4 IMPACT OF ROADS, PARKING LOTS, LIVESTOCK GRAZING, AND HUMAN INFRASTRUCTURE ON WETLAND FUNCTION AND PROCESSES

4.1 INTRODUCTION

This chapter assesses the impacts associated with anthropogenic modifications of the focal study area. The assessment begins with a comparison of the 2003 aerial photograph of the focal study area and observations made during the 2003 reconnaissance surveys to a set of historical aerials from 1940 to 2000. Two of the main impairments to wetland function in the focal study area are related to (1) infrastructure development, including roads, parking lots, and the public access they provide, and (2) livestock grazing. The effects of each of these are examined in detail.

4.2 AERIAL PHOTO TIME SERIES ANALYSIS

These aerial photos document changes within the wetland and upland communities of the focal study area over the past 63 years. The analysis is based upon observable changes in the aerial photos. Unfortunately, subtle changes in vegetation are not readily observable. The results are organized topically by issue area.

A series of six aerial photos, with one representing each decade from the 1940s to the 1990s, were selected to compare with the 2003 aerial photo of the focal study area. The historic aerial photos were provided by the U.S. Forest Service (Forest Service) in hard copy and were scanned and scaled for analysis. Historic photos were scaled using distinct topographic changes on the U.S. Geological Survey (USGS) quadrangle map of the area. The 2003 aerial was projected to real coordinates using ground control points established for this project.

The six main aerial photos (1940, 1952, 1967, 1976, 1983, and 1995) were augmented by two photos (1997 and 2000) that provided additional information specifically for the analysis of changes in lodgepole pine and aspen during that time period. The nine aerial photos (the six main photos, the two additional photos, and the 2003 existing conditions photo) that are included in this assessment were flown on the following dates:

- July 13, 1940 (Exhibit 4.2-1)
- August 14, 1952 (Exhibit 4.2-2)
- Two photos were spliced for 1967, one from May 2 and the other is undated (Exhibit 4.2-3)
- August 24, 1976 (Exhibit 4.2-4)
- September 10, 1983 (Exhibit 4.2-5)
- August 19, 1995 (Exhibit 4.2-6)
- August 14, 1997 (Exhibit 4.2-7)
- July 12, 2000 (Exhibit 4.2-8)
- October 9, 2003 (Exhibit 4.2-9)

4.2.1 INFRASTRUCTURE DEVELOPMENT

Some infrastructure development predates the 1940 aerial photo (Exhibit 4.2-10). Conspicuous features that predate 1940 include:

- a ditch-like feature west of Taylor Creek;
- fence lines in the northwest corner of the Tallac marsh;
- a few unpaved paths and/or roads in upland areas adjacent to Taylor Tallac marsh; and
- a small bridge spanning the mouth of Tallac Creek just upstream of the channel's dogleg turn.

Major new infrastructure development first appears in the 1967 aerial photo (Exhibit 4.2-11). Newly constructed features include:

- the Taylor Creek Visitor Center (VC), amphitheater, and related infrastructure;
- small trails that provide access to Taylor marsh from the VC and Kiva Beach from the amphitheater;
- roads, parking lots, trails, and related infrastructure to provide access to Baldwin Beach;
- small bridges installed across the small, distributary channels of Tallac Creek for livestock; and
- a new fence line that extends south across the dry meadow area along Tallac Creek;

It appears that the small bridge across the dogleg of Tallac Creek was no longer functioning in this photo.

Several new features are evident in the 1976 photo (Exhibit 4.2-12). Constructed features and other related disturbances observed include:

- the Pope-Baldwin Bike Path paralleling SR 89;
- a small cleared area within the lodgepole stand across SR 89 from a gravel pit, just west of Taylor Creek;
- a few new trails/access roads within the lodgepole stand just west of upper Taylor Creek;
- a small cleared area near the eastern parking lot for Baldwin Beach;
- a sewer line that crosses Tallac Creek to service facilities located at the eastern parking lot; and
- a few additional small bridges across the distributary channels of Tallac Creek.

New features noted in the 1983 photo (Exhibit 4.2-13) include:

- an unpaved road(s) and turn around/loop cleared in the lodgepole pine stand across from the gravel pit;
- the stream profile chamber;
- a bridge across the main stem of Taylor Creek to connect the bike path;
- a few additional bridges crossing the lower distributary channels of Tallac Creek; and
- an additional fence line in Tallac marsh.

Very few changes were visible in the 1995 photo, most of the observed differences were disturbance related (Exhibit 4.2-14). Changes in the wetland and upland communities include:

- the zone of disturbance in the lodgepole pine stand across from the gravel pit has increased. A larger area has been cleared and a distinct white spot has materialized;
- the number of bridges across Tallac Creek's distributary channels has increased; and
- a new fence has been installed across the Tallac marsh;

The 2003 aerial photo shows all existing infrastructure and disturbance features (Exhibit 4.2-15).

