Valley Loop Trail. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during the summer or fall and take approximately one month.

**Camp 6: Water Quality, proximity to the River, and fill material within the 5-to 10-year floodplain (RES-2-146) –** Same as Alternative 2.

**Valley Meadows: Valley Loop Trail impacts through meadows (RES-2-005) –** Same as Alternative 2.

**Ahwahnee Meadow oxbows: trail impacts (RES-2-003) –** Same as Alternative 2.

**Former Yosemite Lodge cabins (Pine and Oak) area (RES-2-154) –** Restore 10.9 acres of riparian ecosystem at the site of the former Yosemite Lodge units and cabins (area commonly known as the Oak and Pine cabins, which were removed after being damaged by the 1997 flood). Remove riprap from Yosemite Creek and plant willows along stream bank. Remove informal trails throughout the eastern end of the lodge near Yosemite Creek and formalize one trail through the area. Delineate one service road to the well house and parking. Remove excess service roads. Remove fill, decompact soils and plant riparian plant species. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used.

### *Segment 4*

**Old El Portal: parking and development in valley oaks (RES-4-002)** – Restore the rare floodplain community of valley oaks in Old El Portal through implementation of mitigation measures related to invasive species removal, overwatering, tree pruning, and prohibiting grading and parking in the dripline (see Appendix D). Also, create a valley oak recruitment area of 2.25 acres in Old El Portal in the vicinity of the current Odger's bulk fuel storage area, including adjacent parking lots. Decompact soils, plant appropriate native understory plant species, and treat invasive plants. Prohibit new building construction within the oak recruitment area. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

### *Segment 7*

**Site-Specific Programmatic Wawona golf course: operating in old meadow habitat (RES-7-004) –** Same as Alternative 2.

**Wawona Campground: campground activity near river (ONA-7-001)** – Retains 69 sites and one group site. Remove 27 sites that are either within 150 feet of the river or in culturally sensitive areas.

Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Wawona Stock Camp (RES-7-011)** – Two stock use campground sites relocated from sensitive resource area to Wawona Stables. The sites will then be recontoured, soil decompacted and revegetated. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

## Alternative 4

In this alternative, restoration efforts are targeted at the riparian buffer and select road and bridge removal, with a total of 223 acres restored. Removal of campsites and riparian restoration within 150 feet of the bed and banks would occur. Two bridges—Ahwahnee and Sugar Pine—would be removed and the road through Stoneman meadow would be rerouted out of the meadow and the meadow extent restored. Campsites, informal trails and non-essential roads would be removed from culturally sensitive areas.

### *Segment 1*

**Merced Lake Ranger Station Meadow: grazing (RES-1-002) –** Remove the Merced Lake East Meadow from grazing permanently. Require all administrative pack stock passing through the Merced Lake area to carry pellet feed.

### *Segment 2*

**Ahwahnee Meadow: Northside Drive and bike path impact hydrology and meadow extent (RES-2-004) –**Mitigate effects of the road and bike trail through the meadow with culverts or other engineered solutions that allow passage of underground water. Heavy equipment including excavator, skid steer, loader, and dump truck would be used.

**El Capitan Meadow: bisected by road, informal trails, conifer encroachment (RES-2-009) –** Remove all informal trails from the meadow that incise, promote habitat fragmentation, or are located in sensitive and frequently inundated areas, and restore to natural condition. Use restoration fencing along northern perimeter of meadow and designate appropriate access points using boardwalks and viewing platforms. Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years. Work would take place during summer or fall. Fencing can occur any time of the year.

**Stoneman Meadow and Orchard parking lot: Road through meadow and parking lot (RES-2-008) –** Remove the road through Stoneman Meadow as in Alternatives 2 and 3. Remove part of Curry Orchard parking lot to restore 3.4 acres of meadow. Remove imported fill, decompact soils and recontour using the 1919 maps as a guide. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during the summer or fall and take approximately three months.

**Housekeeping Camp: riparian restoration and river access (RES-2-023)** – Remove 166 units to restore 12.2 acres of riparian zone. Provide for day use arriving via shuttle with trails to access to the large sandbars on the western edge of Housekeeping Camp and across Housekeeping Bridge. Restore natural topography and channels through the removal of fill material. Revegetate with native riparian and wetland species. Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years. Work would take place during low water in the fall.

**Upper and Lower Rivers Campground: abandoned infrastructure (RES-2-021)** – Restore and protect 19.7 acres of the riparian zone at the former Rivers campgrounds site to a mosaic of riparian, meadow, and California black oak habitat. Fence and close the riparian zone at Upper Rivers to protect the riverbank from trampling. Mechanically remove ponderosa pine and incense cedar saplings and mature trees less than 18 inch dbh (diameter at breast height) within the restoration area that are infringing on California black oaks and growing on soils that once supported meadow communities. Revegetate with native meadow grasses, sedges, and shrubs. Plant native riparian species such as willow, alder, and cottonwood along the riverbank. Direct river access to the sandbar at Lower Rivers or to the beach across the Ahwahnee Bridge. Use signage for way finding and for interpretation of river-related natural processes. Remove any remaining abandoned asphalt, decompact soils of former roads and campsites. Restore natural contours and re-establish drainage channels that have been filled. Place large box culverts or other design components such as rolling dips, permeable sub grade, etc to improve surface water flow across roads and trails. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used over a period of up to two months for two years in the fall.

**Valley Campgrounds:** Remove campsites near the river (RES-2-022) – Same as Alternative 3.

**Revetment:** free flowing condition (RES-2-051) – Same as Alternative 3.

**Stoneman Bridge: free flowing condition (RES-2-053)** – Mitigate effects of bridge through engineered solutions. Place large wood to lessen the scouring from bridge. Use brush layering and place a constructed log jam. Add culverts along Northside Drive to improve drainage. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Sugar Pine Bridge and Ahwahnee Bridge and Road Berm: free flowing condition (RES-2-052)** – Remove Sugar Pine and Ahwahnee Bridges as in Alternative 2. Heavy equipment including excavator, skid steer, loader, and dump truck would be used and work would last for up to four weeks.

**Concessioner stables to Happy Isles: pack stock trail (RES-2-143)** – Same as Alternative 2.

**Camp 6: Water Quality, proximity to the River, and fill material within the 5-to 10-year floodplain (RES-2-146)** – Restore 6.1 acres in the 150 foot riparian buffer adjacent to Camp 6: remove unnatural fill as identified in soil studies. Plant native riparian species in unvegetated areas after fill removal. Allow seasonal flooding to re-work remaining topography. Revegetate eroded riverbanks, fence the riparian buffer and increase signage to avoid continued impacts (Figure 7). Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years and take place during low water in the fall.

**Valley Meadows: Valley Loop Trail impacts through meadows (RES-2-005) –** Same as Alternative 2.

**Ahwahnee Meadow oxbows: trail impacts (RES-2-003) –** In the sections of trail (350 feet) that pass through oxbows, remove the asphalt and fill and replace with a boardwalk. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

**Former Yosemite Lodge cabins (Pine and Oak) area (RES-2-154) –** Restore 10.9 acres of riparian ecosystem at the site of the former Yosemite Lodge units and cabins (area commonly known as the Oak and Pine cabins, which were removed after being damaged by the 1997 flood). Remove riprap from Yosemite Creek and plant willows along stream bank. Remove informal trails throughout the eastern end of the lodge near Yosemite Creek and formalize one trail through the area. Delineate one service road to the well house and parking. Remove excess service roads. Remove fill, decompact soils and plant riparian plant species. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used.

### *Segment 4*

**Old El Portal: parking and development in valley oaks (RES-4-002)** – Restore the rare floodplain community of valley oaks in Old El Portal through implementation of mitigation measures related to invasive species removal, overwatering, tree pruning, and prohibiting grading and parking in the dripline (see Appendix D). Also, create a valley oak recruitment area of 1acre in Old El Portal in the vicinity of the current Odger's bulk fuel storage area, including adjacent parking lots. Decompact soils, plant appropriate native understory plant species, and treat invasive plants. Prohibit new building construction within the oak recruitment area. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

### *Segment 7*

**Wawona Campground: campground activity near river (ONA-7-001)** – Same as Alternative 3.

**Wawona Stock Camp (RES-7-011)** – Two stock use campground sites relocated from sensitive resource area to Wawona Stables. The sites will then be recontoured, soil decompacted and revegetated. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during the summer or fall and take approximately one month.

## Alternative 5

This alternative would restore riparian habitat along the Merced River 100 feet from the ordinary high water mark. To enhance free-flowing condition it would remove Sugar Pine Bridge and increase channel complexity below the other bridges through addition of constructed log jams and other bioengineering techniques. It restores 203 acres to natural conditions within the river corridor and includes removing campsites within 100 feet of the bed and banks and removing informal trails and

non-essential roads from sensitive areas. This alternative calls for the study of road removal through Stoneman Meadow.

### *Segment 1*

**Merced Lake Ranger Station Meadow: grazing (RES-1-002)** – Same as Alternative 3.

### *Segment 2*

**Ahwahnee Meadow: Northside Drive and bike path impact hydrology and meadow extent (RES-2-004) –** Same as Alternative 4**.**

**El Capitan Meadow: bisected by road, informal trails, conifer encroachment (RES-2-009) –** Remove all informal trails from the meadow that incise, promote habitat fragmentation, or are located in sensitive and frequently inundated areas, and restore to natural condition. Use restoration fencing along northern perimeter of meadow and designate appropriate access points using boardwalks and viewing platforms. Selectively remove mature conifers that block views of El Capitan from the roadside**.** Equipment including skid steer would be used over a period of up to six weeks for two years. Fencing can occur any time of the year.

**Stoneman Meadow and Orchard parking lot: Road through meadow and parking lot (RES-2-008) –** Study potential for road removal through Stoneman Meadow. Remove roadside parking along Stoneman Meadows and restore to meadow conditions. Remove 1,350 cubic feet of fill, revegetate with native seed and/or transplanted native plants. Remove apple trees in Curry Orchard parking lot. For roadside parking removal, equipment work, hauling, and revegetation would take 10 weeks with work performed in the late summer or fall. Heavy equipment including excavator, skid steer, loader, and dump truck would be used.

**Housekeeping Camp: riparian restoration and river access (RES-2-023) –** Remove 34 units from within the ordinary high water mark to restore 1 acre of riparian habitat (Figure 10). After removal of structures, adjust fence location to provide greater distance away from the bed and banks. Revegetate with riparian plant species. The work would be performed in the fall after the camp is closed for the season. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck may be used over a period of up to eight weeks.

**Upper and Lower Rivers Campground: abandoned infrastructure (RES-2-021) –** Same as Alternative 4.

**Figure 10:** Radiating effects from campsites lead to denuded riparian zones, as seen at this campsite at North Pines Campground. In all alternatives, campsites would be moved back at least 100' from the bed and banks of the river to provide a buffer in which a diversity of riparian vegetation can thrive.

**Valley Campgrounds: campsites near the river (RES-2-022)** -Remove sites at Backpacker's Camp, Lower Pines and North Pines Campgrounds that are within 100 feet of the ordinary high water to restore 6.5 acres of riparian habitat. Remove asphalt, base rock, fill material; decompact soils, recontour and revegetate. Erect new fencing or adjust existing fencing to protect the riparian zone. Harden river access point at North Pines campground. Construct a hardened surface using pinned logs back filled with native gravel. Fence sensitive areas and brush layer to repair eroded riverbank (Figure 10). Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years.

**Revetment: free flowing condition (RES-2-051)** – Same as Alternative 3.

**Stoneman Bridge: free flowing condition (RES-2-053)** – Same as Alternative 4.

**Sugar Pine Bridge and Ahwahnee Bridge and Road Berm: free flowing condition (RES-2-052)** – Remove the Sugar Pine Bridge and berm. At the Ahwahnee Bridge, heading south toward the Lower Pines campground, connect a trail and small bridge going over the cut-off channel. Additionally, re-route the multiple use trail to the north bank of the river. Manually cut pieces of the bridge into smaller sections. Remove bridges with heavy equipment (crane lifts sections or chunks). Pontoon rafts below the bridge would catch debris. All work from the banks would use the reach from an excavator to remove chunks of bridge. Footings would be removed with excavators from the bank. The removal would occur during low flow in late summer or early fall. No work would occur after Oct. 31 due to the potential for high water events occurring. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately three months.

**Concessioner stables to Happy Isles: pack stock trail (RES-2-143)** – Same as Alternative 3.

**Camp 6: Water Quality, proximity to the River, and fill material within the 5-to 10-year floodplain (RES-2146)** – Same as Alternative 4.

**Valley Meadows: Valley Loop Trail impacts through meadows (RES-2-005)** – Construct boardwalks through sensitive wet meadow habitat in Slaughterhouse Meadow. Move 780 feet of the trail that runs through Bridalveil Meadow to the toe of the fill slope of Southside Drive. Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years.

**Ahwahnee Meadow oxbows: trail impacts (RES-2-003)** – Same as Alternative 4.

**Former Yosemite Lodge cabins (Pine and Oak) area (RES-2-154)** – Restore 10.9 acres of riparian ecosystem at the site of the former Yosemite Lodge units and cabins (area commonly known as the Oak and Pine cabins, which were removed after being damaged by the 1997 flood). Remove riprap from Yosemite Creek and plant willows along stream bank. Remove informal trails throughout the eastern end of the lodge near Yosemite Creek and formalize one trail through the area. Delineate one service road to the well house and parking. Remove excess service roads. Remove fill, decompact soils and plant riparian plant species. Heavy equipment including excavator, dozer, skid steer, loader, and dump truck would be used.

### *Segment 4*

**Old El Portal: parking and development in valley oaks (RES-4-002)** – Restore the rare floodplain community of valley oaks in Old El Portal through implementation of mitigation measures related to invasive species removal, overwatering, tree pruning, and prohibiting grading and parking in the dripline (see Appendix D). Also, create a valley oak recruitment area of 1acre in Old El Portal in the vicinity of the current Odger's bulk fuel storage area, including adjacent parking lots. Decompact soils, plant appropriate native understory plant species, and treat invasive plants. Prohibit new building construction within the oak recruitment area. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

### *Segment 7*

**Wawona Campground: campground activity near river (ONA-7-001)** – Retains 83 sites and one group site. Remove 13 sites that are either within 100 feet of the river or in culturally sensitive areas.

**Wawona Stock Camp (RES-7-011)** – Two stock use campground sites relocated from sensitive resource area to another more appropriate location near the Wawona Maintenance Yard. The sites will then be re-contoured, soil decompacted and area re-vegetated. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

## Alternative 6

As with Alternative 5, this alternative is characterized by having limited restoration within 100 feet of the river; removing campsites, informal trails, and non-essential roads from sensitive areas. It addresses free-flowing condition by removing approximately one mile of revetment and increasing channel complexity around the bridges through engineered solutions. The number of acres of riparian and meadow restoration is at least 170 acres, targeting the most sensitive areas.

### *Segment 1*

**Merced Lake Ranger Station Meadow: grazing (RES-1-002)** – Same as Alternative 3.

### *Segment 2*

**Ahwahnee Meadow: Northside Drive and bike path impact hydrology and meadow extent (RES-2-004)** – Same as Alternative 4.

**El Capitan Meadow: bisected by road, informal trails, conifer encroachment (RES-2-009)** – Remove all informal trails from the meadow that incise, promote habitat fragmentation, or are located in sensitive and frequently inundated areas, and restore to natural condition. Use restoration fencing along northern perimeter of meadow and designate appropriate access points using boardwalks and

viewing platforms. Selectively remove mature conifers that block views of El Capitan from the roadside. Equipment including skid steer would be used over a period of up to six weeks for two years. Fencing can occur any time of the year.

**Stoneman Meadow and Orchard parking lot: Road through meadow and parking lot (RES-2-008)** – Mitigate effects of the road through the meadow with culverts or other engineered solutions that allow passage of underground water. Remove roadside parking along Stoneman Meadow and restore the area to meadow conditions. Remove 1,350 cubic feet of fill, revegetate with native seed and/or transplanted native plants. Remove apple trees in Curry Orchard parking lot. Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years in late summer and fall.

**Housekeeping Camp: riparian restoration and river access (RES-2-023)** – Same as Alternative 5.

**Upper and Lower Rivers Campground: abandoned infrastructure (RES-2-021)** – Same as Alternative 4.

**Valley Campgrounds: campsites near the river (RES-2-022)** – Same as Alternative 5.

**Revetment: free flowing condition (RES-2-051)** – An additional 348 feet of riprap south of the berm between Sugar Pine and Ahwahnee bridges would be removed and replaced with brush layering. Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks in the fall during low flow.

**Stoneman Bridge: free flowing condition (RES-2-053)** – Same as Alternative 4.

**Sugar Pine Bridge and Ahwahnee Bridge and Road Berm: free flowing condition (RES-2-052)** – Improve riverbank condition at Sugar Pine and Ahwahnee Bridges by increasing channel complexity through construction of engineered log jams, strategic placement of large wood, removal of rip rap, and bioengineering of the riverbank. Reduce the width of the cut-off channel upstream of Sugar Pine bridge through a combination of fill, constructed log jams, and bioengineered bank stabilization. If subsequent monitoring of riparian condition reveals insufficient improvement (i.e. CRAM rating remains below 0.71) within 10 years of the implementation of these actions, more aggressive management action may be initiated, including the possible removal of Sugar Pine Bridge. Heavy equipment including excavator, skid steer, loader, and dump truck would be used over a period of up to eight weeks for two years during the fall low flow.

**Concessioner stables to Happy Isles: pack stock trail (RES-2-143)** – Same as Alternative 3.

**Camp 6: Water Quality, proximity to the River, and fill material within the 5-to 10-year floodplain (RES-2146)** – Same as Alternative 4.

**Valley Meadows: Valley Loop Trail impacts through meadows (RES-2-005)** – Same as Alternative 5.

**Ahwahnee Meadow oxbows: trail impacts (RES-2-003)** – Same as Alternative 4.

### *Segment 4*

**Old El Portal: parking and development in valley oaks (RES-4-002)** – Restore the rare floodplain community of valley oaks in Old El Portal through implementation of mitigation measures related to invasive species removal, overwatering, tree pruning, and prohibiting grading and parking in the dripline (see Appendix D). Also, create a valley oak recruitment area of 1 acre in Old El Portal in the vicinity of the current Odger's bulk fuel storage area, including adjacent parking lots. Decompact soils, plant appropriate native understory plant species, and treat invasive plants. Prohibit new building construction within the oak recruitment area. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur in the late summer or fall and take approximately one month.

### *Segment 7*

**Wawona Campground: campground activity near river (ONA-7-001)** – Same as Alternative 5.

**Wawona Stock Camp (RES-7-011)** – Two stock use campground sites relocated from sensitive resource area to Wawona Stables. Heavy equipment including excavator, skid steer, loader, and dump truck would be used. Work would occur during low flow in the summer or fall and take approximately one month.

## BEST MANAGEMENT PRACTICES: TOOLS AND TECHNIQUES

### Mitigations

All ecological restoration work would follow the Mitigation Measures outlined in Appendix C.

### Restoration work in Wilderness

For restoration needs in designated Wilderness, a minimum requirement analysis would be completed and the appropriate techniques selected.

### Fencing

Fencing has proven to be effective at rerouting pedestrian traffic to appropriate river access points and allowing colonization of denuded areas with riparian plant species which then stabilizes the river bank from further erosion (Figure 11). Yosemite has used different fencing

**Figure 11:** Frequently flooded area at housekeeping camp.

styles—most often split rail zigzag and post and rail (Figure 12). Log and block fencing has also been introduced as a more sustainable option in areas where plowing and vehicles frequently cause damage to fencing (Figure 13). Fencing has also demonstrated its effectiveness in supporting restoration efforts in meadow environments. Fencing has been used to delineate appropriate trails and to close off sensitive sections of meadows in order to deter trampling of vegetation and the formation of informal trails.

**Figure 12:** Before and after protective fencing placement and revegetation at Housekeeping camp.

**Figure13:** Post and rail fencing (Left) and log and block fencing (right).

## Asphalt Removal

Asphalt surface is broken using heavy equipment. Asphalt is then loaded into dump trucks using a loader and moved off site. Small asphalt pieces may be manually collected and removed.

## Fill Removal & Recontouring

The topography at some meadow, wetland, and floodplain sites has been made uniform through the import of fill material or by grading or flattening contours of the landform. To re-establish contours or increase topographic heterogeneity, an excavator or dozer may be used to excavate depressions, cut-off channels, and oxbows. On steep riverbanks, an excavator or dozer may push soils and material down the

slope of the bank to create a gentler slope which increases revegetation success. Whenever possible, native fill is used from the restoration site. In meadows with drainage ditches and associated berms, the ditches would be contoured and leveled using fill material already present in associated berms.

## Soil Decompaction

Roads, parking, campsites and trails (formal or informal) may have highly compacted soils that are hydrophobic and prevent water from percolating into the soil and alter surface flow patterns. In the field, park staff determines areas of heavy soil compaction and either break up the soils manually using shovels or rakes or with heavy equipment that can support ripping tines such as excavators, skid steer and dozers. Small pockets of fill may be blended into the soil as decompaction occurs with an excavator or dozer with winged rippers. Biologists regularly monitor informal trailing extent and distribution in meadows and apply condition ratings to all informal trails. These ratings reflect the degree to which specific trails have ecological impacts including: bare ground, vegetation condition, and soil compaction. This information would assist restoration workers in identifying areas requiring soil decompaction to promote plant recovery.

## Riprap Removal

Several park restoration projects have involved the removal of riprap and restoration of healthy riparian vegetation (Figure 13). Riprap is removed using a track-mounted excavator. The operator picks up the boulders with the bucket of the excavator and either stockpiles the rocks on the terrace, or loads directly into a dump truck. After riprap is removed the bank may be recontoured to facilitate plant establishment.

## Bioengineering Techniques

Bioengineering techniques commonly used for riverbank stabilization and restoration include willow hydrodrilling, brush layering, and wood incorporation (Figure 14). Willow wattles and anchoring logs may be used to accrete sediment. To propagate willow, cuttings are taken from established plants and placed deeply into the soil to promote regeneration and to prevent them from washing away during high water events. Rocky or compacted riverbanks are most effectively and efficiently planted using a hydraulic excavator. In fine sediment, a hydro-drill (a pump with a high-powered stream of water) can create deep holes into which cuttings are placed. Willows may also be bundled into wattles and partially buried and anchored along riverbanks. Large wood may also be use to provide structure when repairing highly eroded riverbanks or after riprap removal. One objective of bioengineering is to decrease flow velocities by increasing roughness so that river sediment is captured over time, slowly rebuilding the banks.

**Figure 14:** Before (left) and after (right) riverbank restoration through riprap removal and revegetation at the former Lower Rivers Campground. Riparian vegetation thrives on the riverbank.

## Revegetation Methods

In the riparian zone, sedges, rushes and willow and cottonwood are desirable species for planting. Restoration staff collect pole cuttings (for vertical planting using the hydrodrill, Figure 15) from willows and cottonwoods along the Merced River using loppers; targeting straight branches 5-6' long and approximately 1" in diameter. Horizontal planting (such as that done with an excavator or backhoe) is another revegetation method, as well as the primary planting method for bioengineering. This method is utilized at sites with greater disturbance where riverbank integrity and existing root mass does not exist. Overall, willows have a high survival rate although some species do not establish as readily as others.