4.2.2 DISTURBANCE AND FIRE

Other observable changes in the 1995 photo related to site disturbance and fire include (Exhibit 4.2-14):

- a fire that burned through some of the lodgepole stands on the Taylor Creek side of the focal study area. The area that is discernable as blackened by fire is circled on Exhibit 4.2-14, but additional areas may have burned as well; and
- the thinning of the conifer forest along SR 89, near Tallac Creek, between the bike path and the highway.

4.2.3 JEFFREY PINE FEATURE

A curious "comma" shaped feature is readily apparent in the southern central area of the Jeffrey pine community (Exhibit 4.2-16)(a). This large open area dominated by sagebrush and bitterbrush is bordered by more densely forested communities. The feature is especially evident in the earliest photo from 1940 where the boundary between the forested and open area has sharp, linear edges. Only a small scattering of Jeffrey pine trees can be seen in this photo. Over the following 63 years, an increased number of trees have established including Jeffrey pine and white fir, and the boundaries are less distinct. However, the shape is still a prominent feature in the 2003 photo (Exhibit 4.2-16)(b).

This feature is located on the highest elevation area of the focal study area site and has well-drained soils (Tallac gravelly coarse sandy loam-see Chapter 3 for description). These dry environmental conditions contribute to the dominance of drought tolerant plant species such as sagebrush and bitterbrush commonly found on the eastern side of the Sierras. Even given that this area is drier than its surroundings, the linear nature of the feature suggests that some other factor(s) may be influencing this pattern.

The conspicuously linear nature of this feature may indicate that the area was significantly disturbed prior to 1940. In xeric environments, large-scale disturbance can have long-lived effects as plant establishment and growth are slow under these conditions. This pattern of measured growth and establishment is exacerbated by the short growing season of higher elevation sites. Under these conditions, vegetation removal in combination with soil compaction, or other significant soil disturbance such as topsoil removal, may cause extremely slow recovery rates. Possible disturbances that may have caused this feature include homesteading, corralling of cattle or other livestock, and logging.

4.2.4 LODGEPOLE PINE GROWTH AND DECLINE

The growth and decline of lodgepole pine stands located on the remnant beach ridges can be seen in the aerial photo series (Exhibits 4.2-1 to 4.2-9):

- The 1940s photo in Exhibit 4.2-1 depicts a open lodgepole pine community with some structural diversity. The stands appear to have a diverse range in age and height as evidenced by the dark areas of younger, denser trees and lighter areas dominated by taller, mature trees interspersed with large canopy openings of wetter meadow.

- By 1952, the stands have filled in considerably and only small areas open meadow can be distinguished. The area occupied by open meadow within the stand in 1940 has been considerably reduced by 1952, as indicated by the arrow (Exhibit 4.2-16)(d).

- Stand density was even greater by 1976 and structural diversity appears to be decreasing. The arrow on the 1976 photo points to the same area in the previous photos, which has become solid with trees (Exhibit 4.2-16)(e). Structural diversity is lost as crowded, thin trees begin reaching the heights of existing mature trees and dense shading prevents regeneration. In this photo, the stand is dominated by the darker green signature that signifies crowded younger trees, while the gray-green mature trees are only observable in small, scattered patches.

- Extensive mortality in the stand becomes apparent in the 1983 aerial photo (Exhibit 4.2-5). The reddish-brown tops of dead or dying trees that haven't lost their needles can be seen throughout the remnant beach ridge stands. Approximately half the pines are still green.

- In 1995, the stands are still actively dying, which is reflected by the large swaths of reddish-brown trees (Exhibit 4.2-6). Some trees that were dying (reddish-brown) and dead (white) in the 1983 photo have been removed by 1995. The areas of tree removal, which are adjacent to the western edge of the access road, appear as open meadow in the 1995 photo.

A darker, blackened signature is apparent in the eastern fringe of the lodgepole stands indicating a recent fire.

- By 1997, the majority of the trees in these stands are dead (Exhibit 4.2-7). Residual effects of the fire in the eastern portion of the stands can be seen in the 1997 photo. The higher, drier areas of this section of marsh are a prominent tan/light brown compared to surrounding vegetation.

- Little change is evident in the 2000 photo (Exhibit 4.2-8). However, a small area has been cleared of snags along the access road and the burned area is not quite as prominent.

- The community appears to be recovering in 2003 and regeneration is perceptible across the stands, with the exception of the burned area (Exhibit 4.2-9).

As mentioned in Chapter 3, lodgepole pine communities are typically dependant on disturbance such as recurrent fire for regeneration. The lack of recurrent fire or active management of this community type generally induces overstocking and the reduction of structural diversity. In these crowded conditions, it is difficult for lodgepole pines to mature and the stand remains even-aged because new seedlings cannot survive under the densely shaded canopy. A stressful environment created by overstocking and prolonged drought reduces some tree's ability to ward off insect infestations and may induce large areas of die-off in forest stands. Drought and disease outbreaks are typically cyclical as climate patterns change and insect populations crash. The lodgepole pine stands along the access road to Baldwin Beach exhibit this pattern. To promote historic conditions of these lodgepole pine stands, management of this area could include significant thinning and/or prescribed fire. More details on management issues, including lodgepole pine stands, are provided in Chapter 7.

4.2.5 ASPEN STAND

An interesting pattern was revealed while investigating the dead aspen stand along Tallac Creek (Exhibit 4.2-17):

- It appears that this stand was well-established in the 1940 and 1952 photos, as evidenced by the dark signature adjacent to the lighter gray conifers. The stand is somewhat dispersed and scattered patches of meadow are visible in canopy openings.

- Even though the quality of the 1967 aerial photo is a bit distorted, it appears that this stand is dead. The tall, whitish-grey trees apparent in the 1967 photo clearly contrast the adjacent conifer stand as well as the darker signature aspen stands in the 1940 and 1952 photos. An aspen stand across the meadow to the east also appears dead. The large stands of aspen south of these stands are not visible in this photo, so it is difficult to discern if this pattern was consistent throughout aspen stands in the focal study area.

- By 1976, the dark green signature returns indicating that the aspen have reestablished. Areas of open meadow are easily seen throughout in comparison to the 1952 photo, but

large white snags are conspicuously absent. Slightly southwest of this stand, beaver dams along Tallac Creek have created small ponds.

- Close examination of the 1983 photo reveals a small area of stand retreat along the western edge adjacent to the well-established beaver ponds. No snags are evident.
- By 1995, the aspen stand appears be smaller and more linear while the extent of beaver ponds is increasing.
- Two years later, in 1997, the size of the stand has decreased and dead trees are evident. It appears that aspen within the stand have begun dying and consequently much of the area occupied by aspen has transitioned to wet meadow. Snags are apparent in this photo.
- In the 2003 photo, the stand no longer has any mature green trees and it appears that the entire stand is dead.

It is not apparent why this stand died sometime between 1952 and 1967. The death of aspen was possibly the result of a fire or disease outbreak. The trees in this stand quickly regenerated within the next decade. The second decline of this stand occurred following the establishment of the beaver ponds. The stand progressively becomes smaller as the beaver ponds become larger. Some of the decrease in the stand's extent in 1983 and 1995 is likely attributed to direct harvesting by beavers. That would explain the absence of white snags and why the side of the stand adjacent to the beaver ponds migrates east, while the eastern edge does not significantly change. The extensive die-off occurs following several years of flooding and a wetter climatic period in the mid to late 1990s. While aspen are adapted to wetter environments, they cannot withstand prolonged flooding. Aspen are tolerant of flooding for periods up to or slightly over a year but is not able to withstand more extensive periods of inundation (Warrance et al. undated). In a wildlife habitat enhancement project in Lassen National Forest, the creation of a permanent pond adjacent to an aspen stand resulted in its mortality (Rickman, pers. comm., 2003). The extended ponding of water resulting from beaver dams on Tallac Creek has produced sustained high groundwater levels and prolonged soil saturation.

The dead aspen stand was observed during the October 2003 reconnaissance surveys of the focal study area. It was noted that the meadow between the beaver ponds and the dead aspen stand was inundated to a depth of a foot or more and small channels were distributed throughout. The dominant vegetation in this meadow included strongly hydrophytic species of sedges and rushes and several of the aspen snags had been felled and/or removed by beaver. A small amount of stand regeneration was observed in the form of stump sprouting on the eastern side of the stand.

4.2.6 BEAVER ACTIVITY

A beaver dam complex along the eastern channel of Tallac Creek has created extensive areas of ponded water in the meadow. Beaver activity likely beginning sometime between 1967 and

1976 has increased over the past 30 years and created the large ponded areas that exist today (Exhibit 4.2-17):

- A few small beaver ponds first appear along the eastern fork of Tallac Creek in the 1976 photo. These were probably established closer to 1976, as opposed to 1967, for the ponded areas are still fairly small in this photo.
- The series of dams were creating a significant area of ponded water by 1983, and beaver activity was moving downstream. The majority of willows within the largest (heart-shaped) beaver pond appear to be surviving the extended inundation.
- In the 1995 photo, the willow shrubs in the largest pond are less apparent. It is likely that the water depth has increased and is obscuring many of the smaller willow shrubs. The most downstream pond has significantly increased in size from the last photo, but the larger upstream pond has only expanded slightly.
- The ponded area in the 2003 photo is not quite as extensive, but prolonged flooding over this period was sufficient to cause noticeable willow mortality within the largest pond. The shrubs in the largest pond are mostly white skeletons, though willows along the middle dam in this pond appear to be surviving and expanding.
- Beaver are also present along Taylor Creek just downstream of the Stream Profile Chamber. However, the ponding associated with these dams is not as observable in the aerial photo series.