**Figure 15:** Yosemite restoration staff have employed bioengineering techniques in past park projects including Brush layering with willows (left). Restoration workers insert live willow cuttings with the aid of a hydrodrill to revegetate this riverbank (right).

On riverbank terraces, species matching the surrounding native flora would be planted. Watering or irrigation is part of post-planting maintenance for 3 years as it increases plant survival, especially on higher and drier sites such as terraces. Vegetation along the riverbanks plays an important role in flow attenuation and sediment capture during flood events. Native riparian vegetation is also naturally recruited on exposed sediment. Nursery-grown plants would be propagated from local genetic stock. Plants would be salvaged prior to ground disturbance and replanted.

In meadow environments, park biologists use a variety of techniques for ecological restoration. Imported fill material is removed from meadows using heavy equipment such as an excavator, loader, and dump truck. When removing informal trails, restoration workers would decompact soils, recontour the area to remove the linear feature and spread locally gathered native speed to promote plant establishment. Sometimes, vegetation plugs are salvaged using an excavator and skid steer and replanted in the disturbed areas. Mulching to promote revegetation and reduce erosion would be used as necessary. Bare areas would be revegetated with native plants grown from locally collected seed. Erosion control blankets and wattles are sometimes needed to control erosion until vegetation becomes established.

## Large Wood Incorporation

To restore riverbanks that have receded due to unnatural bank erosion, large wood may be incorporated into riverbanks. Large logs are placed strategically to limit scour and promote accretion and may or may not be anchored. For example, logs may be placed into a trench dug in the terrace to anchor it. Cabling could also be used to anchor wood to the shore.

These techniques are similar to what has been used in Yosemite Valley riverbank restoration projects in the past. For example, incorporation of large wood was successfully used in the 1995 Housekeeping Camp Restoration, along with riprap removal, brush layering and fencing.

## Opportunistic Large Woody Debris Addition through Hazard Tree Mitigation

Potentially hazardous trees are sometimes felled along the river for safety reasons. To assist in the riverine habitat recovery, these hazard trees can be purposefully felled into the river. Trees are felled using both excavators and forestry loaders with winch. This retention of the root wad provides needed weight to help anchor the tree to the shore. Felled trees add biomass, slow water flow, create structural and microclimatic diversity, and provide shade for riparian organisms.

## Constructed Log Jams

Constructed log jams (CLJs) increase channel complexity, capture sediment, mitigate channel widening and provide aquatic habitat. CLJs are constructed of 10-20 logs, often with their root wads intact, 12” or greater in diameter. The composite structure can be 30-150’ long and 10-30’ wide with a height of 8 feet. Thus, an CLJ may occupy an area of 33 500 square yards with volumes ranging from 90 – 1,300 cubic yards. The particular size of a given CLJ depends on the objective (deflecting flow away from a vulnerable riverbank to facilitating bar formation) and its location in the river. CLJs are

constructed in the river channel and anchored by burying ends of logs in sediment. CLJs would be designed to look natural, without straight-cut edges and with root wads remaining. Planting of riparian vegetation on the CLJ further enhances the natural aesthetic (Figure 16).

**Figure 16:** Natural wood loading in the Merced River (left) and an engineered log jam (right, photo courtesy of A.P. Brooks).

## Boardwalks

Boardwalks have proven to be a low-impact way of providing access to wet, sensitive and highly visited areas that are susceptible to trampling (Figure 17). Boardwalks are often used in restoration as alternative to complete closures of sensitive habitats. Boardwalks are an effective way to promote sheet flow, protect native vegetation, and reduce the potential vectors for the spread of non-native species, while allowing visitors to experience the flora and fauna of these unique environments. In Yosemite, boardwalks have been successful in allowing visitation of sensitive meadows and can provide access and throughways in locations where current trails are frequently inundated with water, cause severe damage to plants and soils, and fragment sensitive vegetation and wildlife communities.

**Figure 17:** Trails through frequently inundated wet meadows, such as in cook's meadow pre-restoration (left), cause periperal vegetation trampling and soil compaction and make access difficult. A boardwalk installed in 2005 allows for visitor access into the meadow environment and protects the meadow soils and hydrology.

## REFERENCES

Cooper, D. J. and E. C. Wolf

2008 Yosemite Valley: Hydrologic Regime, Soils, Pre-Settlement Vegetation, Disturbance, and Concepts for Restoration. Colorado State University.

Falk, D. A., M. A. Palmer, and J. B. Zedler

2006 Foundations of Restoration Ecology. Island pr.

Madej, M. A., W. E. Weaver, and D. K. Hagans

1991 Analysis of Bank Erosion on the Merced River, Yosemite Valley, Yosemite National Park, USA. Pages 235-250 Environmental Management. Pacific Watershed Associates, Arcata, California.

Mitsch, W. and J. Gosselink

2007 Wetlands. 4th Edition. Wiley, New York.

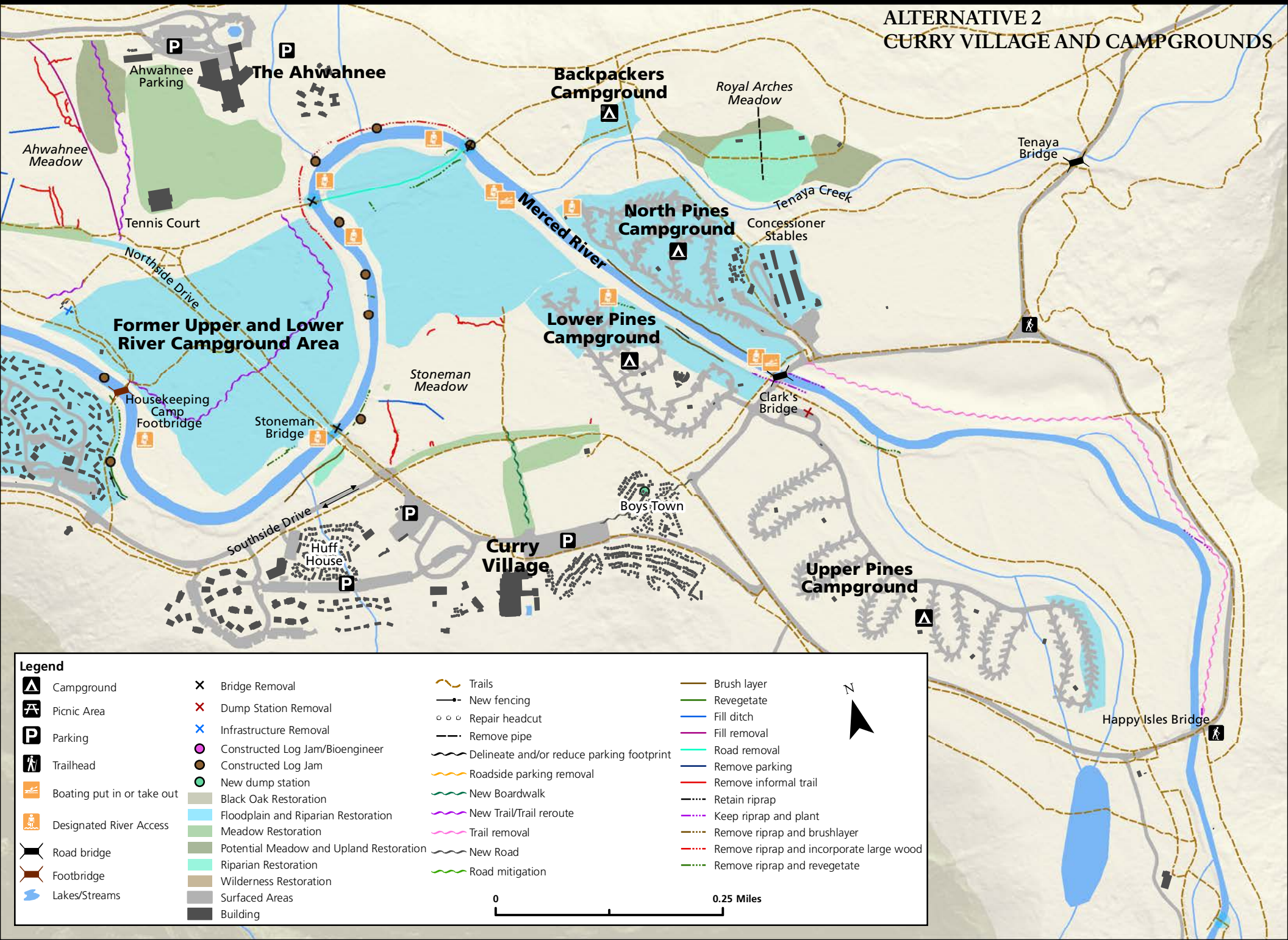
SER International Science Policy Working Group

2004 The SER International Primer on Ecological Restoration. Society for Ecological Restoration International Tucson, Arizona.

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

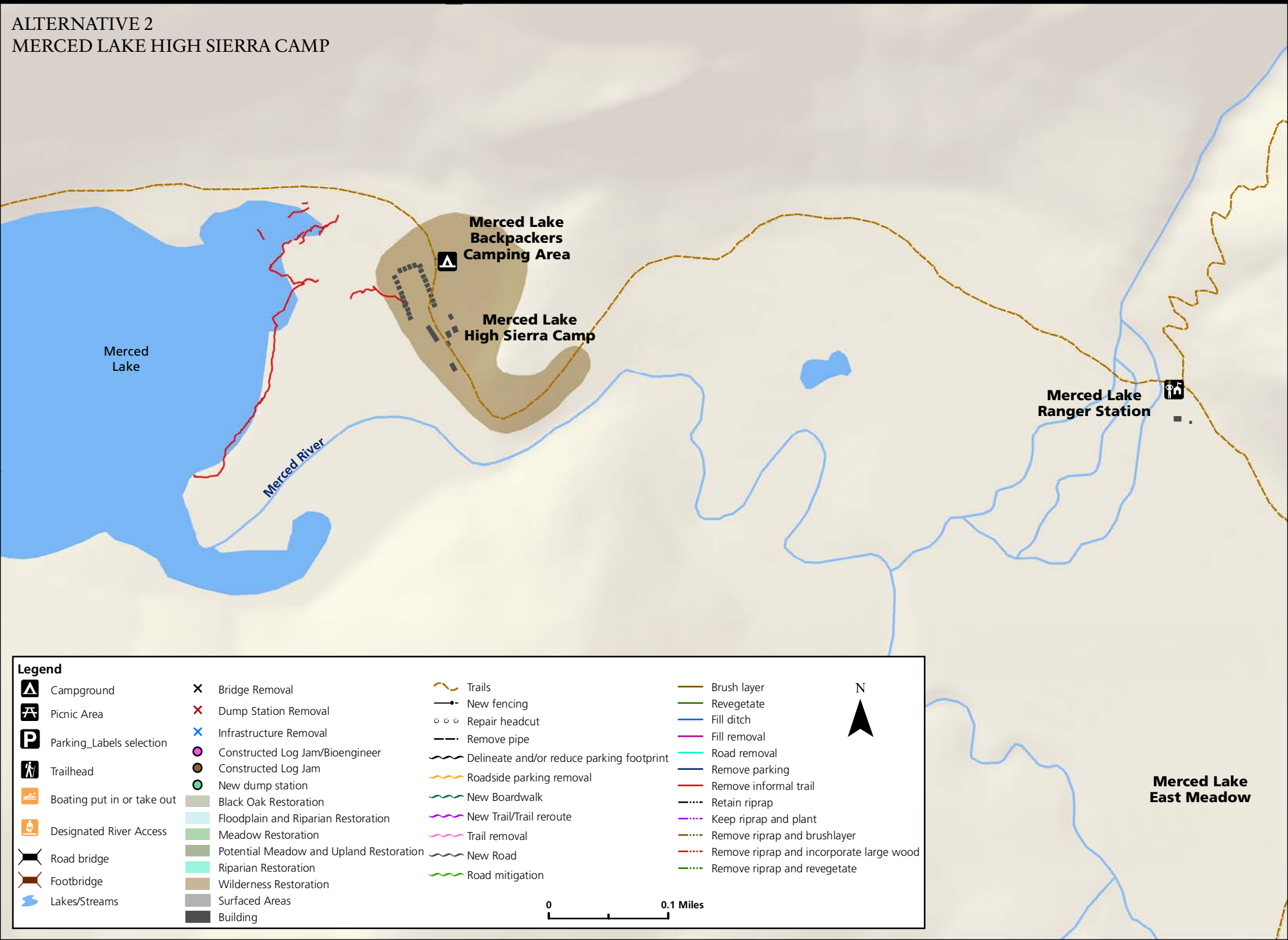


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 2
MERCED LAKE HIGH SIERRA CAMP



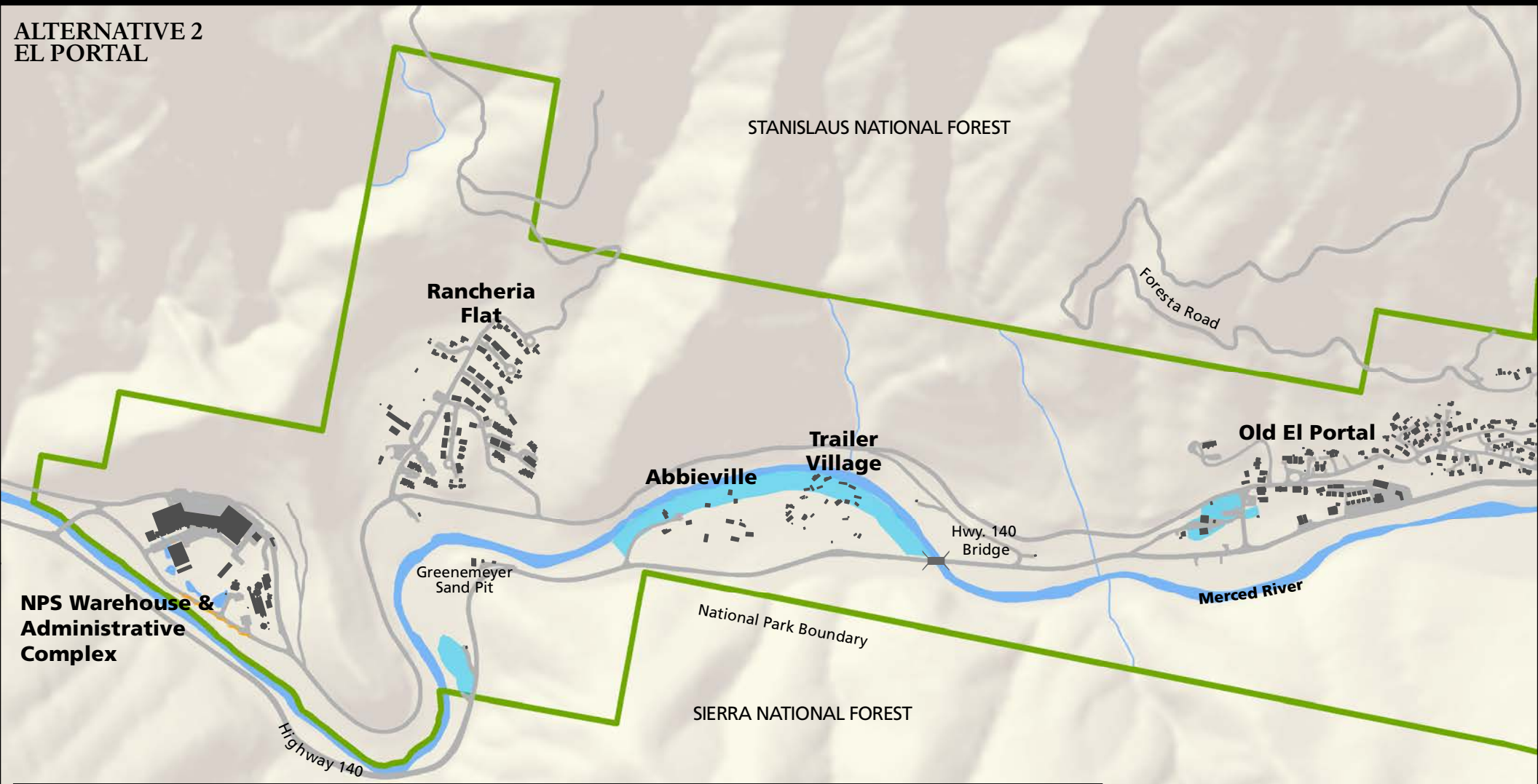

**Legend**

- Campground
- Picnic Area
- Parking_Labels selection
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior




**Legend**

- Campground
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

N

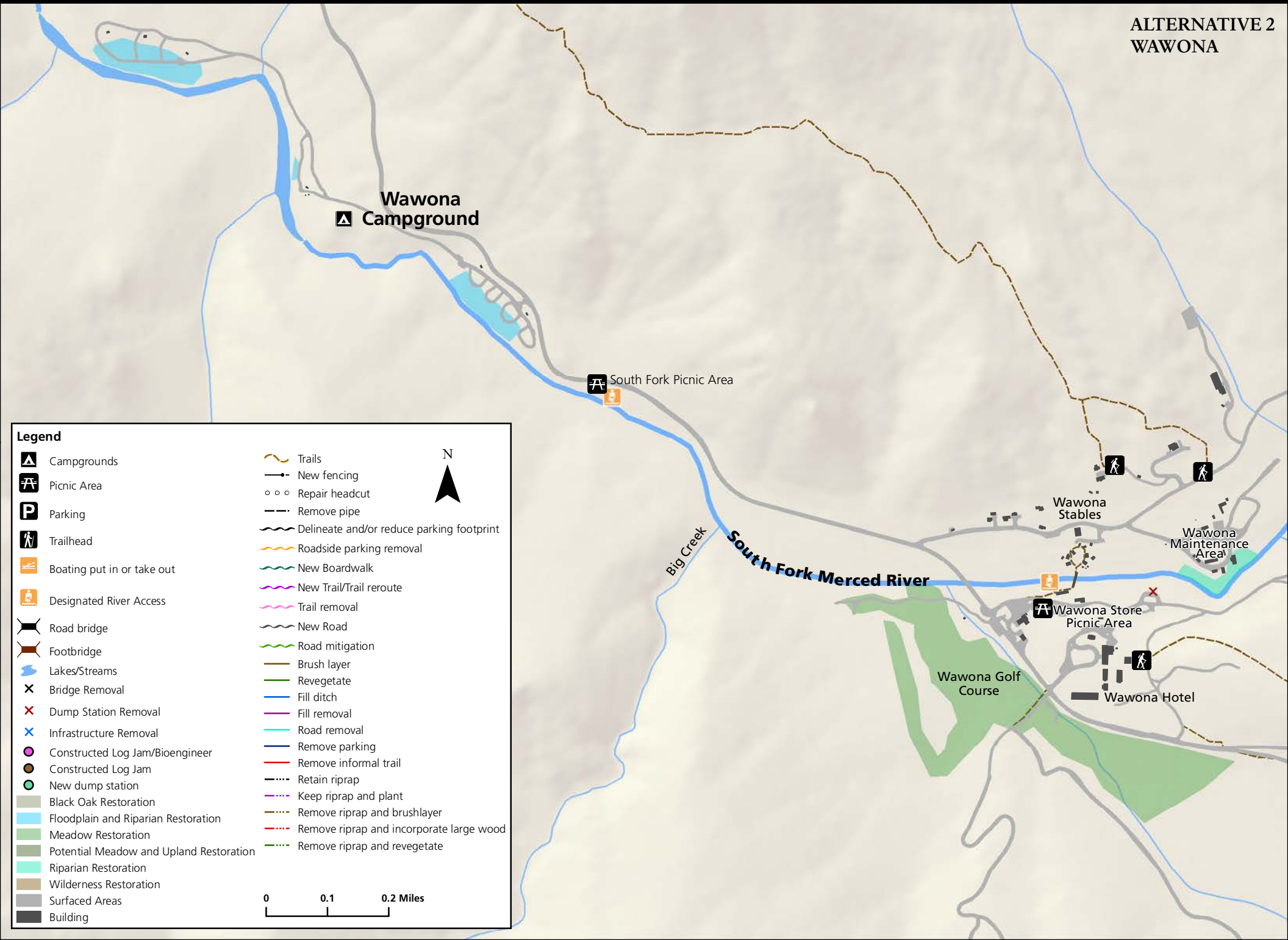
0 0.4 Miles

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 2
WAWONA



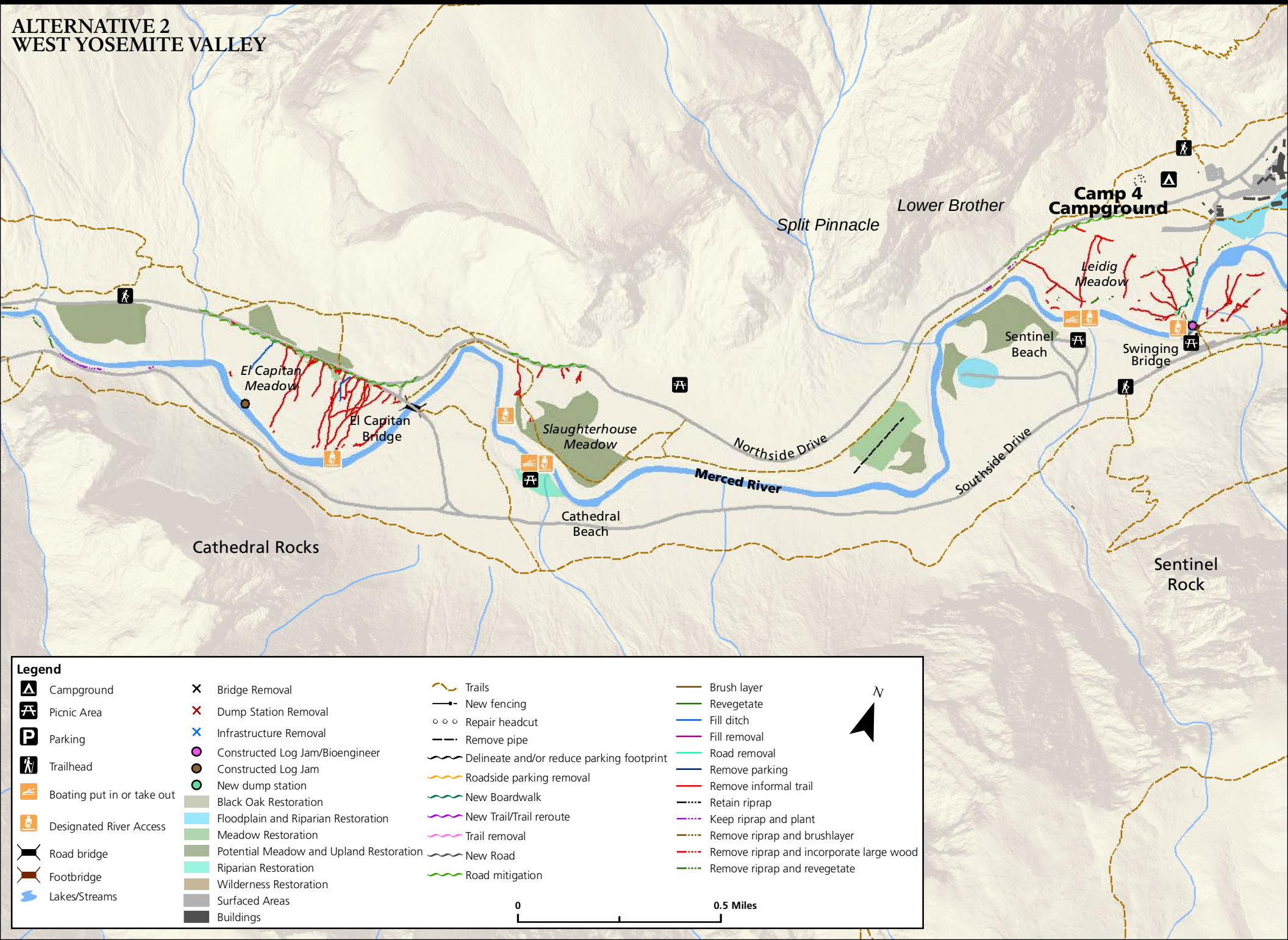

**Legend**

- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

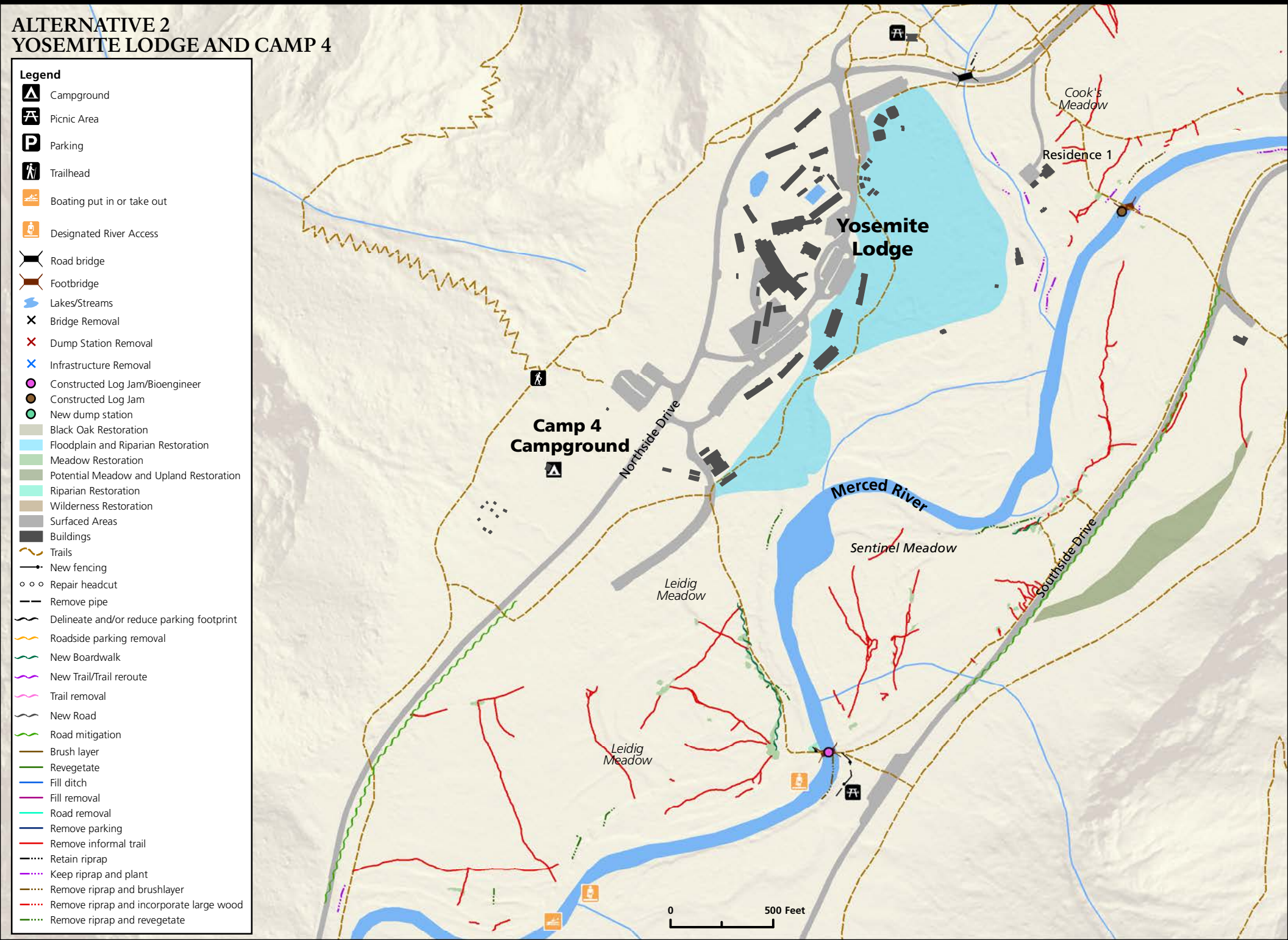


# Yosemite National Park
California

Merced River Plan
Restoration Elements

National Park Service
U.S. Department of the Interior

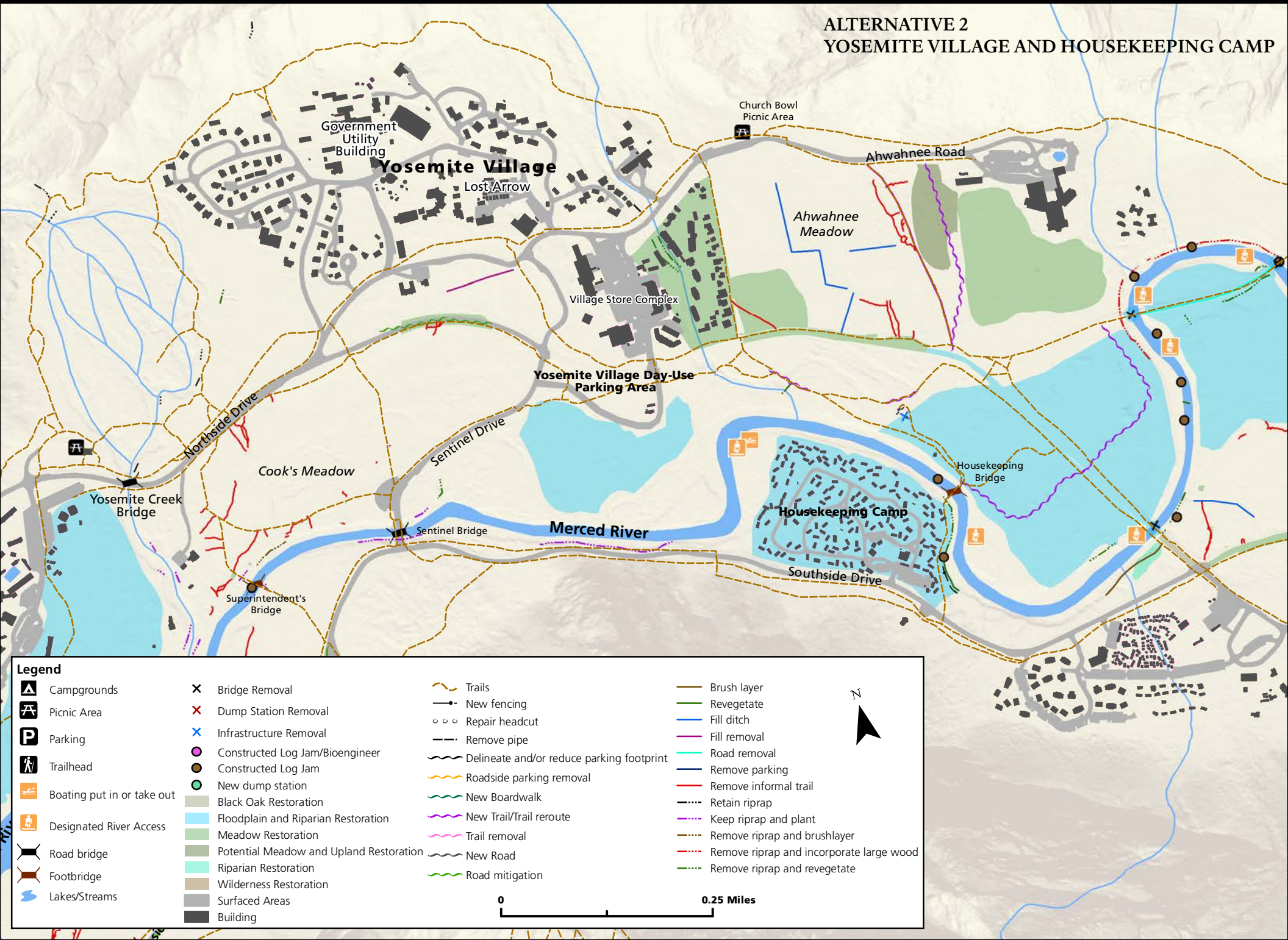
## ALTERNATIVE 2
## YOSEMITE LODGE AND CAMP 4



# Yosemite National Park
California

Merced River Plan Restoration Elements

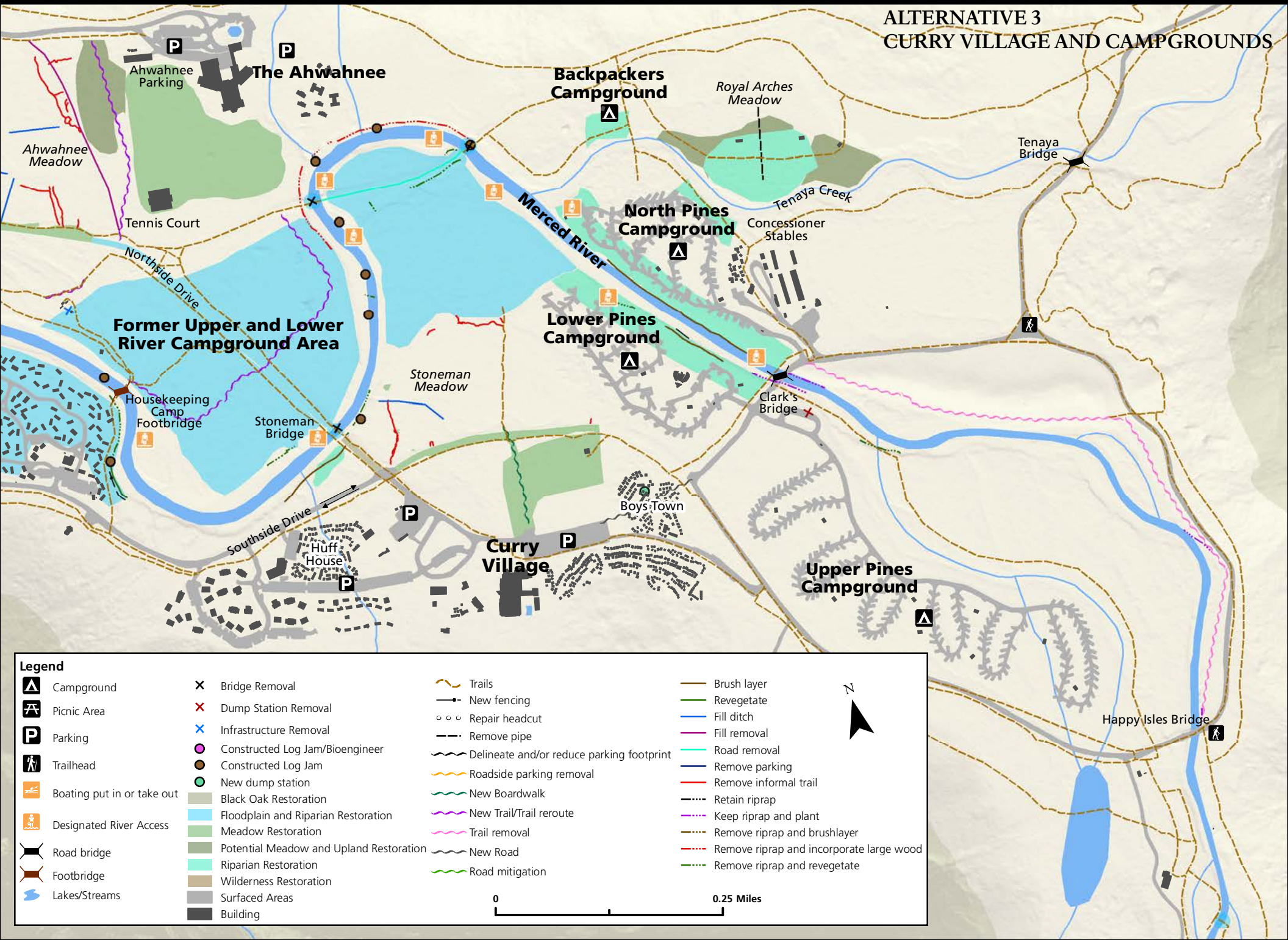
National Park Service
U.S. Department of the Interior



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

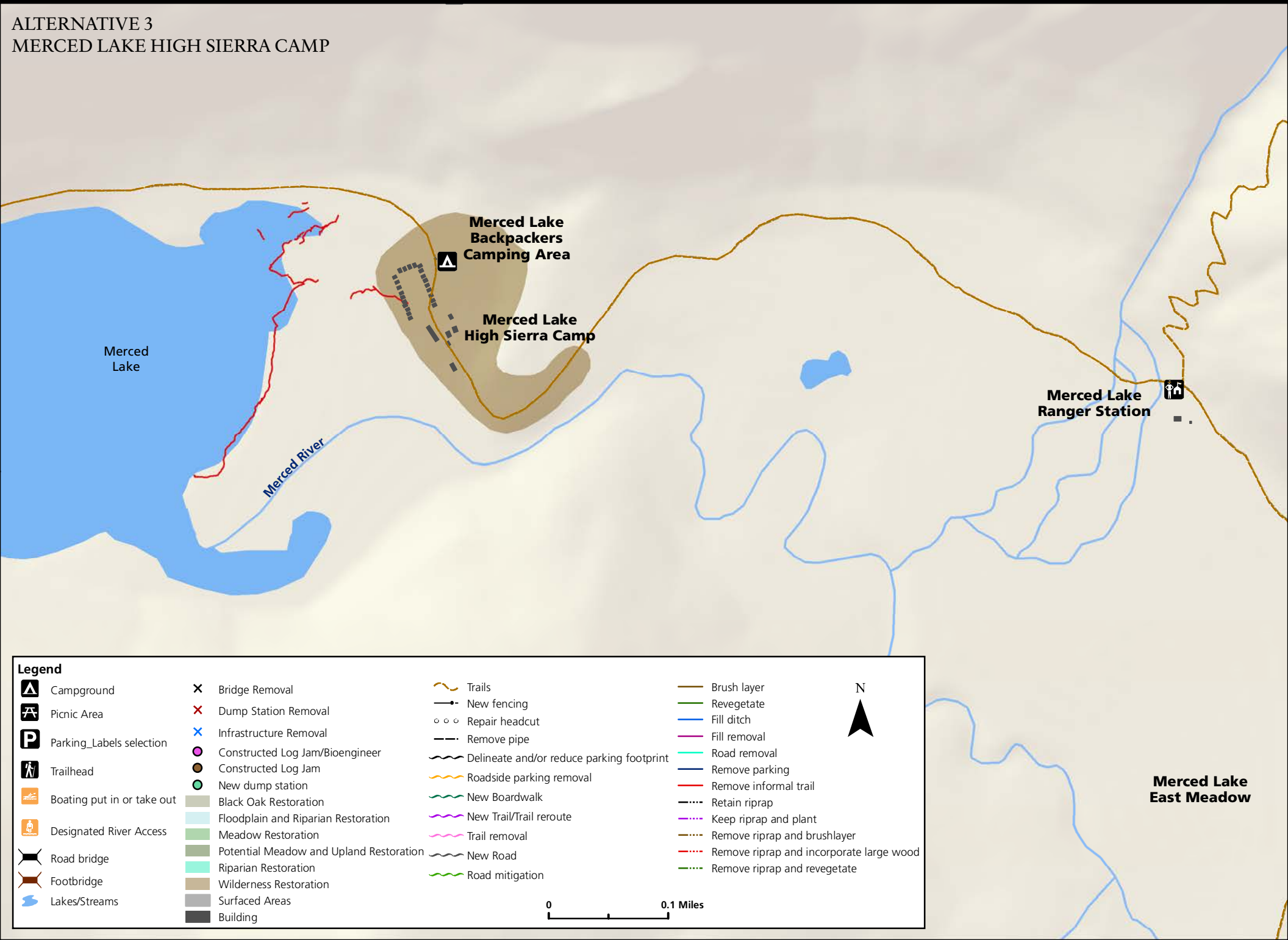


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

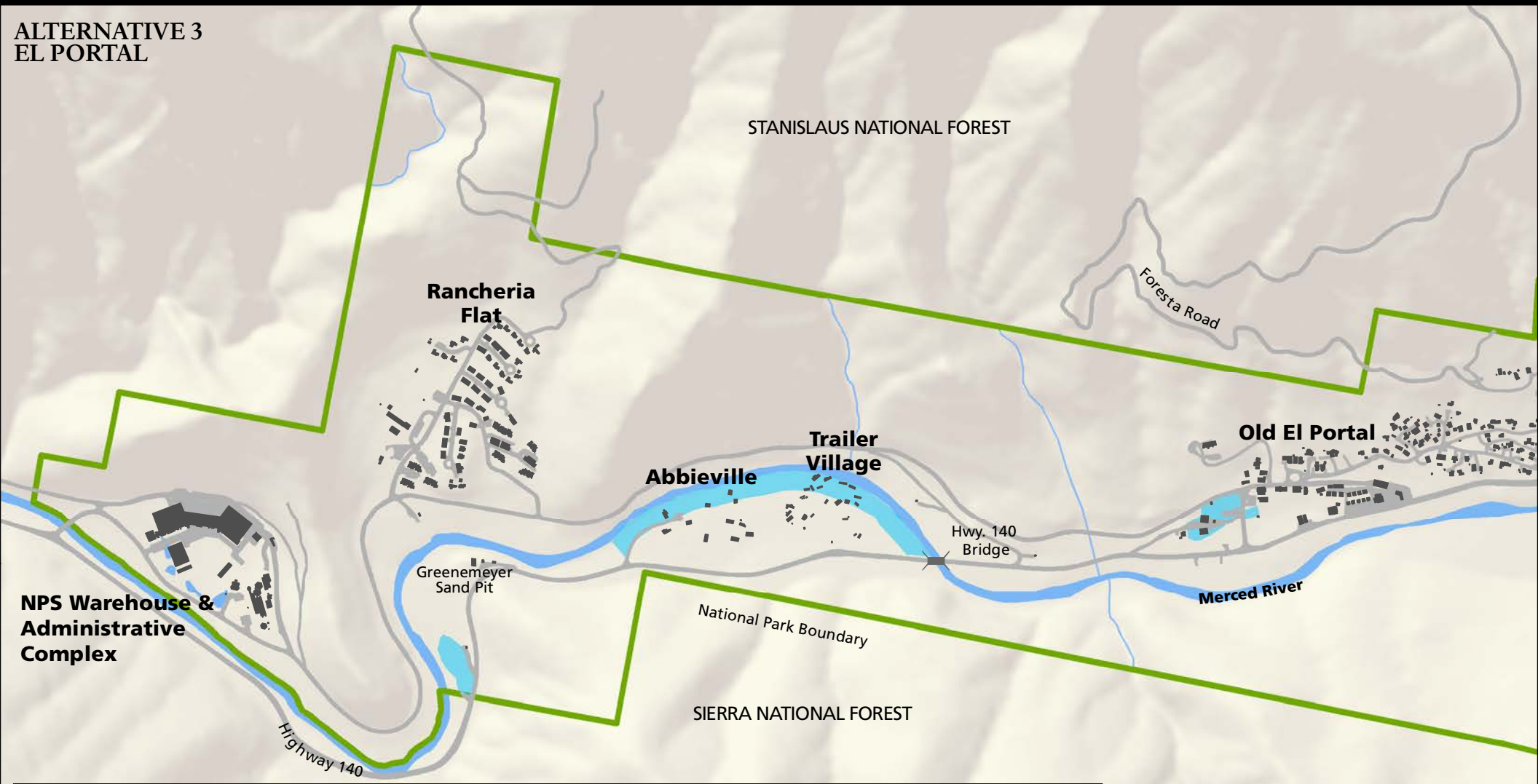
ALTERNATIVE 3
MERCED LAKE HIGH SIERRA CAMP