While the presence of the beaver and these ponds do have some negative effects on vegetation that is not tolerant of extended inundation, the ponds and surrounding willow shrubs are excellent habitat for wildlife. More details on the effects that beaver have on the surrounding ecosystem, including vegetation and wetland processes, are described in Chapter 3, Section 3.3.10.

4.2.7 WETLAND SYSTEM

A review of the photo aerial series shows a wetland system that fluctuates greatly in extent of flooded lagoonal area (Exhibits 4.2-1 through 4.2-9). This variation is related to fluctuations in lake stand levels, which influence groundwater levels in the near shore segment of the wetland. While the area occupied by lagoon is observable in the photos, changes in the vegetation of the wetland meadow are difficult to detect. A good signature for more subtle changes in the dominance of one herbaceous community compared to another is not easily identifiable. The one exception is the area of drier meadow associated with Tallac marsh. This meadow is consistently lighter in color when compared with the darker wetter meadow signature.

Some noticeable shifts in wetlands within the focal study area were observed in the aerial photo series (Exhibit 4.2-18):

- In the 1940s photo (a), the wet meadow Swale 4 between the Jeffrey pine and the lodgepole pine communities is open and there appears to be a connection between the Tallac Creek side of the meadow and the Taylor Creek side.
- By 2003 (b), Swale 4 has become considerably narrower because of tree establishment and is no longer connected because of the road system constructed in the 1960s.
- The 1967 photo (c) shows a small, unpaved access road established along the eastern fork of the Baldwin Beach road. This access road crosses lodgepole pine, wet meadow, and lagoon.
- By 2003 (d), the edges of this road are lined with conifer trees established in areas previously occupied by wet meadow and lagoon.
- In the 1952 photo (e), Swale 1 appears to be vegetated along the edges and surrounded by lagoon.
- The edges of the swale appear to have a denuded zone along its perimeter in the 2003 photo (f).
- Another notable feature of the wetland meadow is a finger of lagoon just east of the eastern fork of Tallac Creek that is observable in every photo of the time series (Exhibits 4.2-1 through 4.2-9). This wetland feature is located just to the west of the northern portion of the drier meadow community. The extent of this drier meadow community has remained constant throughout the aerial photo series and appears to have consistently remained dry, while the lagoon finger remains wet in the drier years. In the 2003 aerial photo, the finger appears to be pointing to the most southern swale that separates the Jeffrey pine community from the lodgepole pine.

The discernable changes in wetland meadow in the photo series are generally related to infrastructure development and recreational use. The Baldwin Beach road system bisects a previously connected wetter meadow swale and has initiated conifer encroachment. The fill material placed in the swale to provide a road base has likely altered the swale's hydrology allowing for conifer establishment. Additionally, the unpaved access path across the near shore swales has disturbed hydrological connections and also provided an area for conifer establishment.

The near shore swales adjacent to the eastern parking lot have two access paths to allow visitors to reach the beach from the parking lot. The swales are underlain by mostly unconsolidated beach soil with high erosion potential. While these swales may have been denuded by natural erosion processes, it is likely that the upper portions of these swales receive significant foot traffic by recreational users and that this trampling removes plants and hinders vegetation establishment.

The area occupied by drier meadow has been fairly consistent over the past 63 years. It is generally lighter in color than the surrounding vegetation and stands out in contrast to the darker signature of the wetter meadow. This meadow is slightly higher in elevation than the surrounding wetter meadow and the site is also underlain by gravelly alluvial soils (Exhibit 3.3-

5). These gravelly soils likely have a reduced water holding capacity compared to the wetter meadow to the north and east. Reduced soil moisture in dry summers supports a different suite of meadow species and increases the area's vulnerability to grazing stress.

Just north of the drier meadow is an area that appears to have been formed as lagoon under a previous higher lake stand or barrier beach location. The area occupied by this lagoonal feature has fluctuated in extent over the past 63 years, but a central portion generally remains inundated. A lagoon forms on the lower portions of Tallac Creek when lake levels and groundwater levels are high. It is possible that this lagoon is a remnant feature of a higher lake stand and has persisted because this depression is deep enough to intersect contemporary groundwater levels even in drier years.