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior




**Legend**

- Campground
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

N

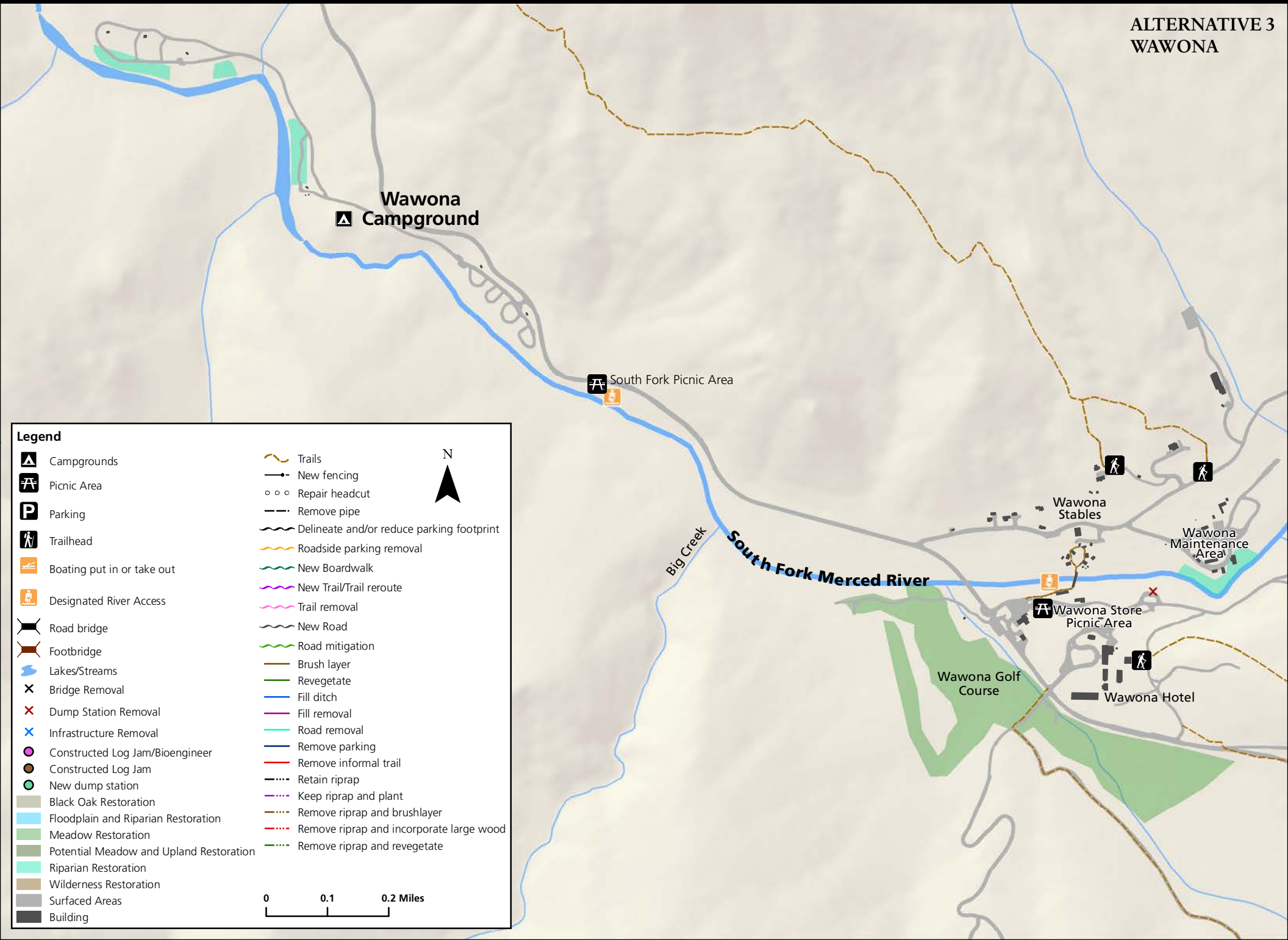
0 0.4 Miles

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 3
WAWONA



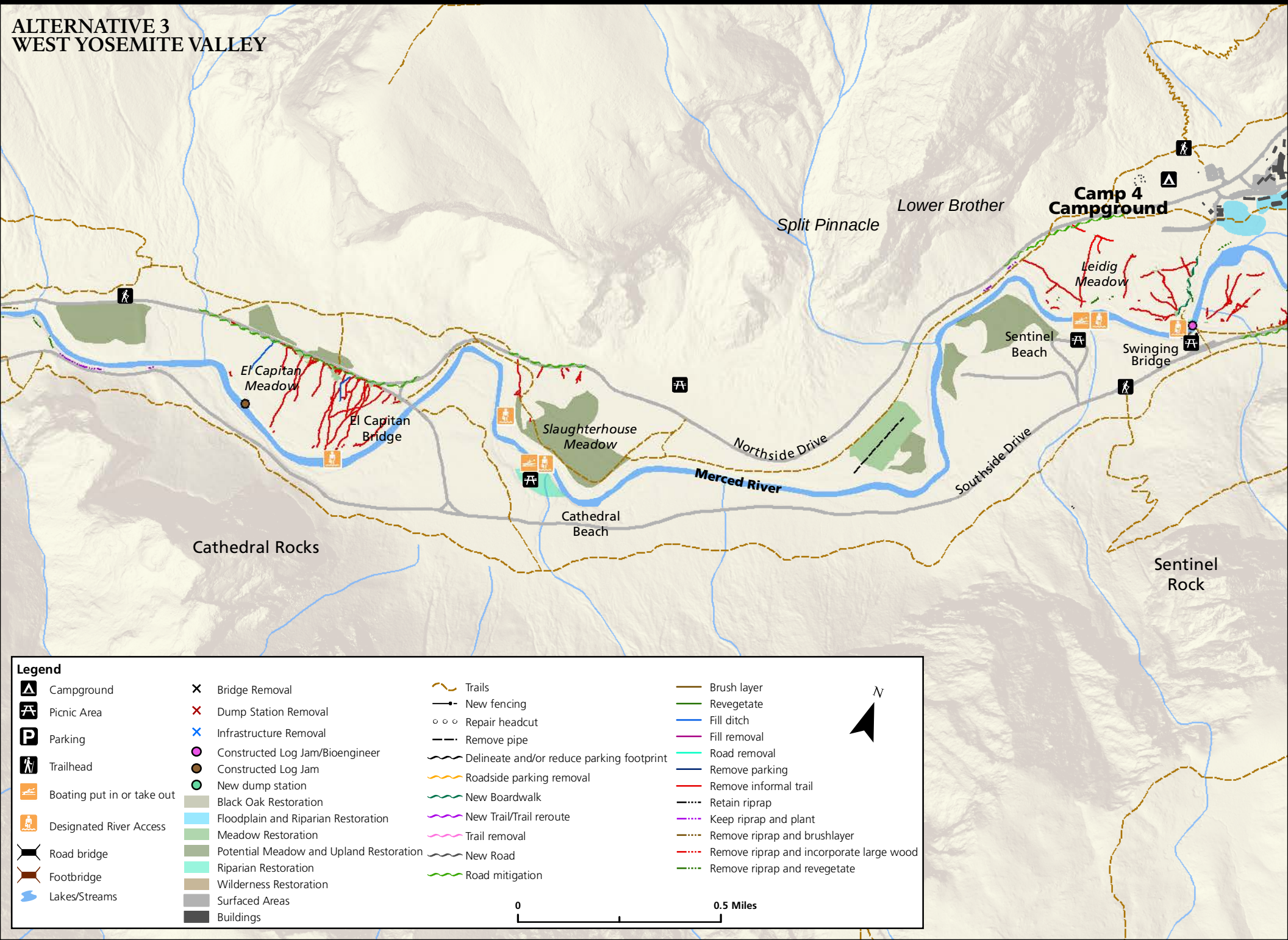

**Legend**

- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

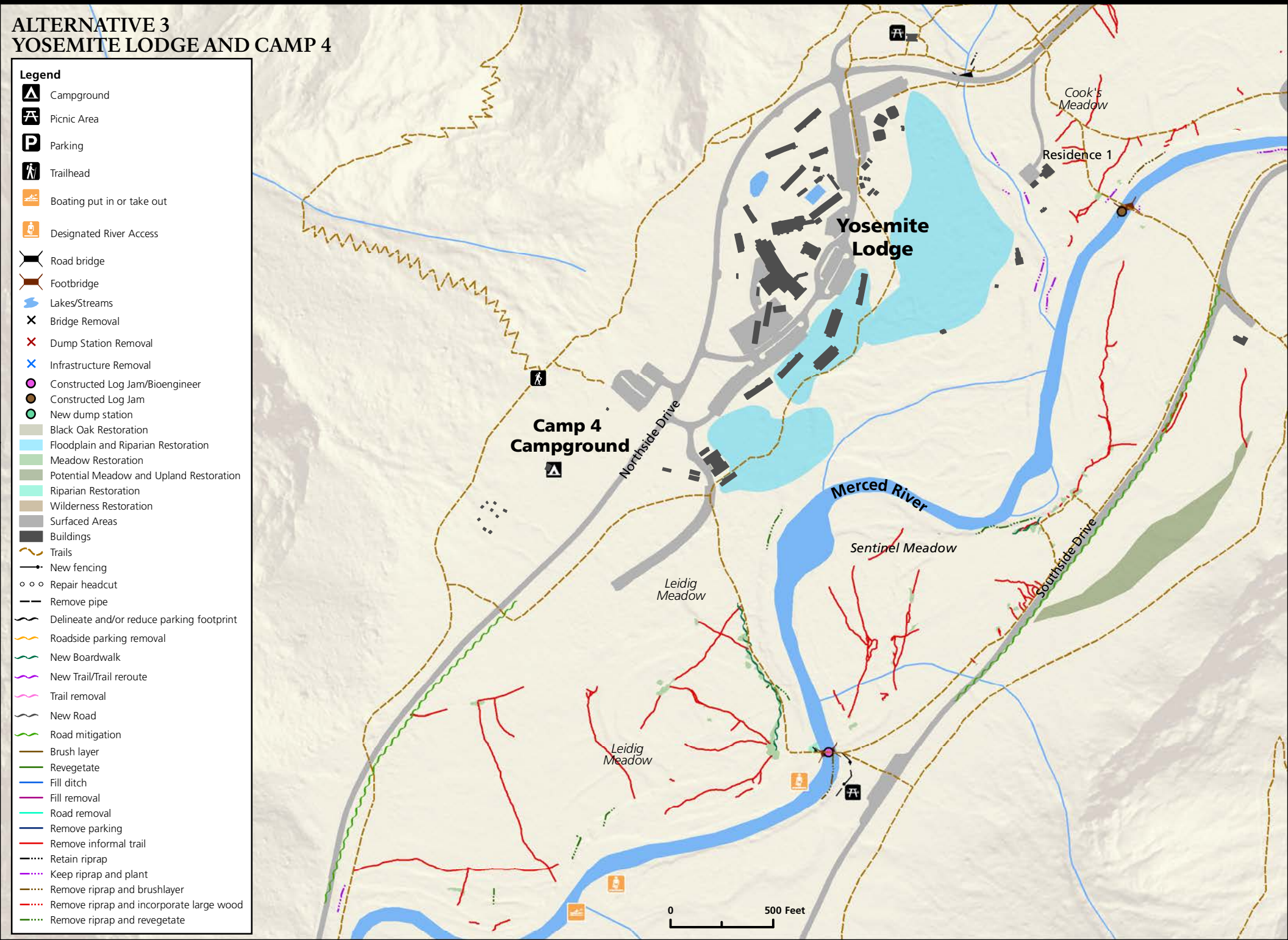


# Yosemite National Park
California

Merced River Plan
Restoration Elements

National Park Service
U.S. Department of the Interior

## ALTERNATIVE 3
## YOSEMITE LODGE AND CAMP 4

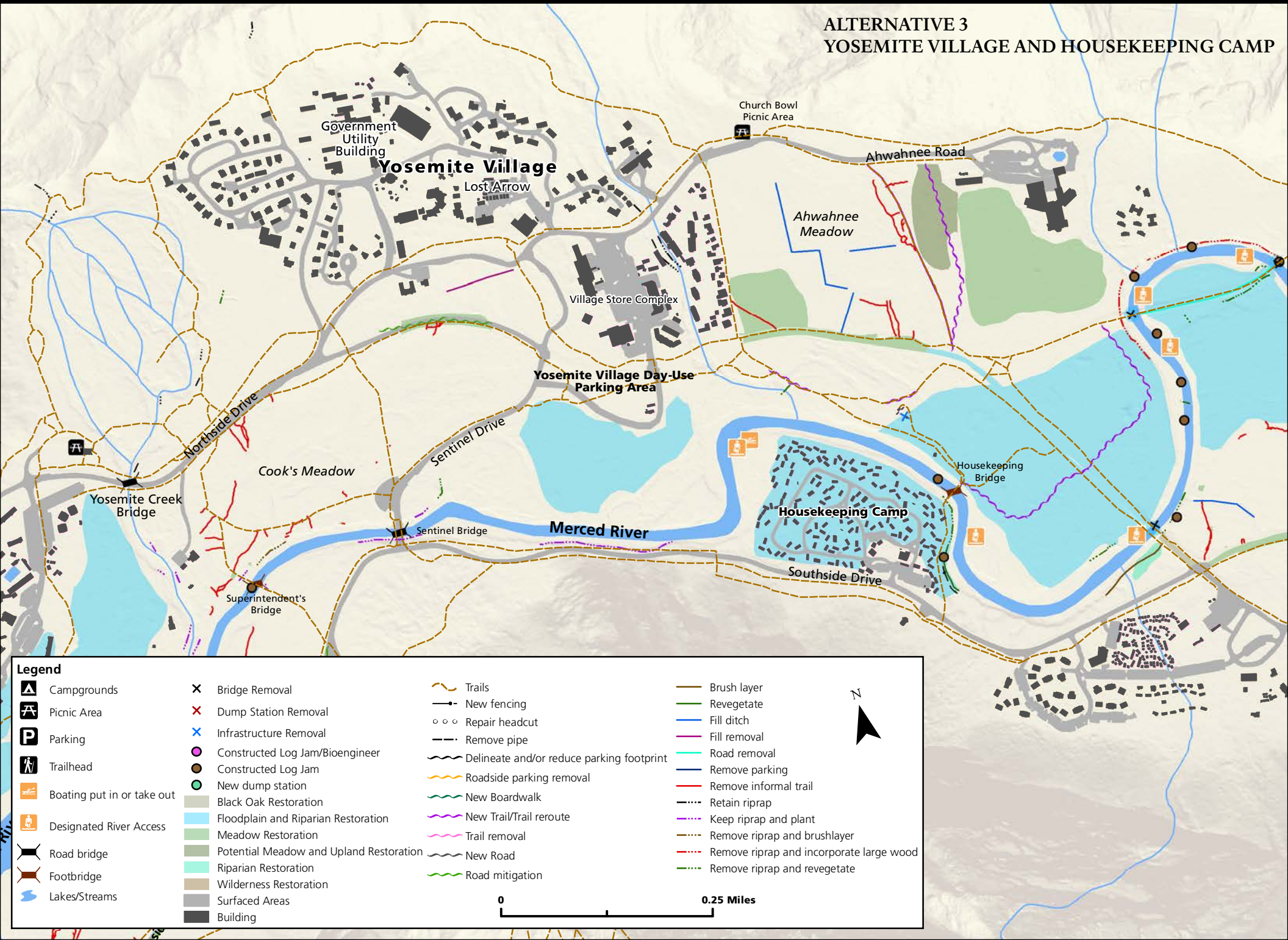


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

## ALTERNATIVE 3
## YOSEMITE VILLAGE AND HOUSEKEEPING CAMP



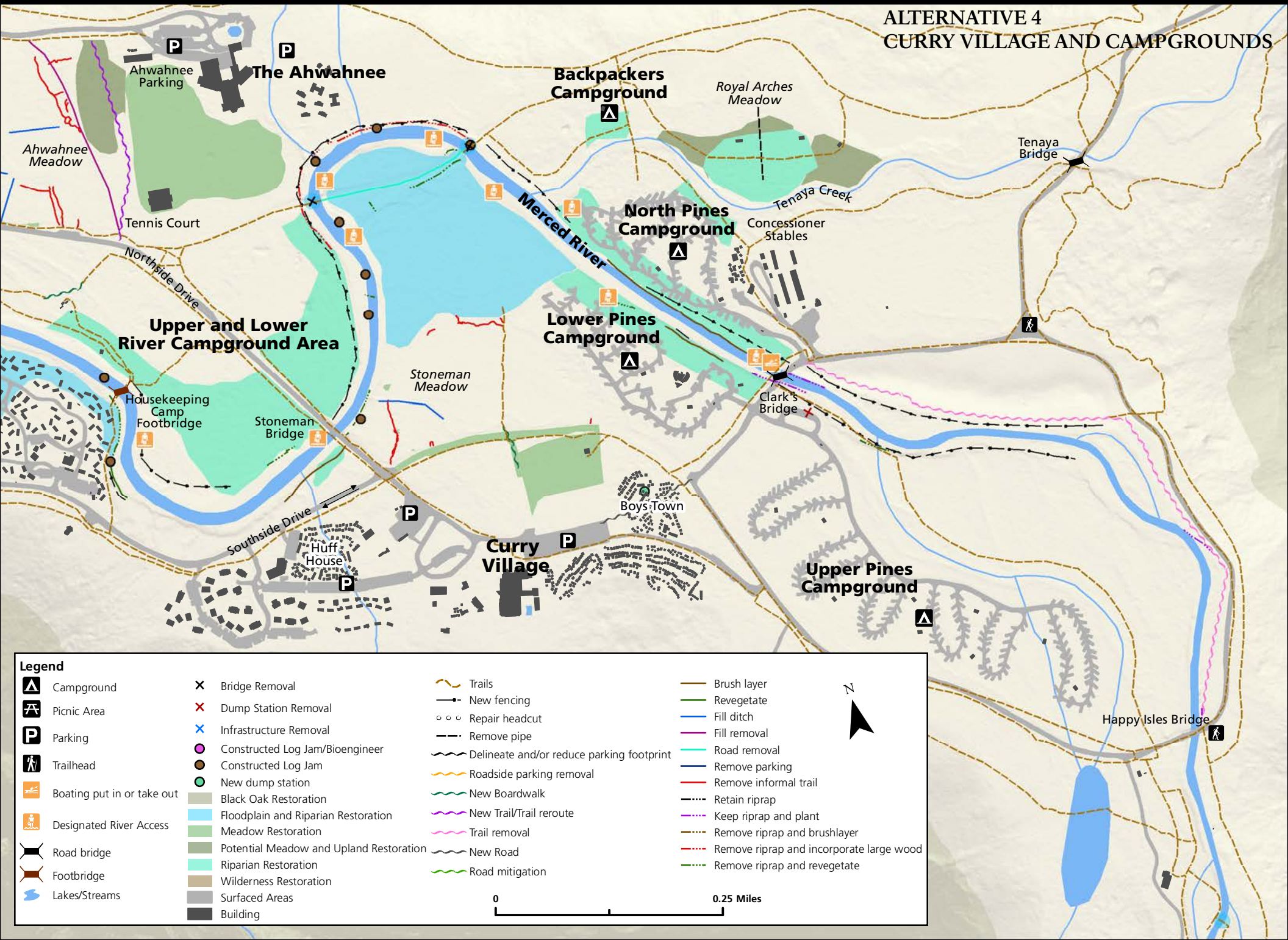

**Legend**

- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

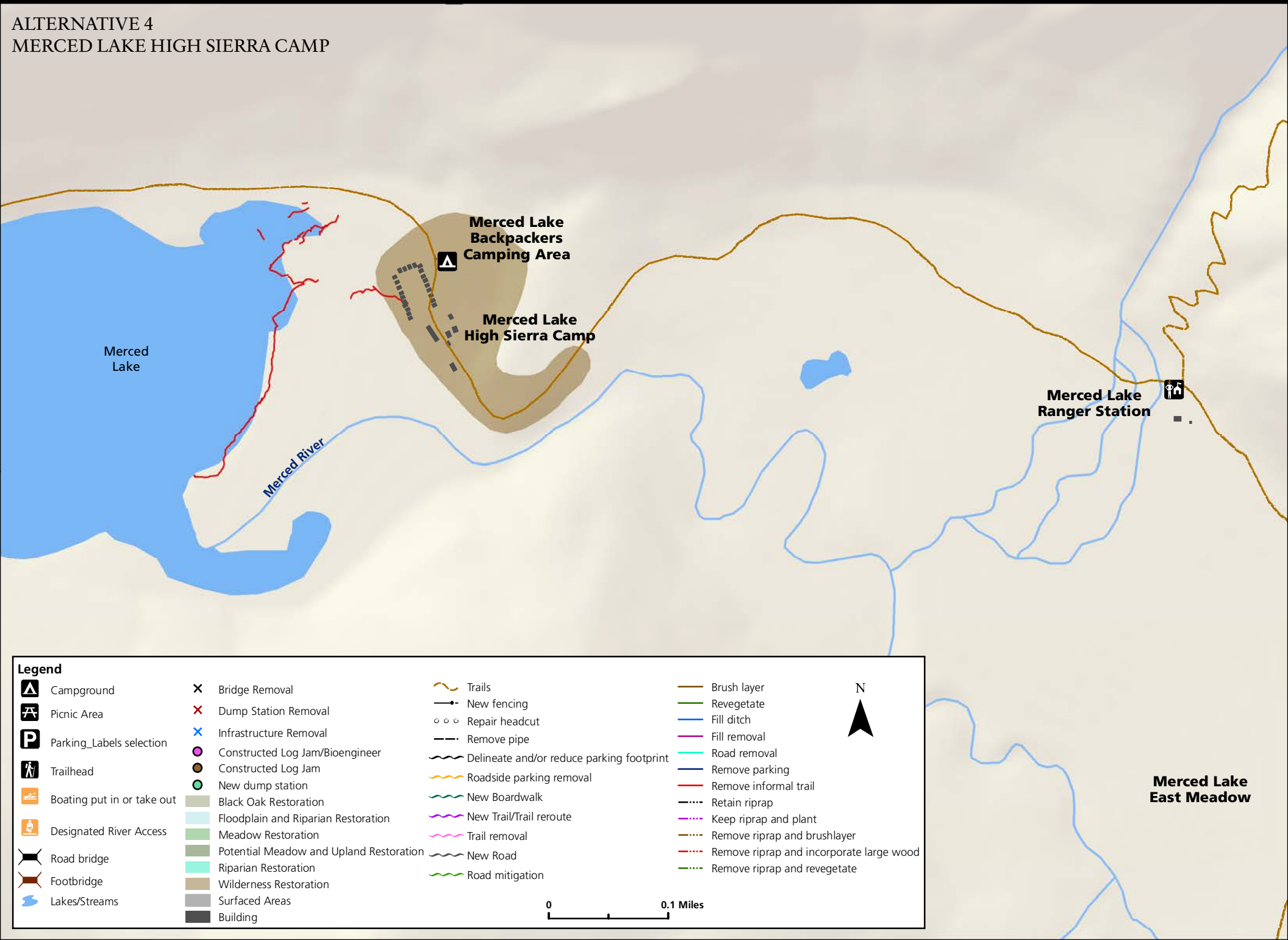


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 4
MERCED LAKE HIGH SIERRA CAMP



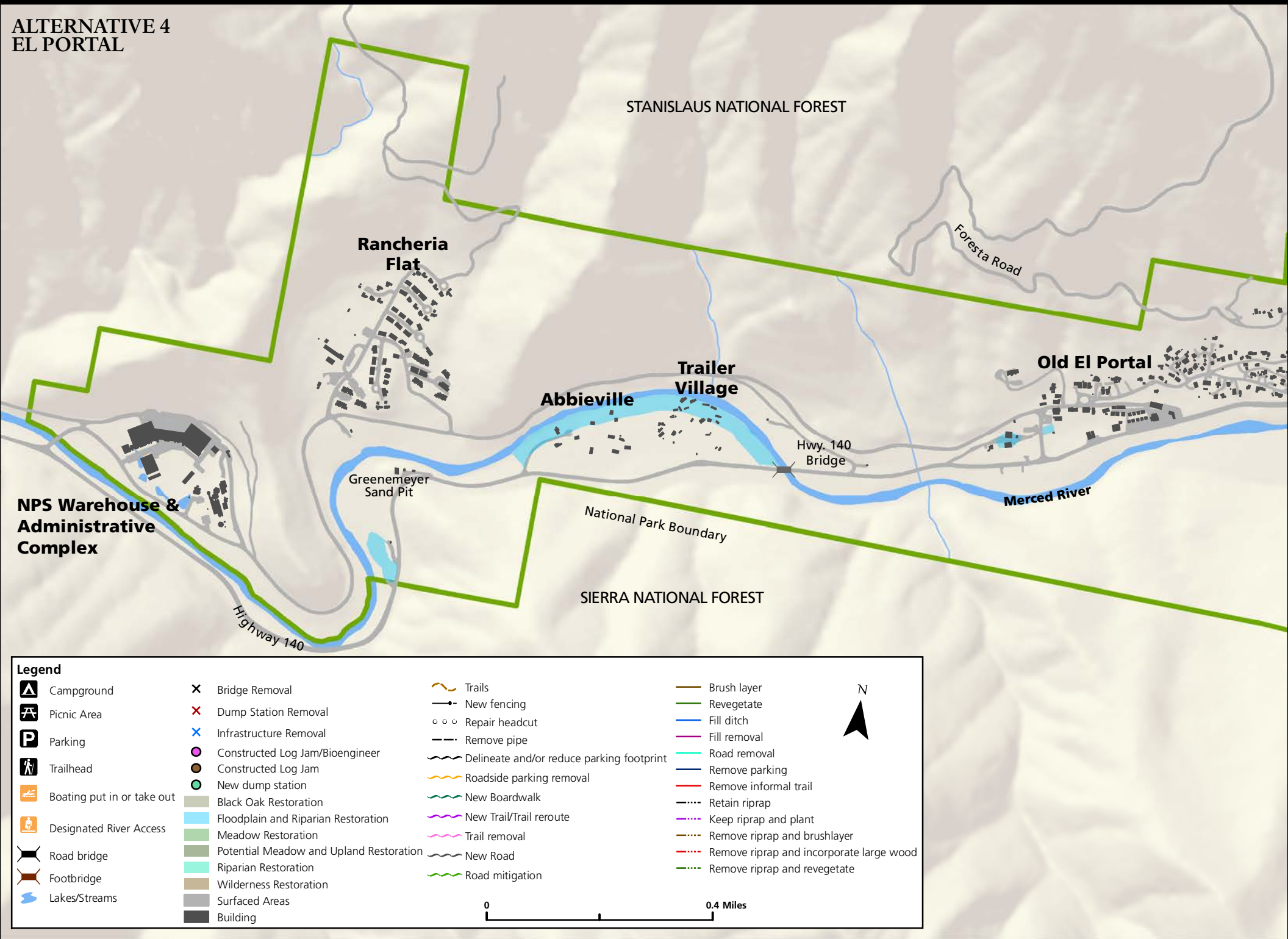

**Legend**

- Campground
- Picnic Area
- Parking_Labels selection
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