4.2.8 INFRASTRUCTURE SUMMARY

Infrastructure observable in the earliest historic aerial photo from 1940 includes unpaved access roads and paths, small bridges, fences, and a drainage ditch (Exhibit 4.2-10). Beginning in the mid 1950's, land management priorities shifted to support growing recreational and public access needs. In 1956, infrastructure consisting of paved access roads and two paved parking lots was constructed to support recreational use of Baldwin Beach (Muskopf, pers. comm., 2004). Restroom facilities, a sewer line, and pump station were installed in 1976 (Muskopf, pers. comm., 2004). Additional bridges and fences were constructed to maintain the Baldwin grazing allotment in Tallac marsh, which are observable in the aerial photos from 1967, 1976, 1983, 1995, and 2003 (Exhibits 4.2-11 to 4.2-15). Recreational use of the site was also supported by the construction of the Taylor Visitor Center and interpretive trails in 1965, the bike path and bridge (sometime between 1976 and 1983), and the Stream Profile Chamber in 1967. The effects of the existing infrastructure in the focal study area are examined in detail in the following section.

4.3 EFFECTS OF INFRASTRUCTURE DEVELOPMENT

Infrastructure development in Taylor Tallac Marsh has modified plant communities and wetland function. Constructed features such as roads and parking lots, bridges, the sewer line, and the drainage ditch depicted in Exhibit 4.3-1 have both directly modified habitat and indirectly altered processes supporting the wetland areas. A discussion of these infrastructure features on wetland function and processes is provided below. The locations of existing infrastructure elements and other features discussed in the following section are identified in Exhibit 4.3-1.

4.3.1 Vegetation Loss

Parking lots and roads in Taylor Tallac Marsh have replaced vegetation with asphalt and altered the hydrology of wetland features. The majority of the road and parking lot system in the focal study area was built on drier, upland habitat. However, the western parking lot and approximately half of the access road associated with the western parking lot are likely constructed on fill in areas that were previously wetland (see Section 4.3.2). An obvious

physical change in the Tallac marsh is the replacement of native vegetation cover by asphalt. Replacement of vegetation with asphalt directly affects water infiltration and wildlife use, and can be indirectly associated with additional habitat disturbance due to recreational use. Calculations were made using GIS analysis tools to determine the acreage of displaced plant communities.

Approximately 3.8 acres of asphalt associated with the access road and parking lots have replaced the following:

- 0.2 acre of wetter meadow
- 1.2 acres of beach ridge meadow
- 1.4 acres of lodgepole pine
- 1 acre of Jeffrey pine

The parking lots were built in areas previously occupied by beach ridge meadow (Exhibit 3.3-1). The western parking lot was constructed in a portion of the beach ridge meadow that was likely somewhat wetter and densely vegetated by Baltic rush (*Juncus balticus*). The signature in historic aerials indicates that this area was similar to the meadow just to the west, which is dominated by a homogenous stand of Baltic rush. The eastern parking lot has also replaced beach ridge meadow, but this area is different in character from the densely vegetated Baltic rush meadow. The area replaced by the eastern parking lot was similar in character to the adjacent meadow, which is characterized by expanses of unvegetated sand and patchy, sparse vegetation. The dominant species in this meadow is also Baltic rush, but the area supports scattered lodgepole pines (*Pinus contorta* ssp. *murrayana*) as well. Repeated disturbance by human foot traffic, sewerline construction, and other maintenance activities have contributed to the currently sparse vegetative cover in this area.

The road corridor was constructed perpendicular to a series of four wet swales (Exhibit 4.3-1). The loss of connection between wetland features crossed by the road due to fill and undersized culverts may be altering wetland habitat by changing the historic hydrological regime, and in turn affecting the type of vegetation they support. Swale 4 (Exhibit 4.3-1) has been increasingly encroached upon by tree species and the width of the wetland swath has decreased. The road crossing at this swale lacks a culvert, and the fill underneath the road has disconnected a feature that previously linked the hydrology of the Tallac and Taylor wetland systems (alterations of Swale 4's hydrology is discussed in more detail in Section 4.3.2). Photographs taken from the access road during reconnaissance surveys illustrate the number of trees and shrubs now established in this area (Exhibit 4.3-2). In addition, culverts underneath the road crossings of Swale 1 (the main access road and the sewer line access road) are undersized and not maintained.