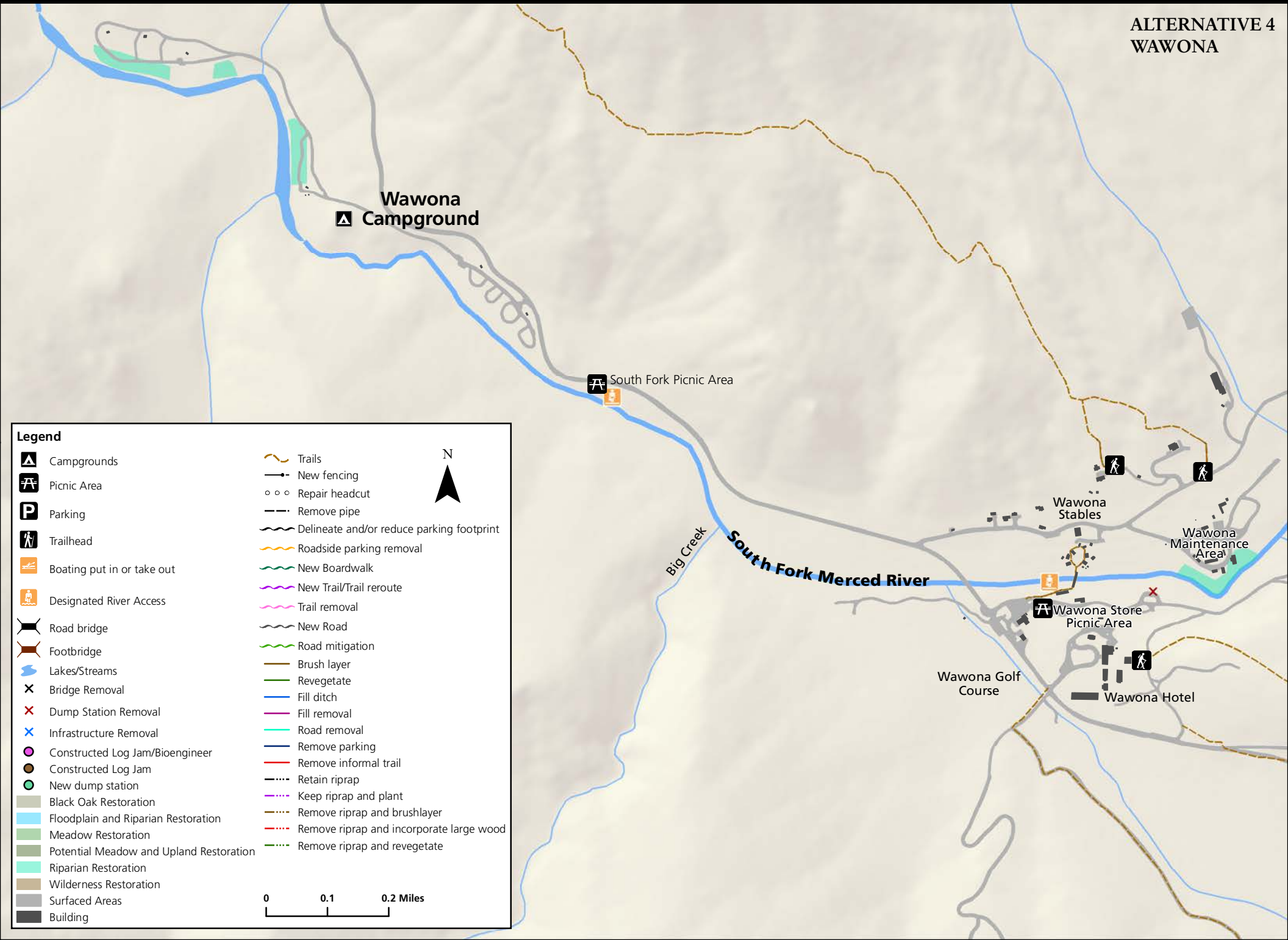


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 4
WAWONA




**Legend**

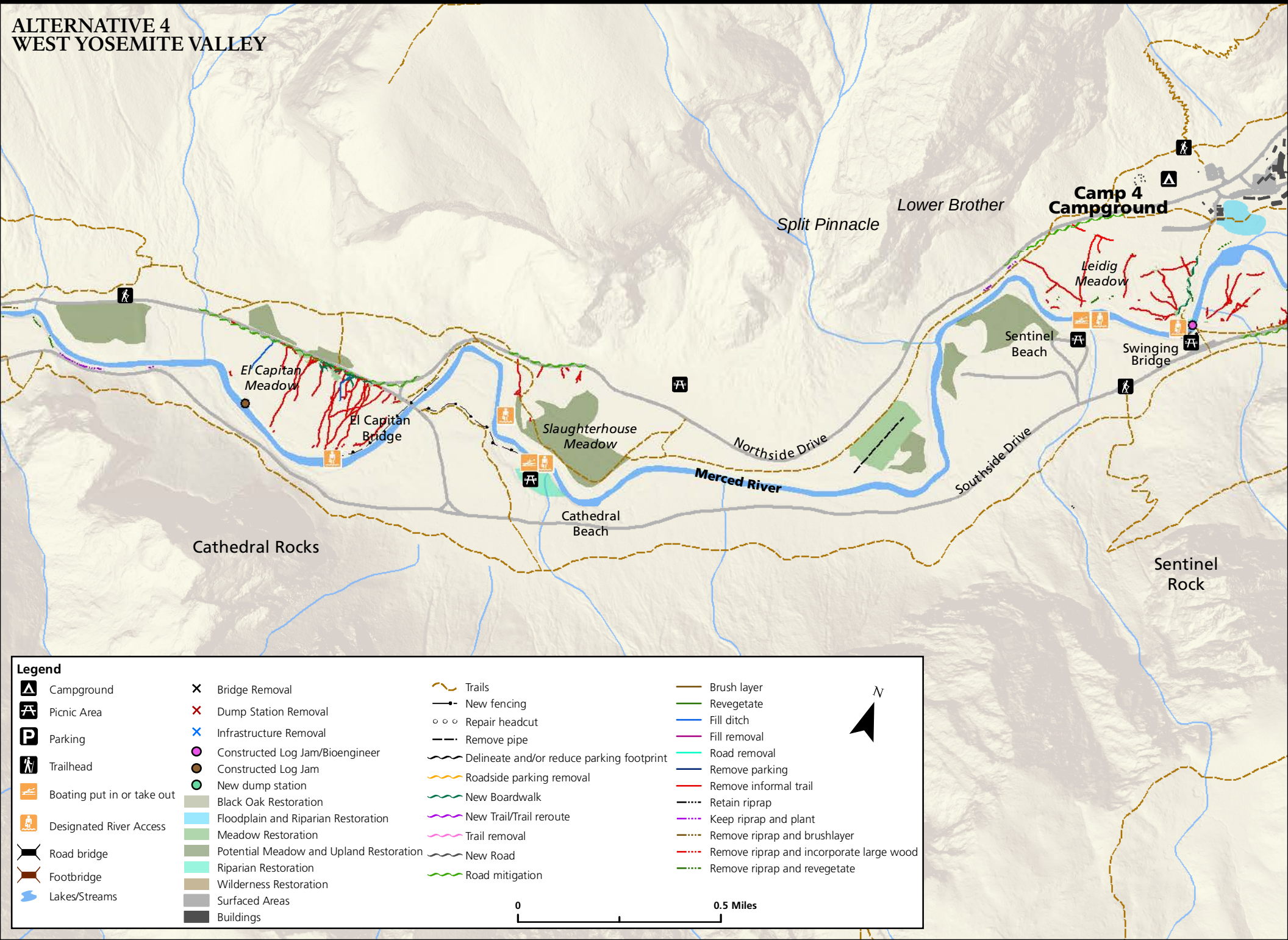
- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building

- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

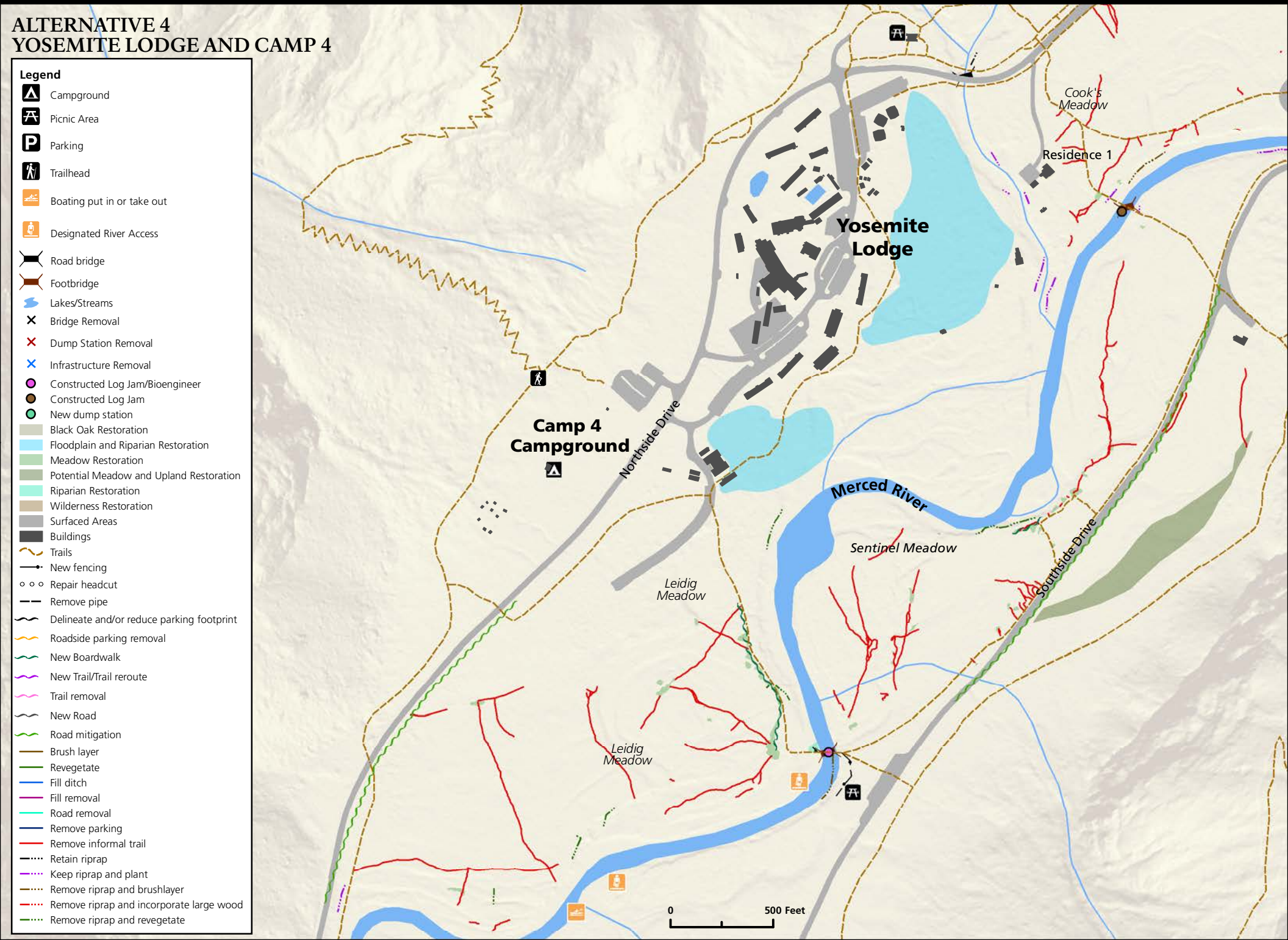


# Yosemite National Park
California

Merced River Plan
Restoration Elements

National Park Service
U.S. Department of the Interior

## ALTERNATIVE 4
## YOSEMITE LODGE AND CAMP 4

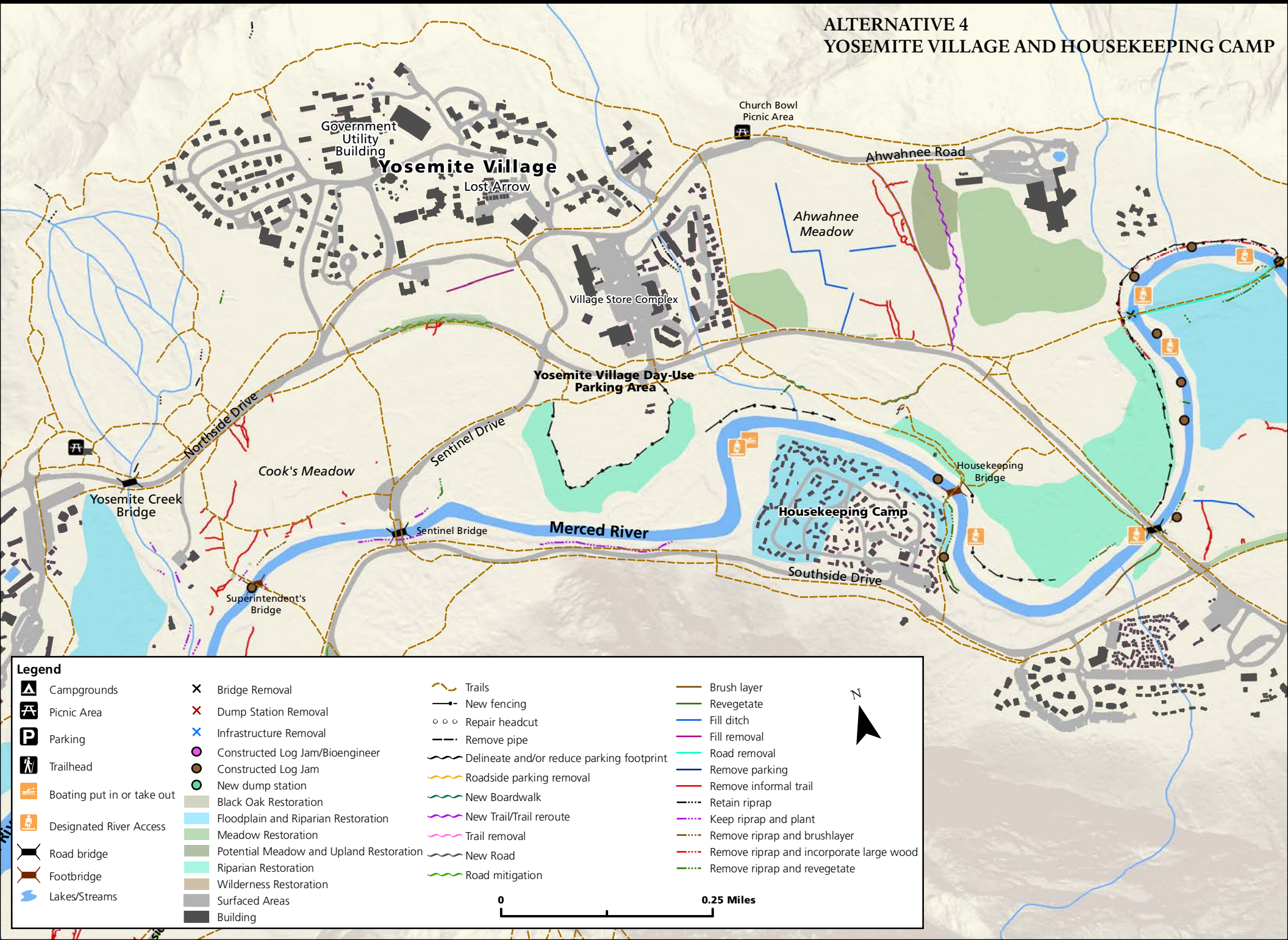


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

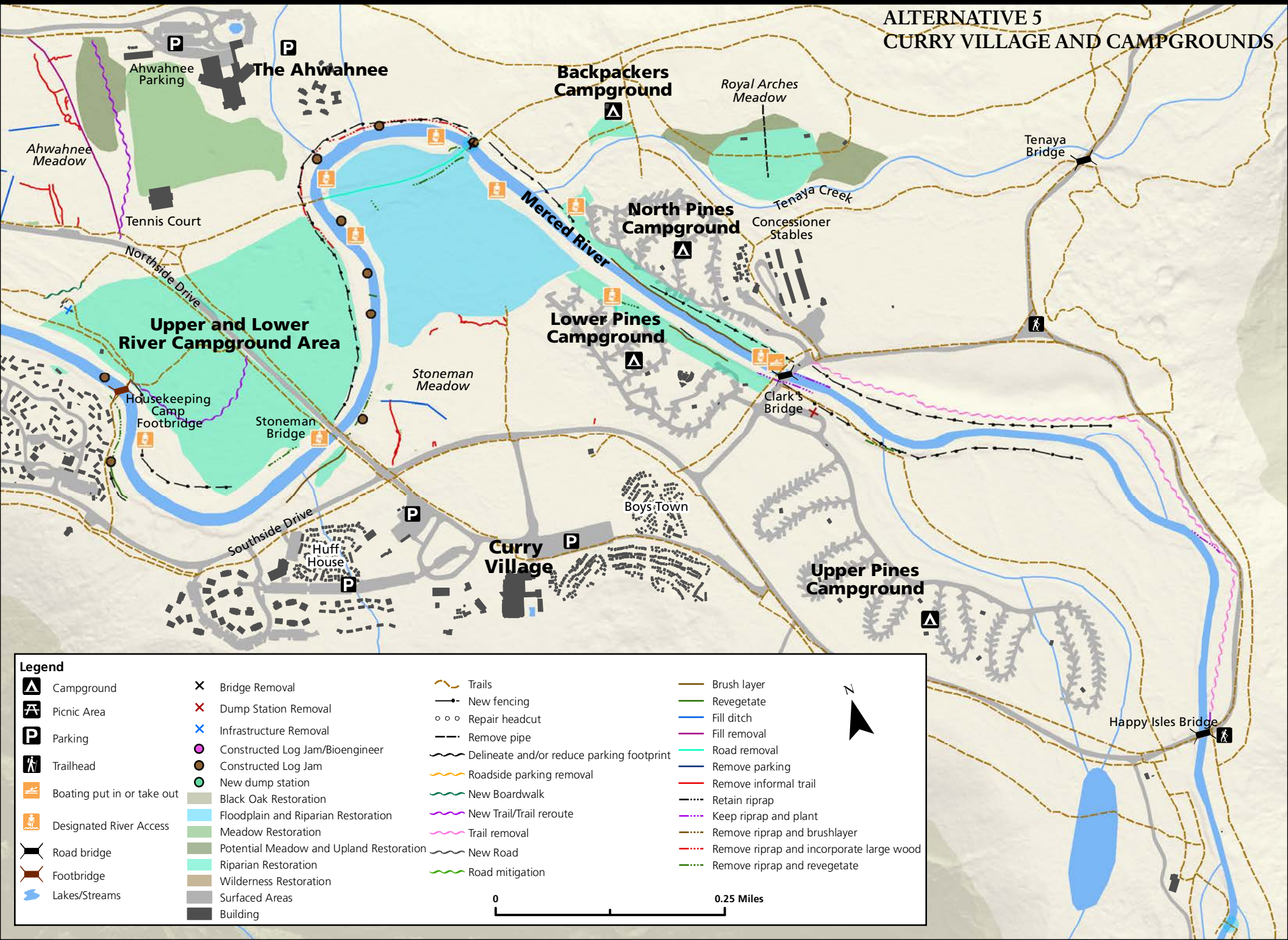
## ALTERNATIVE 4
## YOSEMITE VILLAGE AND HOUSEKEEPING CAMP



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

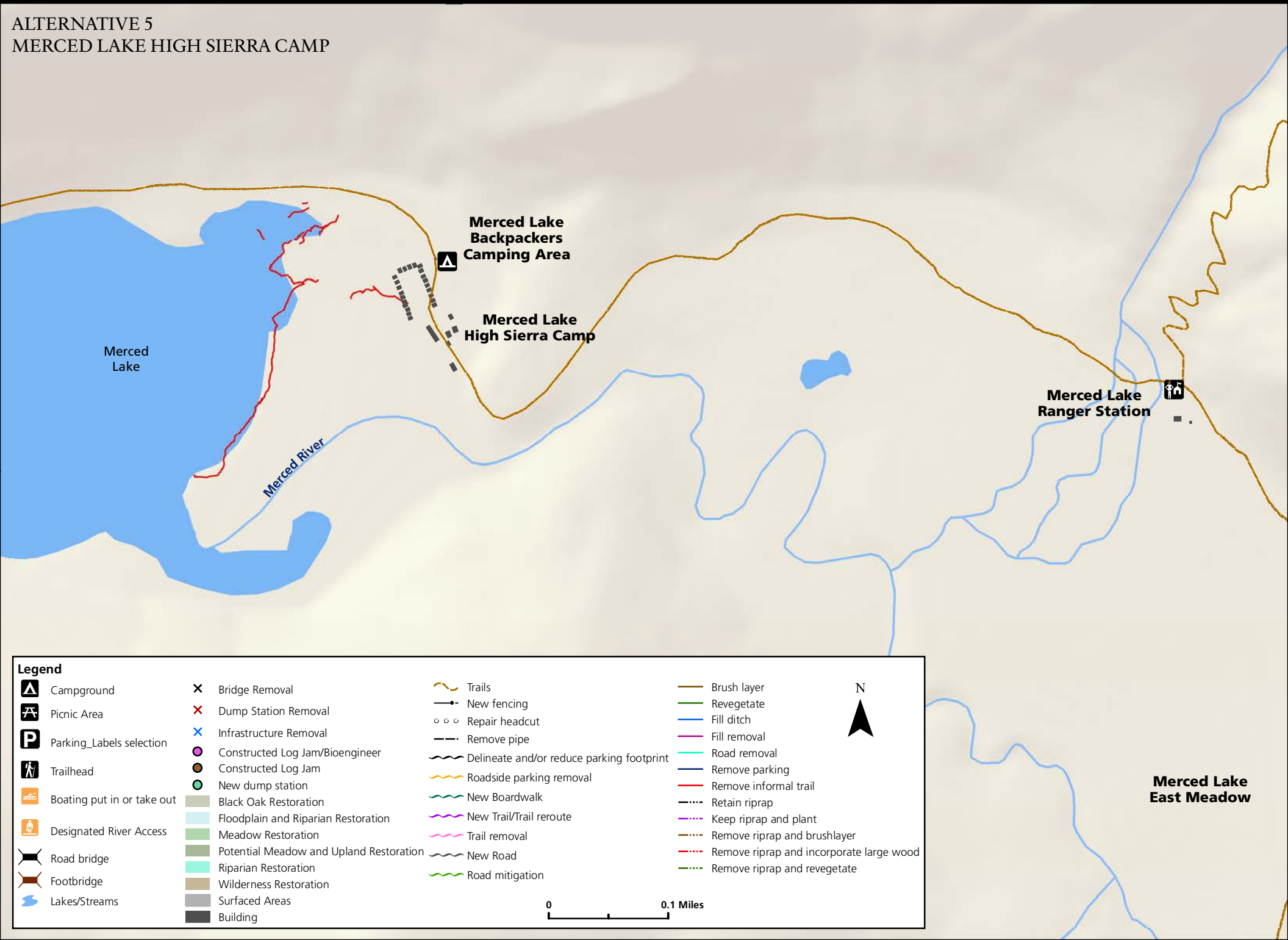


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

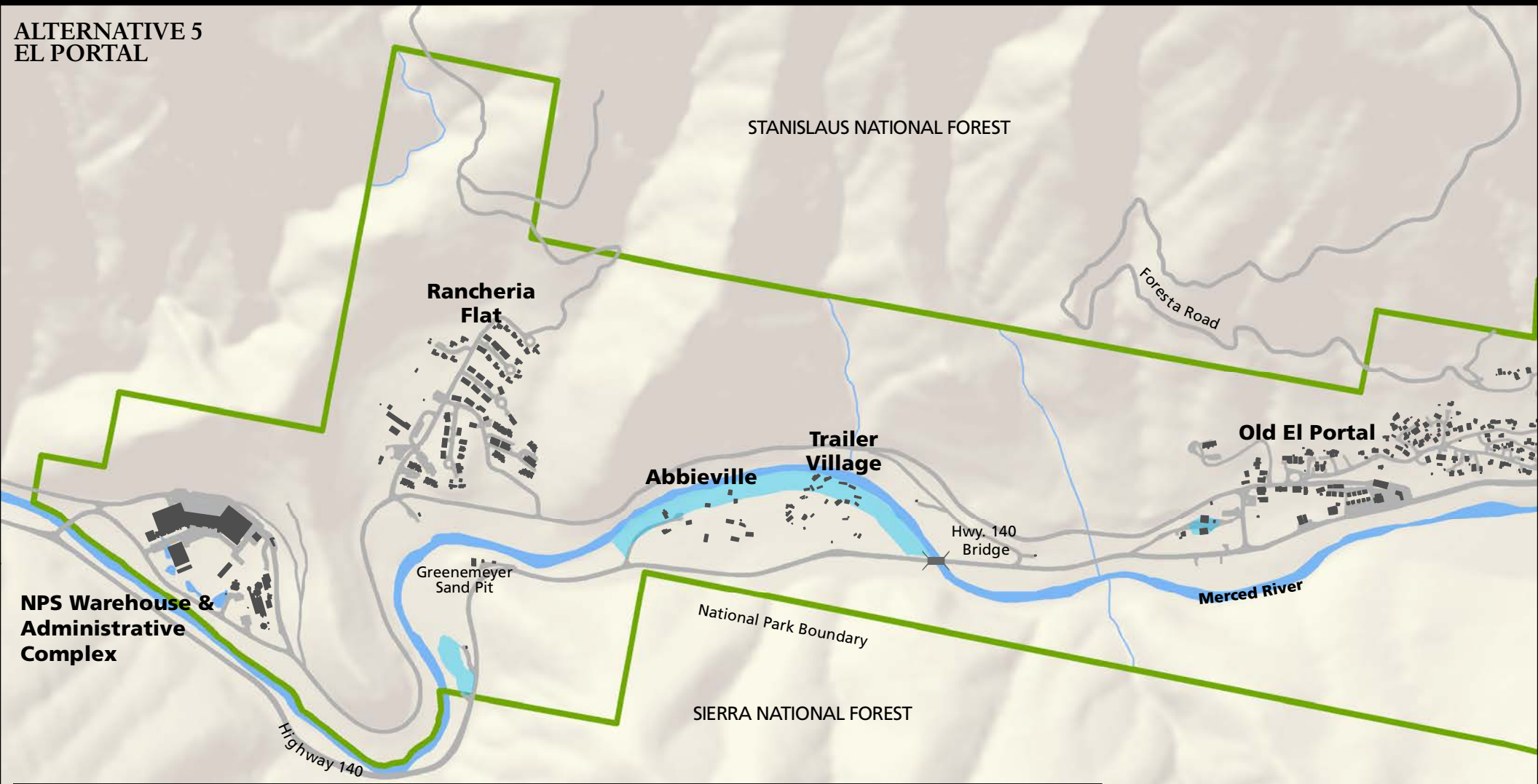
ALTERNATIVE 5
MERCED LAKE HIGH SIERRA CAMP



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior




**Legend**

- Campground
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

N

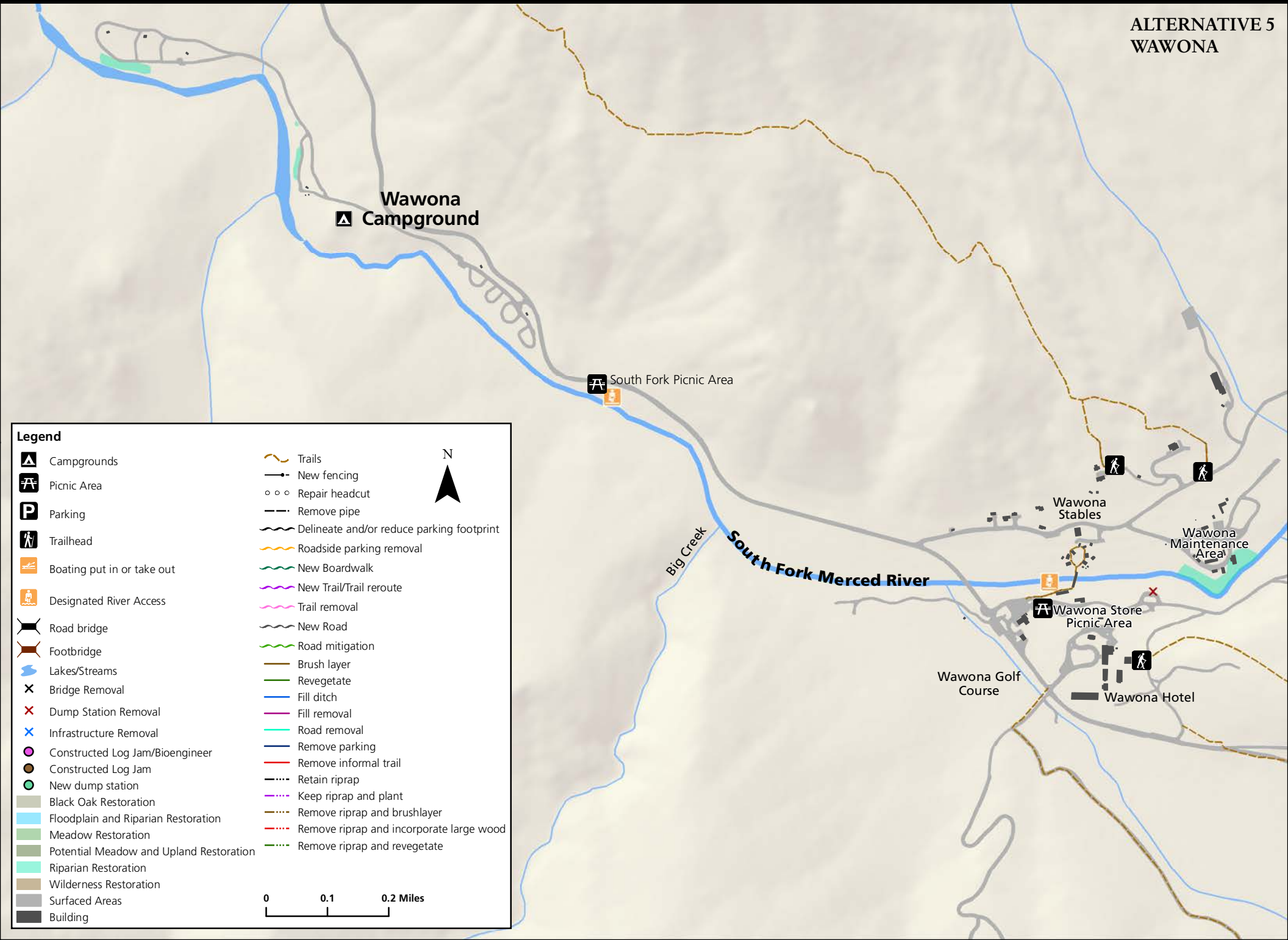
0 0.4 Miles

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 5
WAWONA



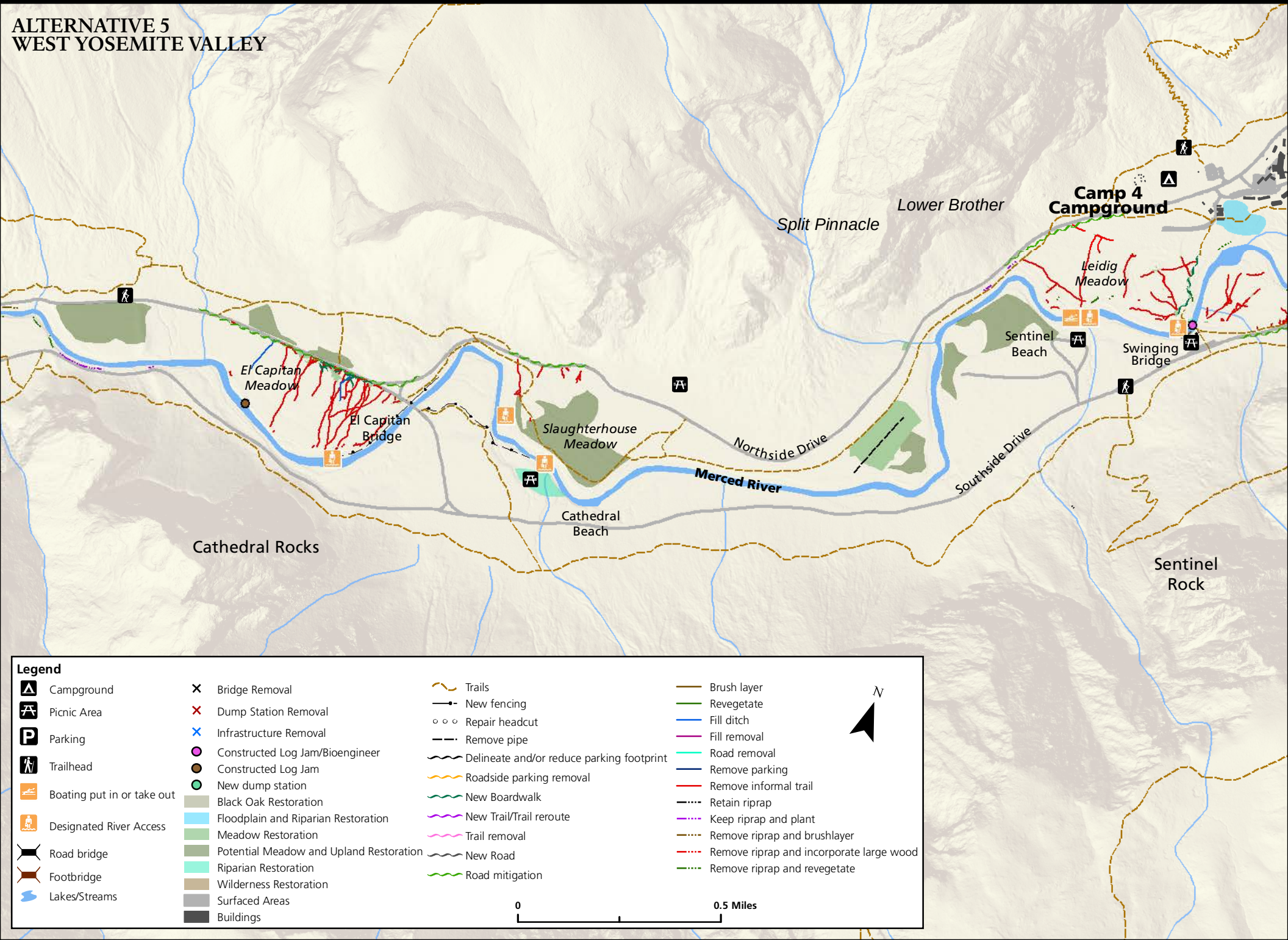

**Legend**

- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

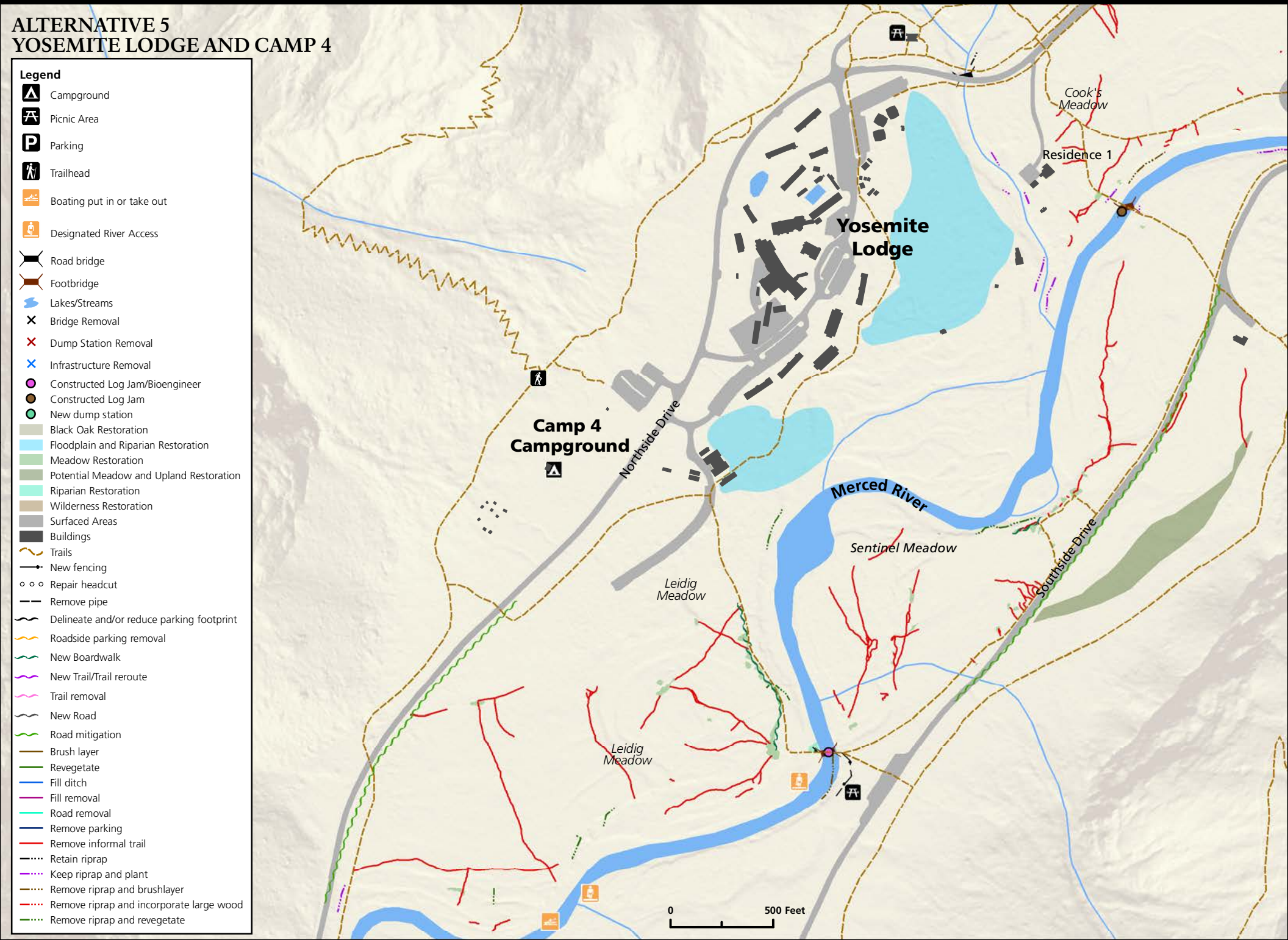


# Yosemite National Park
California

Merced River Plan
Restoration Elements

National Park Service
U.S. Department of the Interior

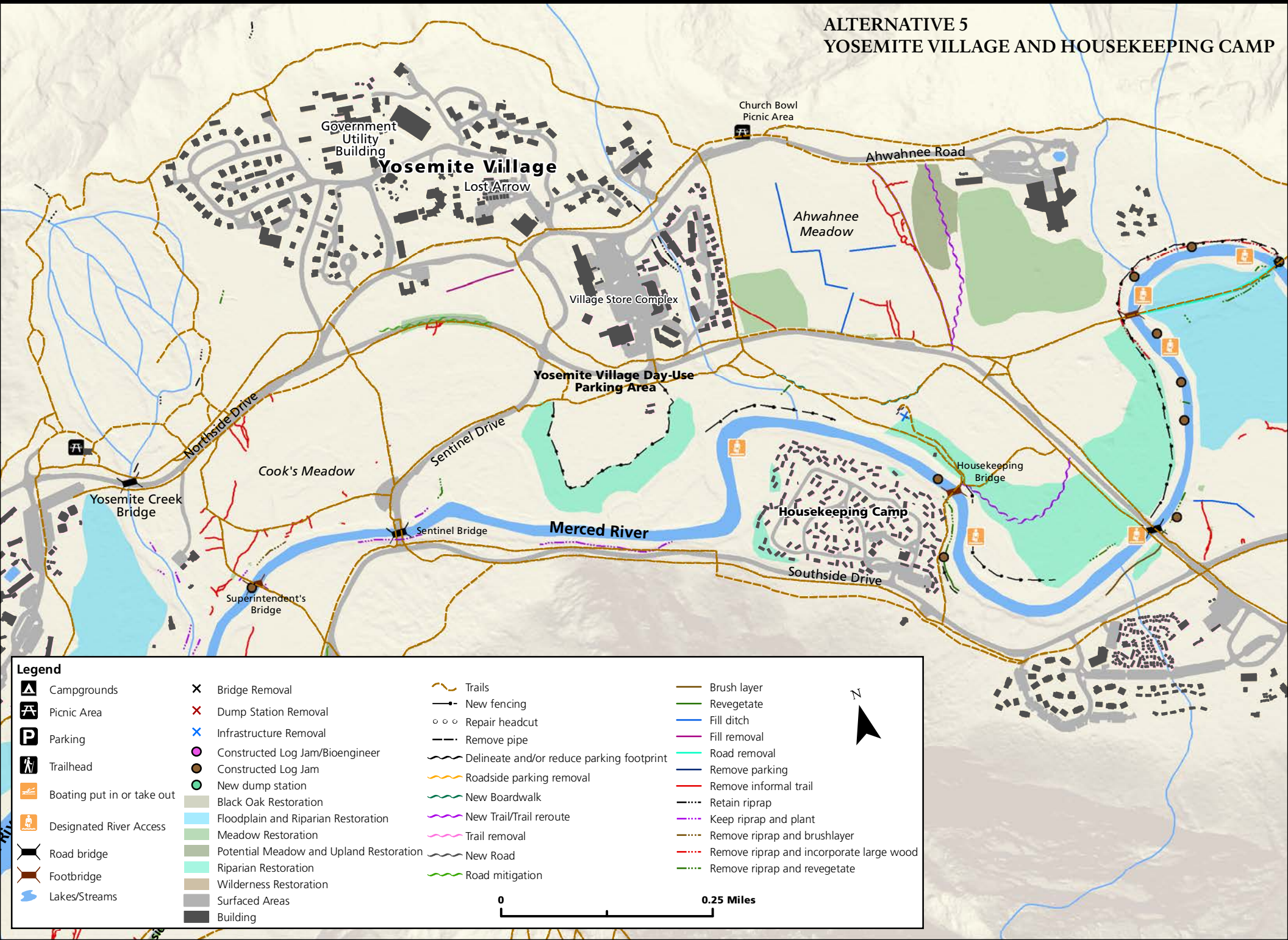
## ALTERNATIVE 5
## YOSEMITE LODGE AND CAMP 4



# Yosemite National Park
California

Merced River Plan Restoration Elements

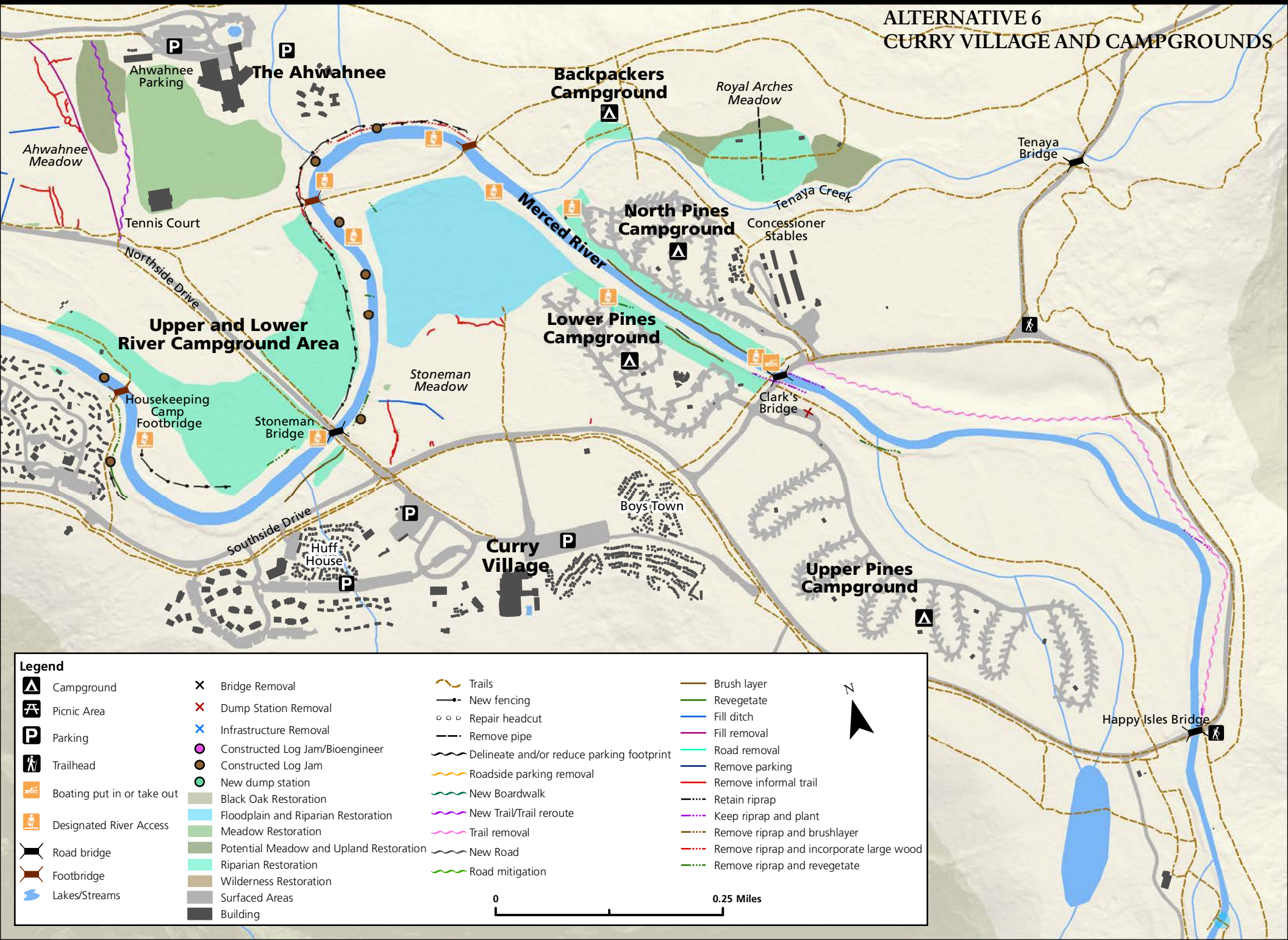
National Park Service
U.S. Department of the Interior