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4.3.2 EFFECTS ON SURFACE WATER CONNECTIVITY AND GEOMORPHIC PROCESSES

Based on field observations and aerial photographic reconnaissance, the parking lots and access roads, which were constructed in 1956, were generally constructed on higher elevation ground between the Tallac and Taylor Creek wetlands. However, the west parking lot and associated access road, as shown in Exhibit 4.3-3 would appear to be inundated under high lake levels based on an analysis of the topographic model in comparison to historic levels or the legal maximum limit. Exhibit 4.3-3 indicates that the west parking lot and a section of the access road immediately adjacent to the parking lot were probably constructed, at least partially, on fill. This is further illustrated in Exhibit 4.3-4, which shows the existing parking lots and access roads overlain on the 1940 aerial photo when the lake level was roughly one foot below the legal maximum limit (6228.0 feet NGVD 29). The outline of the access road to the west parking lot (not constructed in 1940) is encroaching on the Tallac Creek wetlands. When the access road was constructed, an undersized culvert was placed under the road to convey surface water. Clearly, the combination of the presence of this fill material and undersized culvert reduces potential inundation area under higher lake elevations. Reduction in inundation area results in reduction in potential wetland area. The resulting reduction in hydrologic connectivity may affect geomorphic processes that shape and maintain the swales, such as sediment transport through the swale system. There is insufficient data to support a detailed description of sediment transport processes through the swales. However, it could be hypothesized that increased hydrologic connectivity through the swales could result in increased sediment transport generally through the swale system. It is likely that sediment transport through most of the swales is minimal and hydrologic effects are more significant.

In contrast, the east parking lot appears to be on naturally higher ground and has less encroachment on the adjacent wetlands and swales. It is unlikely that geomorphic processes such as sediment transport are affected by this parking lot, although groundwater hydrologic connection may be affected in the vicinity because of compaction of the subsoil during parking lot construction. However, the stability of the adjacent swales may also be affected by human foot traffic causing the swales to slough. Erosion of these unvegetated areas may be exacerbated by wind as well.

Exhibit 4.3-5 shows the existing parking lots and roads highlighted on the 2003 base photograph. Each area of interest is numbered and discussed below.

1. The ditches parallel to the access road from SR 89, which generally fall from SR 89 towards Lake Tahoe, concentrate runoff and snowmelt along with contaminants such as oil and grease. Because of the porous nature of the material in which the ditches were formed, runoff, and pollutants likely infiltrate but may also be partially conveyed to Swale 4. If the runoff and pollutants are conveyed to the isolated ponds on either side of Swale 4 during spring melt, it is likely that they only interact with the ponded and percolated water at Swale 4. If this is the case, then the percolated runoff and pollutants may be reasonably well filtered before reaching Lake Tahoe.

2. Presently, the surface water connection between the Tallac and Taylor Creek wetlands through Swale 4 is restricted by the access road. The restriction in surface water connectivity occurs either in the spring, as Forest Service staff regularly observe ponding water on either side of the access road, or in select summers when lake levels are between 6227.5 feet NGVD 29 and the legal maximum level of 6228.0 feet NGVD 29 (see Exhibit 4.3-3).

   Restoring the connectivity through Swale 4 would result in a system that is subject to a hydrologic regime more similar to historic conditions for lake levels approaching the legal maximum limit. It will allow the morphology and habitat at the site to be more dynamic and responsive to the full range of physical processes present. It is typically during the months of July and August, in select summers, that the lake approaches its legal maximum level. An exception to this rule was during the winter flood of February 1997 when the Lake level exceeded the legal maximum level by 0.04 feet. With such high lake levels occurring simultaneously with high runoff, it is expected that water levels further up in the system, i.e. near the Swale 4, are greater than at the lake and result in increased inundation and connectivity between the Tallac and Taylor systems than is shown in Exhibit 4.3-3. This restored connectivity may help to distribute flood effects throughout the wetland system, potentially reducing hazards and damages.

3. It is likely that the lack of a hydraulic structure under the access road at Swale 3 does not present a problem in terms of hydraulic connectivity since Swale 3 was likely disconnected due to glacial or sedimentary processes over time prior to construction of the access road (see Chapter 2).

4. The culvert under the access road to the west parking lot on Swale 1 likely presents a restriction on surface water connectivity and geomorphic processes that shape and maintain the channel. The culvert is significantly narrower than the channel, and such a constriction retards the flow velocity to the point where active channel scour is greatly reduced or eliminated, particularly if Taylor Creek has connected with the eastern end of Swale 1, which can typically occur in high flow events or high lake elevations . This is also true of the other causeways and culverts on Swale 1 where the channel width is much wider than the hydraulic openings. During situations where the Tallac Creek mouth is blocked by

a barrier beach it could be hypothesized that during a high flow event, it is possible that the constrictions could also prevent the creek from achieving a sufficiently high shear to cut open a new outlet. (Additional data is required to substantiate this hypothesis). Thus, the limitations caused by undersized culverts are likely to significantly affect both the morphology and dynamics of Swale 1. Existing data and anecdotal evidence suggests that Taylor Creek will typically breach Swale 1 in high flow events.