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

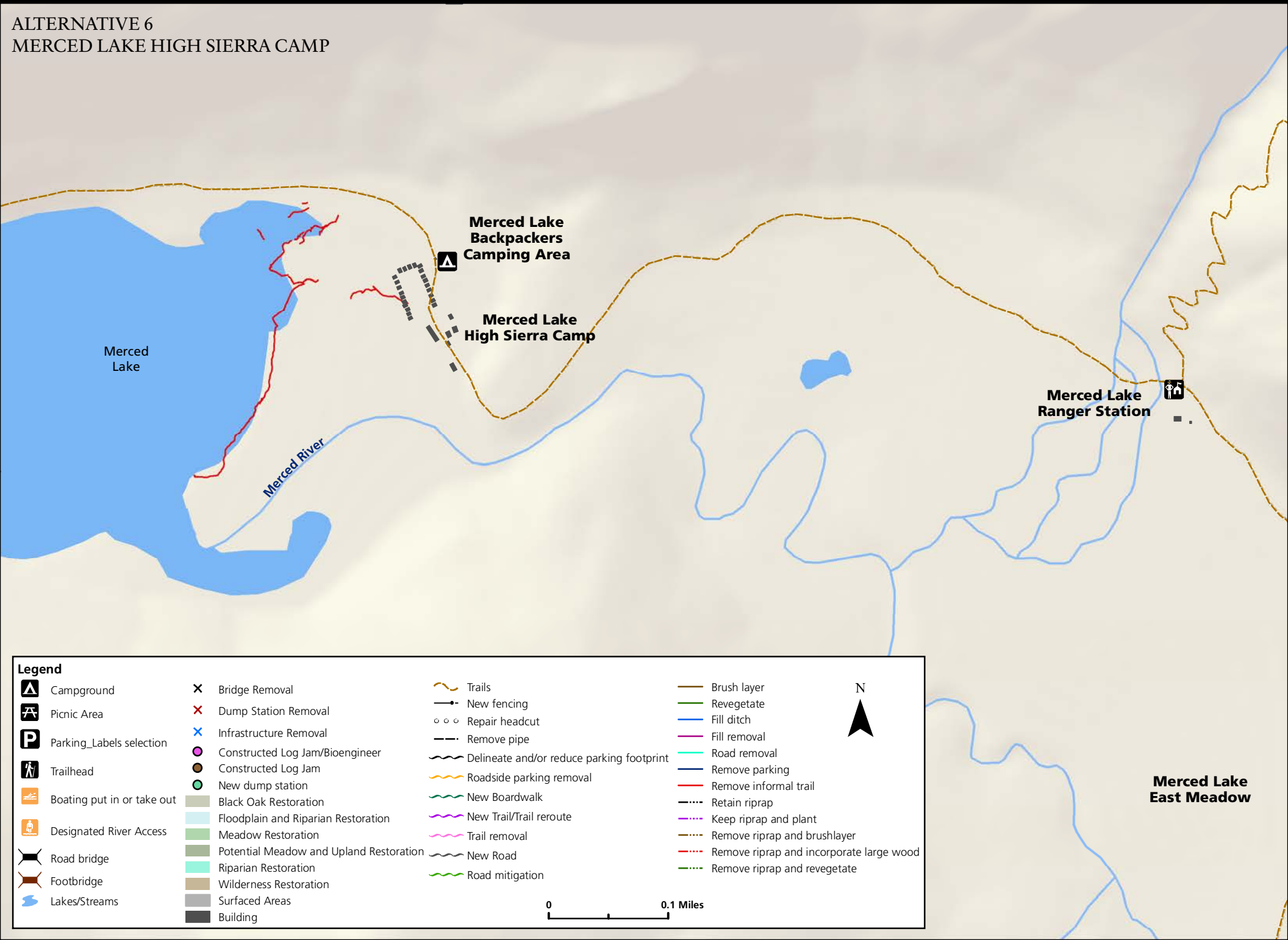


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

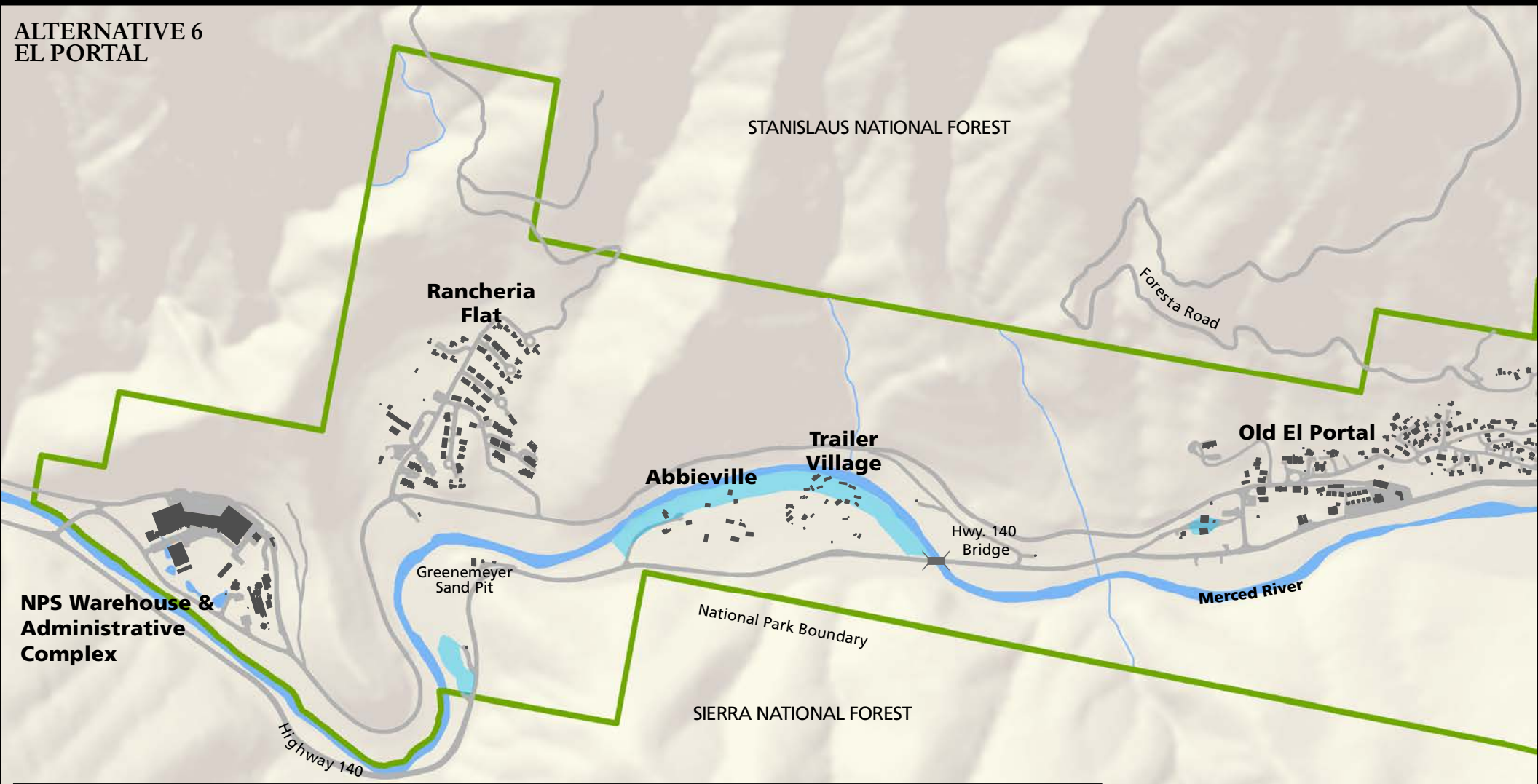
ALTERNATIVE 6
MERCED LAKE HIGH SIERRA CAMP



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior




**Legend**

- Campground
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

N

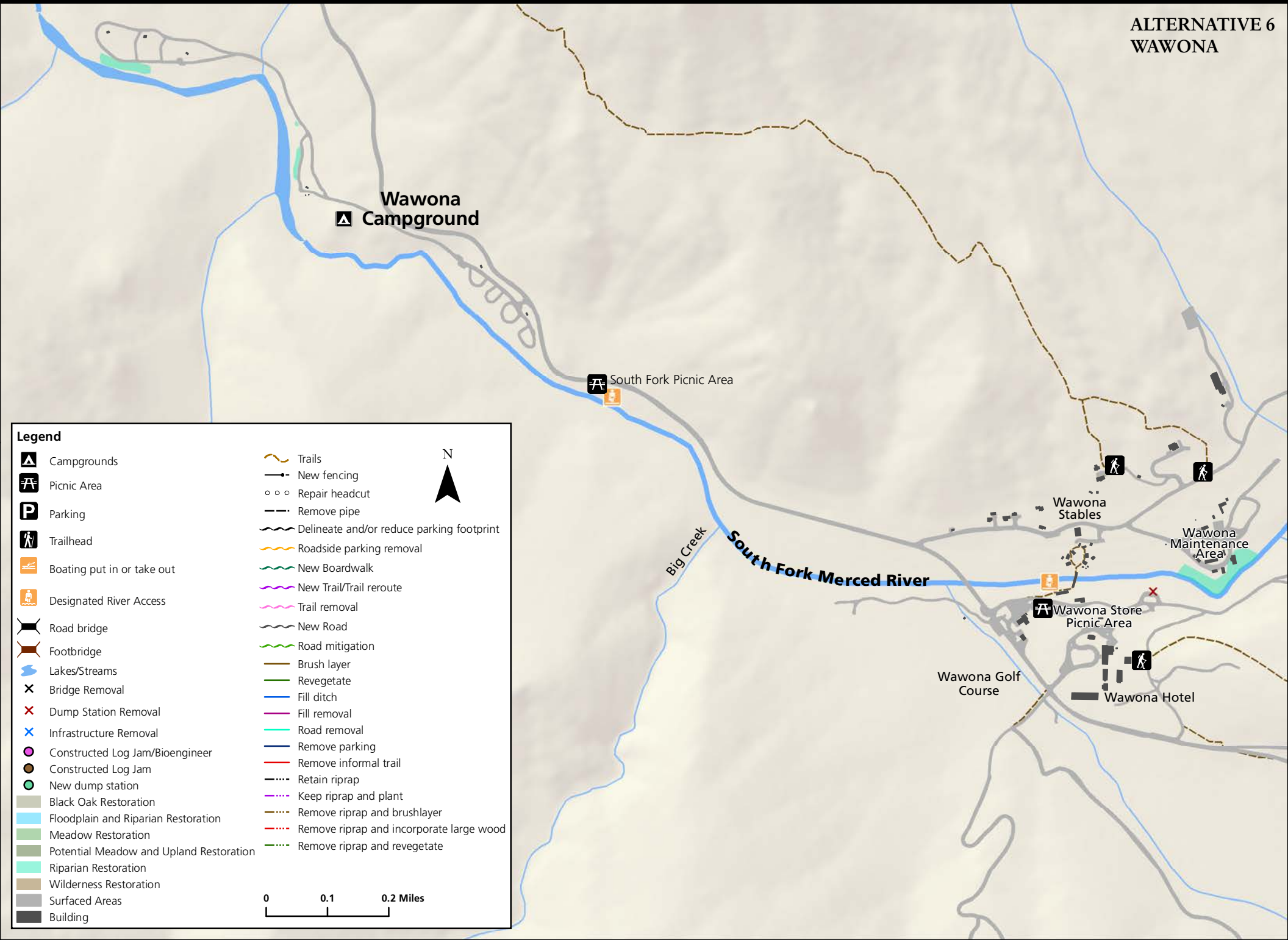
0 0.4 Miles

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

ALTERNATIVE 6
WAWONA




**Legend**

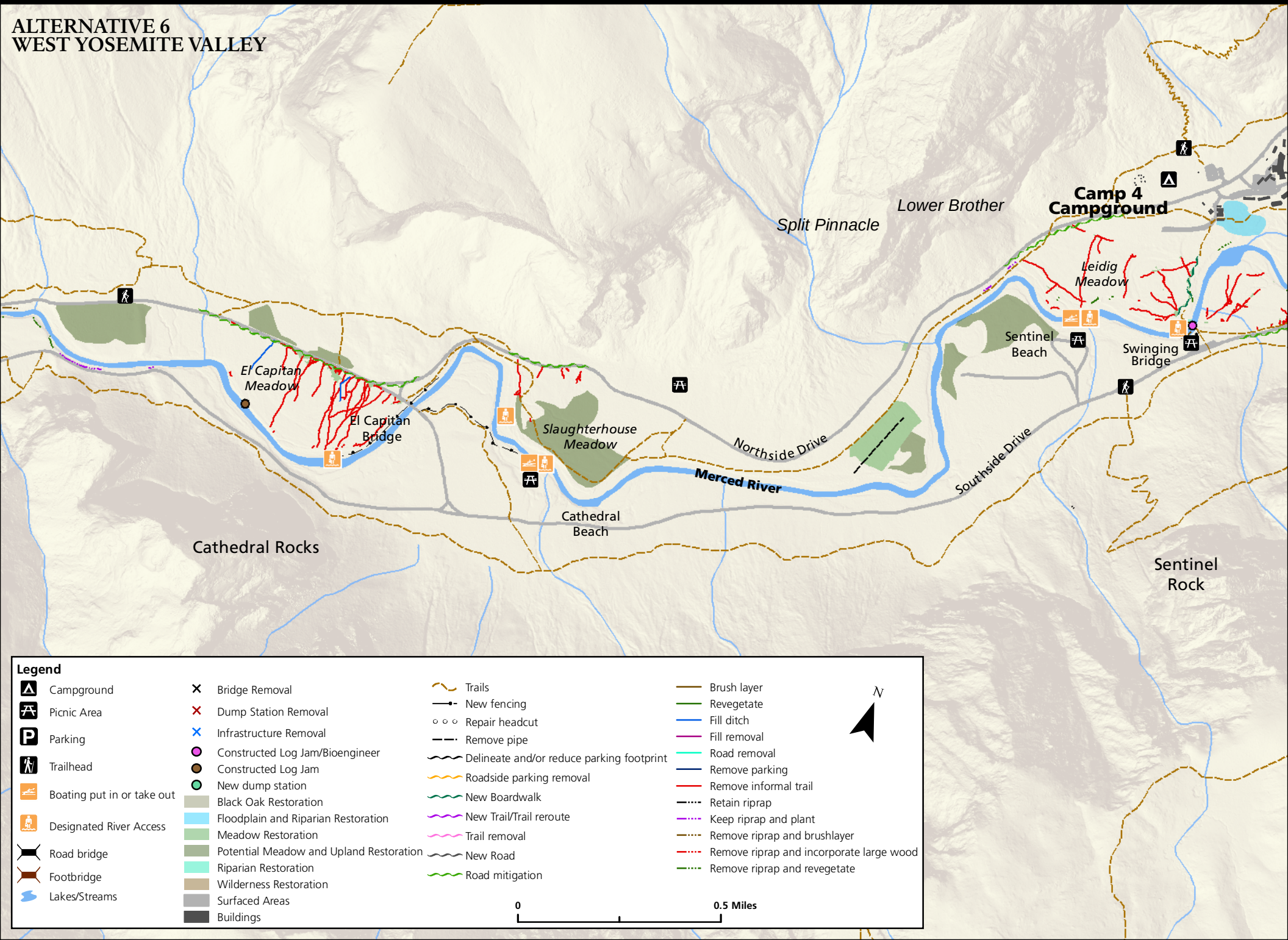
- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building

- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

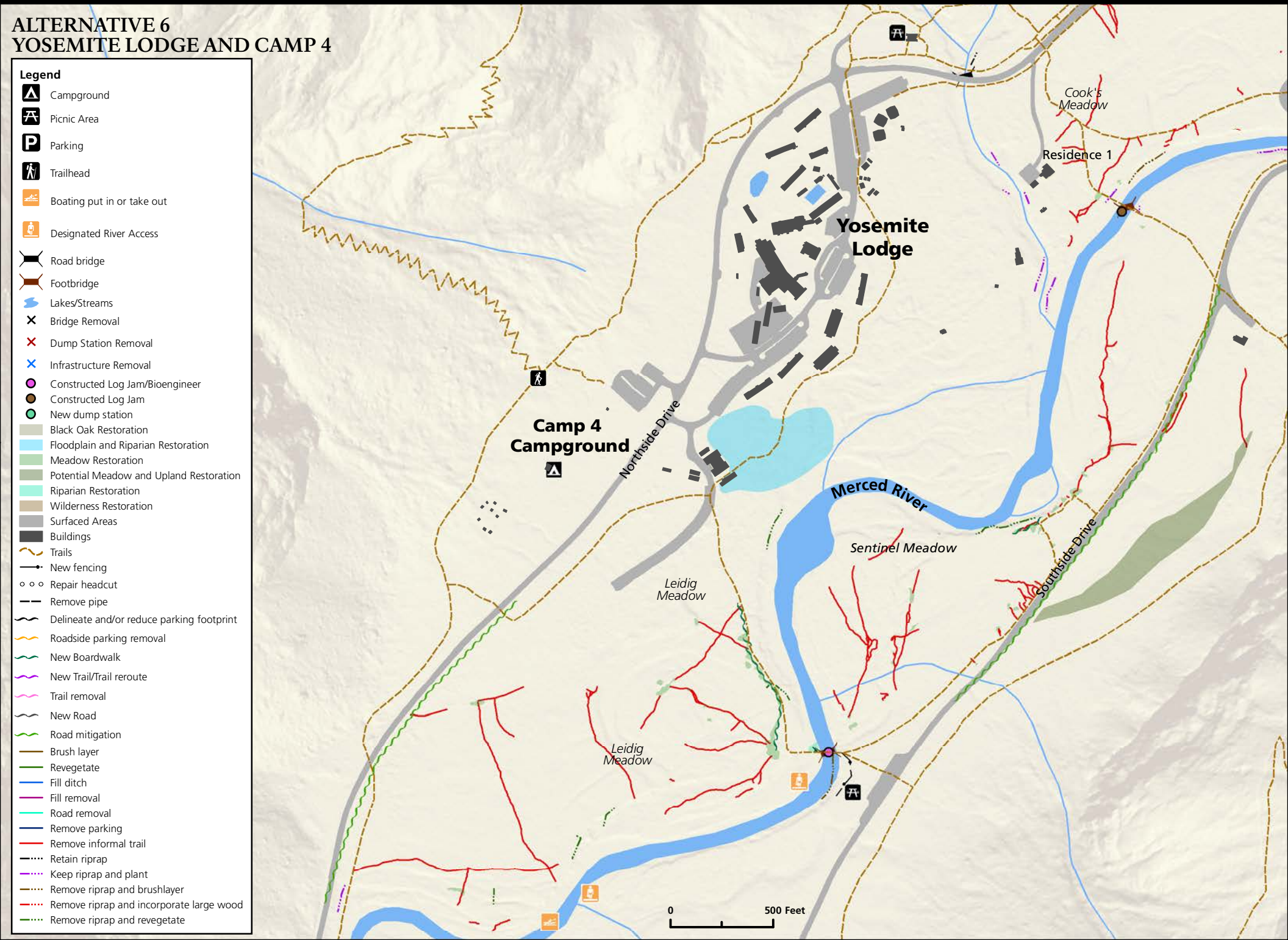


# Yosemite National Park
California

Merced River Plan
Restoration Elements

National Park Service
U.S. Department of the Interior

## ALTERNATIVE 6
## YOSEMITE LODGE AND CAMP 4

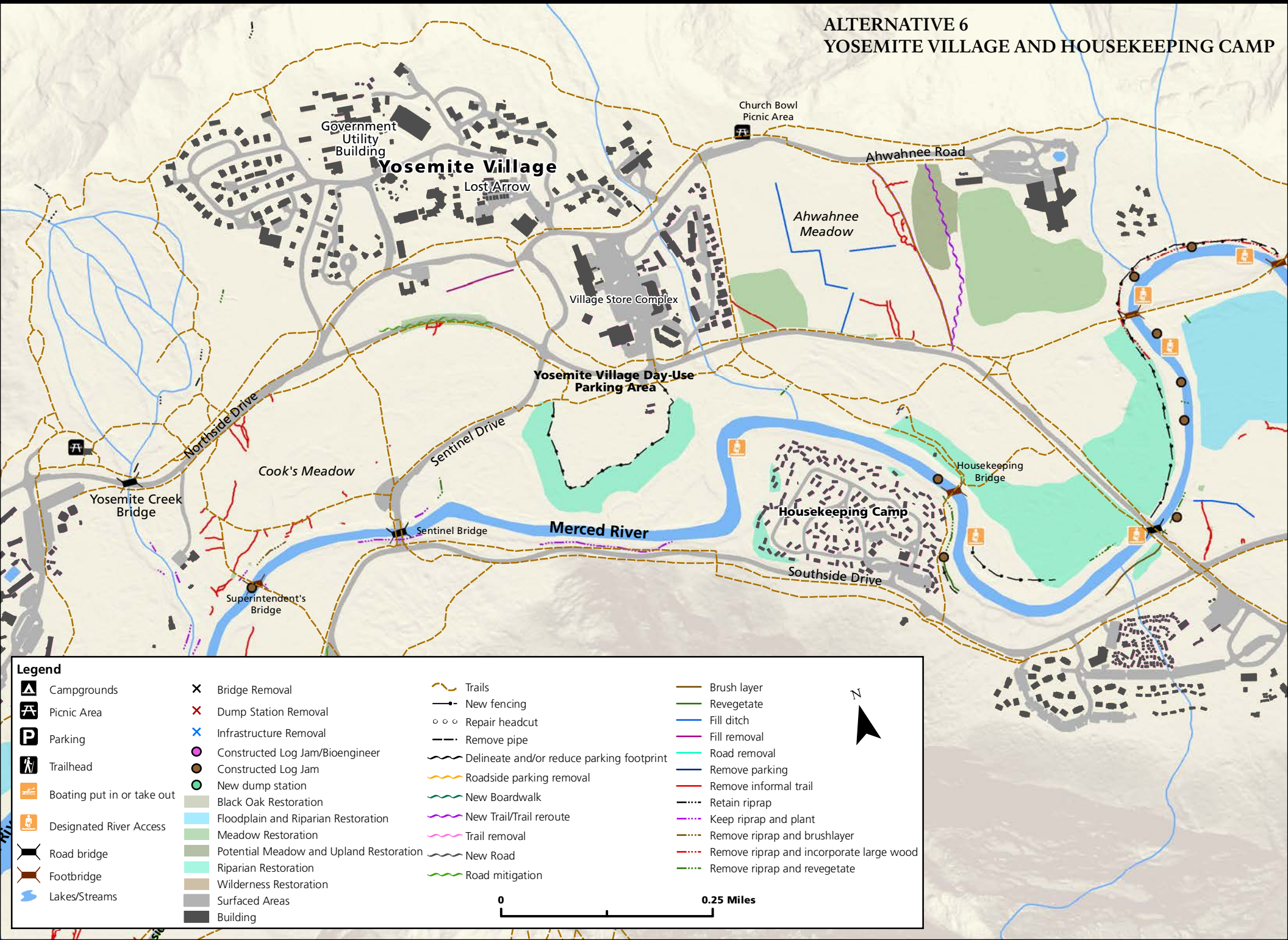


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

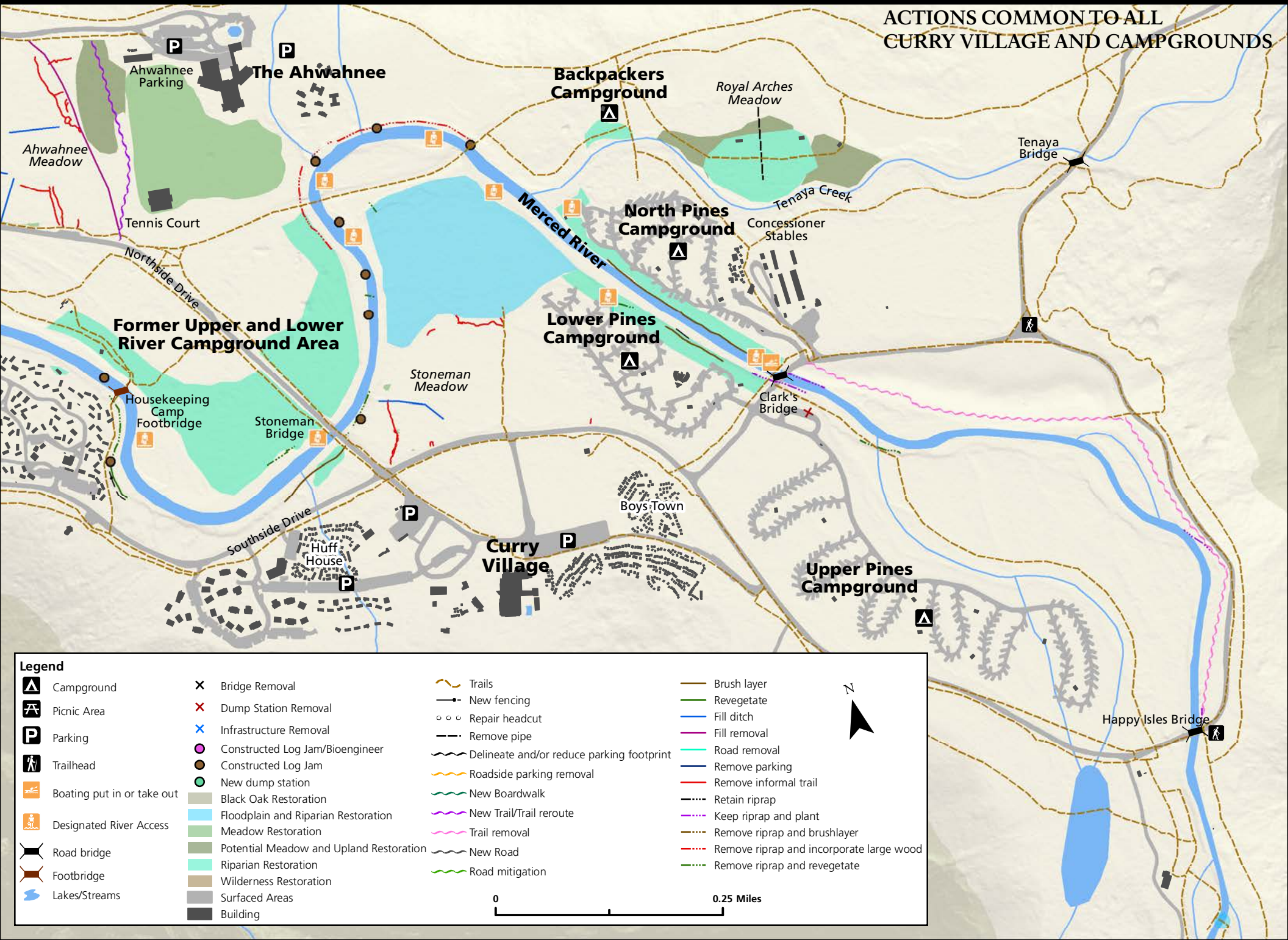
## ALTERNATIVE 6
## YOSEMITE VILLAGE AND HOUSEKEEPING CAMP



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

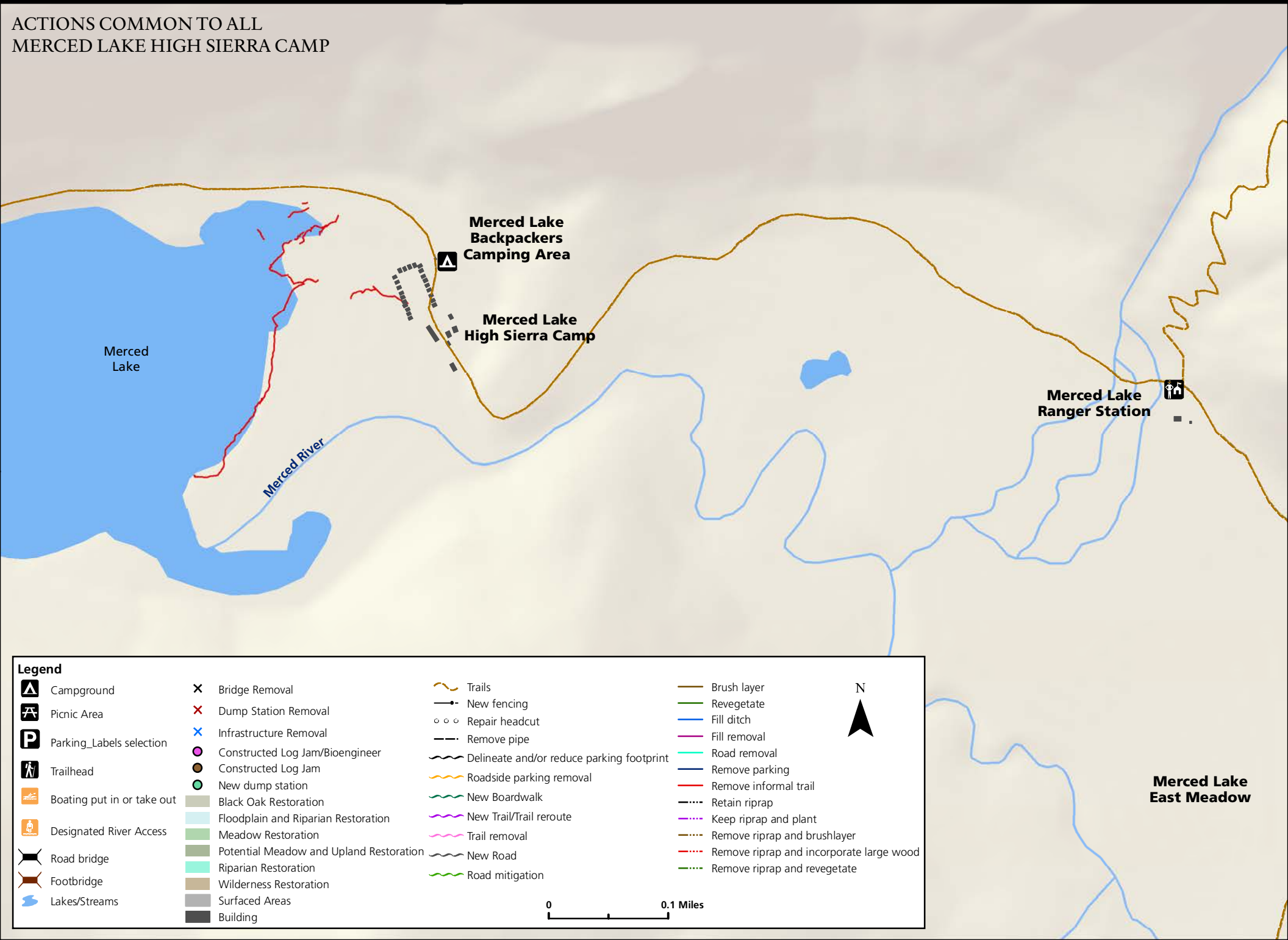


# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

## ACTIONS COMMON TO ALL
## MERCED LAKE HIGH SIERRA CAMP



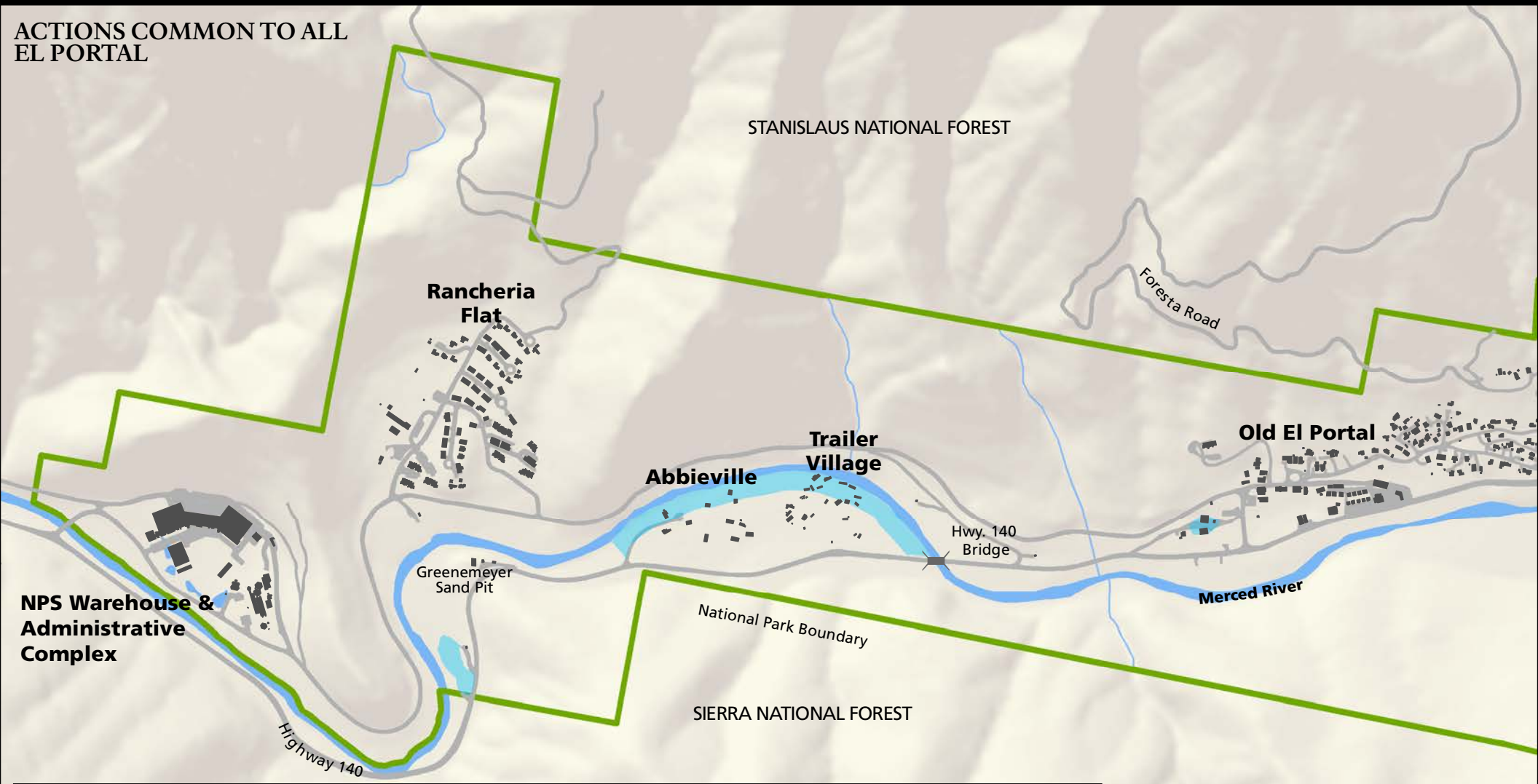

**Legend**

- Campground
- Picnic Area
- Parking_Labels selection
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior




**Legend**

- Campground
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building
- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

N

0 0.4 Miles

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

## ACTIONS COMMON TO ALL
## WAWONA

Wawona Campground

South Fork Picnic Area

Big Creek

South Fork Merced River

Wawona Stables

Wawona Maintenance Area

Wawona Store Picnic Area

Wawona Golf Course

Wawona Hotel

**Legend**

- Campgrounds
- Picnic Area
- Parking
- Trailhead
- Boating put in or take out
- Designated River Access
- Road bridge
- Footbridge
- Lakes/Streams
- Bridge Removal
- Dump Station Removal
- Infrastructure Removal
- Constructed Log Jam/Bioengineer
- Constructed Log Jam
- New dump station
- Black Oak Restoration
- Floodplain and Riparian Restoration
- Meadow Restoration
- Potential Meadow and Upland Restoration
- Riparian Restoration
- Wilderness Restoration
- Surfaced Areas
- Building

- Trails
- New fencing
- Repair headcut
- Remove pipe
- Delineate and/or reduce parking footprint
- Roadside parking removal
- New Boardwalk
- New Trail/Trail reroute
- Trail removal
- New Road
- Road mitigation
- Brush layer
- Revegetate
- Fill ditch
- Fill removal
- Road removal
- Remove parking
- Remove informal trail
- Retain riprap
- Keep riprap and plant
- Remove riprap and brushlayer
- Remove riprap and incorporate large wood
- Remove riprap and revegetate

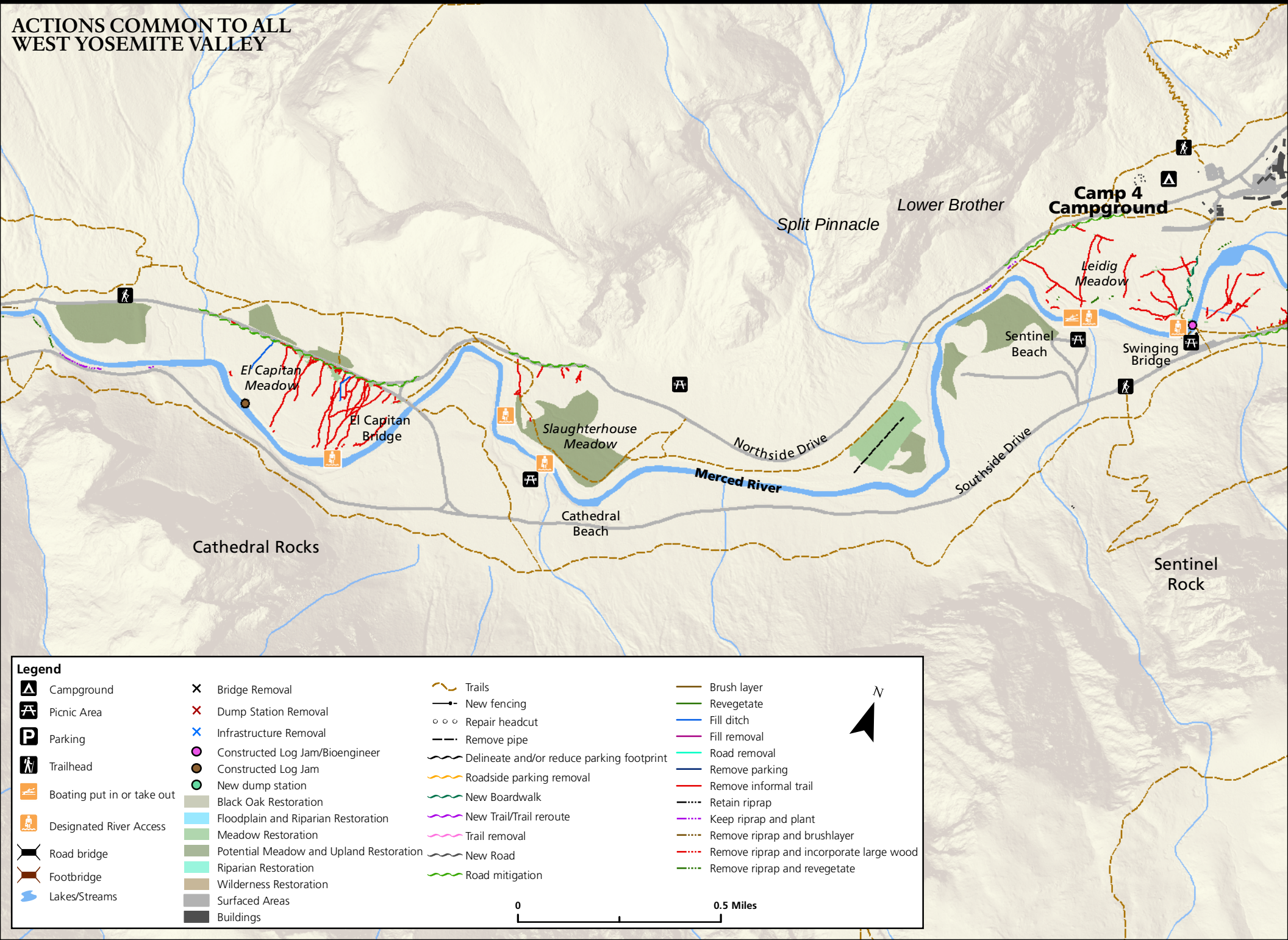
N

0 0.1 0.2 Miles

# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior

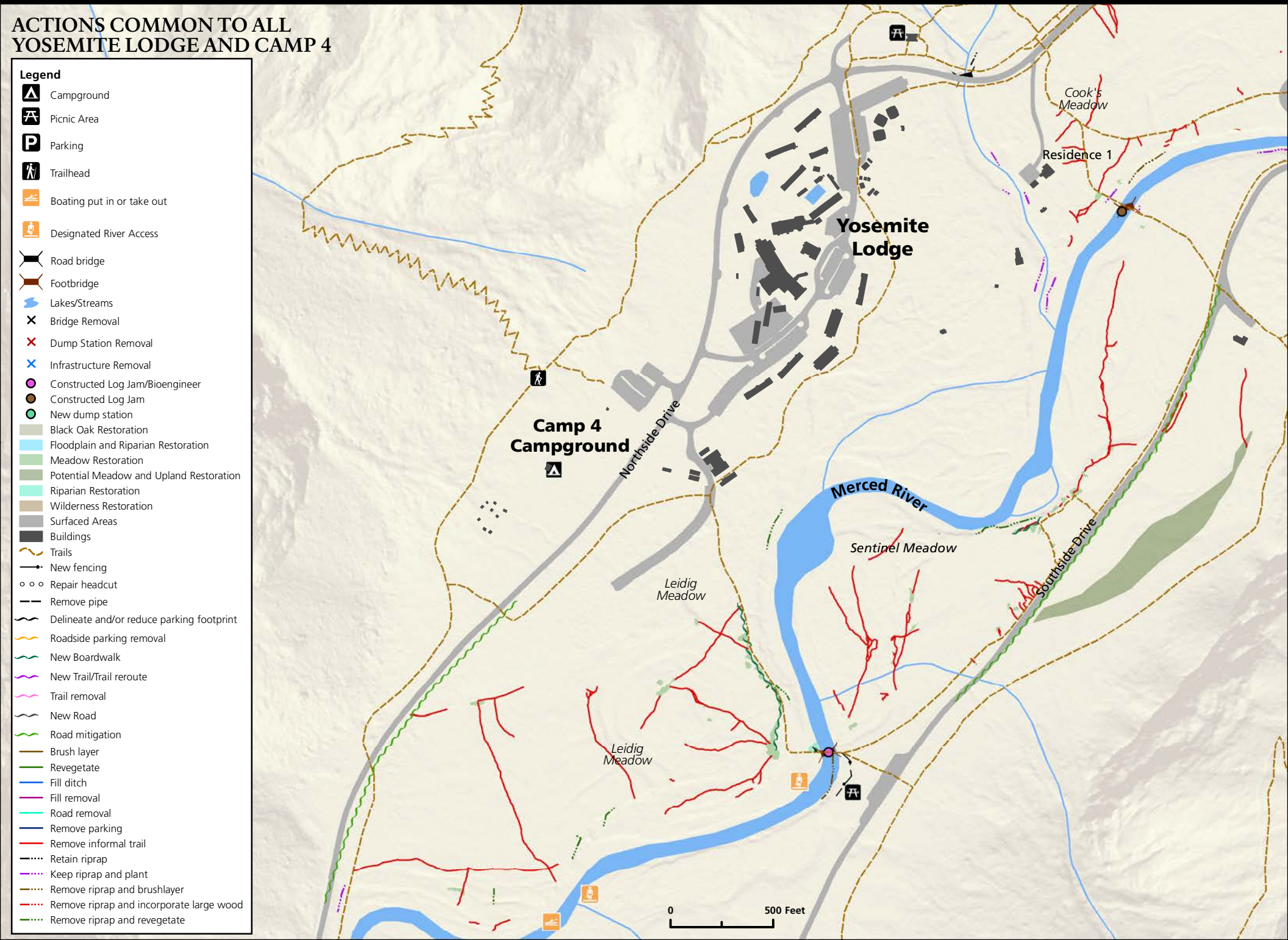


# Yosemite National Park
California

Merced River Plan
Restoration Elements

National Park Service
U.S. Department of the Interior

## ACTIONS COMMON TO ALL YOSEMITE LODGE AND CAMP 4



# Yosemite National Park
California

Merced River Plan Restoration Elements

National Park Service
U.S. Department of the Interior