5. See bullet 4
6. See bullet 4
7. See bullet 4
8. See bullet 4

4.3.3 EFFECTS ON GROUNDWATER CONNECTIVITY

Chapter 2 provides a general discussion of groundwater patterns in the project site. A more detailed discussion of the effect of the existing parking lots and access roads on local groundwater flow patterns follows.

Exhibit 4.3-6 shows the location of the LTBMU piezometers overlain on the 2003 base map. Piezometer 10 is located near a beaver dam and consequently water levels are artificially elevated and the observations do not accurately describe the groundwater table downstream of the beaver dam. Even if beaver activity increased within the meadow, groundwater would not be similar to those water levels observed at piezometer 10 since piezometer 10 is on higher elevation ground. Piezometer 9 is isolated to the west side of the Tallac Creek wetland and a lack of a groundwater observation between piezometer 9 and 2 does not allow for an accurate description of the groundwater table in the wetland south of Swale 4. The remaining piezometers lie to the north of Swale 4 and generally can be used be used in conjunction with lake levels (Exhibit 4.3-7) to describe the local groundwater patterns between Swale 4 and the lake as performed in Section 2.3.5. Exhibit 4.3-8 shows typical groundwater contours. Unfortunately, observations at piezometer 4 show a discrepancy noted by the closed contours. This may be a result of errors in the piezometer survey and/or observations since the piezometer is located on a sandy berm and the actual ground surface to which the piezometer observations are referenced may have changed.

While not shown in Exhibit 4.3-8, observations at piezometers 1 (east of access road) and 2 (west of access road) show that there is an average of 0.3 feet of head on the west side of the main access road at Swale 4. Based on this evidence, it can be deduced that compaction and consolidation of the material under the access road and west parking lot does pose some physical barrier to subsurface interaction between the swales, despite the highly porous (sand) nature of the subsurface material.

4.3.4 EFFECTS OF POLLUTANT LOADING

Pollutant loads from the existing parking lots and access roads were estimated using Lake Tahoe Basin Storm Water Quality Improvement Committee (SWQIC) procedures (NHC, 2003). Runoff from the existing parking lots and access roads either flows into the neighboring

wetlands or roadside ditches, infiltrates during lower Lake levels, or mixes with ponded water during higher Lake levels. With the runoff are fine sediments and pollutants that are transported into the surrounding receiving waters. This runoff may eventually reach Lake Tahoe and impair the water quality of the lake by reducing water clarity and increasing algal growth through increased nutrient supply. Pollutants that might be generated from the parking lots and access roads include oil and grease as well as suspended solids, nitrates and phosphates. Tables 4.3-1 and 4.3-2 summarize the results using the SWQIC procedures for the impervious surfaces of the parking lots and roads, calculated to be 3.7 acres. These values are estimates based on the loading coefficients of Reuter and Heyvaert (Reuter et al., 2002; Heyvaert et al., 2003) as developed for the Lake Tahoe area. Further research is ongoing, but these data represent the best available to date. These values will later be used in Chapter 7 to assess the relative change in pollutant loads for each conceptual alternative. Table 4.3-1 shows the runoff statistics for which the values shown represent. Table 4.3-2 shows the average annual pollutant loading for each of the above identified pollutants assuming loads are flow dependent and have characteristics similar to paved asphalt areas.

Table 4.3-1
Runoff Statistics from Existing Parking Lots and Access Roads

	Exceedance Probability (percent)		
	5	10	50
Runoff (in/hr)	0.30	0.21	0.11
Volume (in)	1.45	0.97	0.20

Table 4.3-2
Average Annual Pollutant Loads (in tons) from Existing Parking Lots and Access Roads

Nitrate (NO_3)	Total Kjeldal Nitrogen (TKN)	Soluble Reactive Phosphate (SRP)	Total Phosphorous (TP)	Total Suspended Solids (TSS)
0.000391	0.001727	0.000235	0.001010	0.3456

The values shown by Table 4.3-2 are presented here for comparative purposes between existing and proposed conditions only and should be compared with the values calculated in Chapter 7 for proposed conditions. The water quality constituents listed above have been identified as priority pollutants in the Lake Tahoe Basin in Section 303(d) of the 1972 Clean Water Act implemented by Lahontan Regional Water Quality Control Board (LRWQCB). In addition, recent research by experts such as Heyvaert, Reuter and Goldman at the Tahoe Research Group has suggested that available research indicates that phosphorous, nitrogen and fine suspended sediment particles contribute the most toward clarity loss in the lake (USDA, 2000). The values shown in Table 4.3-2 are relatively small in comparison to typical values obtained from heavily urbanized areas around the basin. The pollutant loads shown in this table are a function of impervious area and therefore proposals to reduce impervious area from the existing condition will result in lower pollutant loads.

4.3.5 NONNATIVE PLANT INTRODUCTIONS

Roads act as dispersal corridors for the introduction of nonnative plant species and plant diseases into uninfested areas. While it is not obvious that the access road has functioned in this capacity thus far, providing vehicle access is a common way that nonnative species and diseases are introduced into natural areas (Forman and Alexander 1998; Forman and Deblinger 2000; Trombulak and Frisell 2000). Tires and muddy undercarriages can carry seeds and other plant propagules of nonnative species found along roadsides and other disturbed areas. The propagules of some disease organisms are also carried by mud and plant materials. Air movement from passing vehicles may promote the spread of these pest plant species once they have established (Forman and Alexander 1998, Cusic 2000).

4.3.6 EFFECTS OF THE SEWER LINE

A section of the concrete enclosed sewer line runs in an east to west direction along the near-shore beach ridge meadow and perpendicularly crosses the mouth of Tallac Creek (Exhibit 4.3-1). As discussed in Chapter 2, the sewer line acts as a grade control on Tallac Creek and restricts the process of headcutting from moving up the system at low lake stands. This downward cutting process is responsible for creating the large lagoon fingers along the mouth of Taylor Creek. Tallac Creek downstream of the sewer line is incised. Upstream of the sewer line the channel appears to have incised partially in the vicinity of the sewer line crossing, as shown by the fact that the concrete casing of the Tallac Creek sewer line crossing is now exposed (at the time of construction in 1972 it was buried). However, the channel is only approximately one-foot deep from top of bank to the channel bed upstream of the sewer line crossing and therefore it appears that the sewer line crossing has reduced the rate of incision and there may even have been some aggradation of the channel in this upstream reach . In the absence of the sewer line crossing, swales 1 and 2 may function as lagoon features more often or for longer periods on the western side of the road, and the increase in hydroperiod would support open water/pond lily habitat when lake levels are high. The sewer line does not appear to affect Taylor Creek. Lagoonal incision is much more predominant on Taylor Creek. We would hypothesize, in the absence of more detailed data, that perhaps the sewer crossing has prevented Tallac Creek from forming similar lagoonal features. The installation of the sewer line in the beach ridge meadow has likely contributed to the area's low vegetation cover (Exhibits 4.3-1 and 3.1-1). This habitat has a sparse cover of perennial herbaceous species and scattered lodgepole pine, but the majority of this area is characterized by unvegetated open sand. The unconsolidated, sandy soils underlying the beach ridge meadow vegetation are easily disturbed and they are difficult substrates for vegetation establishment and growth. Disturbance associated with the installation of the sewer line, along with repeated trampling from recreational users (discussed in Section 4.3.9), is likely responsible for the lack of vegetation in this area.

4.3.7 EFFECTS OF BRIDGES

Several bridges have been and are still located within the Taylor Tallac Marsh including a small bridge that is observable in the 1940 aerial photo (Exhibit 4.2-10), several bridges used to

cross distributary channels in the Baldwin allotment (Exhibits 4.2-11 to 4.2-15, and Exhibit 4.3-1), and the bridge constructed over Taylor Creek for the bike path crossing (Exhibit 4.3-1). The historic bridge across the mouth of Tallac Creek observable in the 1940 aerial and some of the bridges placed in the grazing allotment for horse crossings are no longer present.

Bridges affect stream systems by altering flow regimes and scouring sediments (Forman et al. 2003). During high flow events, water within a stream channel intersects bridge abutments causing the constriction of its flow. The velocity of streamflow increases around these abutments making them susceptible to scour. Scour also occurs when water accelerates as it flows through a bridge opening that is narrower than the channel and floodplain upstream from the bridge. Eventually, the scouring of sediments may cause the downcutting of a streambed. It is difficult to ascertain from the aerial photos, but the bridge across the mouth of Tallac Creek, which is evident in the 1940 and possibly the 1952 aerial photos (Exhibits 4.2-10 and 4.2-11), may have caused a widening of the elbow area on the creek's dogleg turn. The small wooden bridges in the Baldwin grazing allotment prevent streambank damage and do not appear to be significantly affecting stream dynamics. As well, the bike path bridge over Taylor Creek does not appear to be affecting flow dynamics or causing channel incision.

4.3.8 EFFECTS OF THE DRAINAGE DITCH

The drainage ditch just west of Taylor Creek likely contributes to dewatering the surrounding wetland area. During a previous study of the marsh, it was observed that groundwater was seeping out of the upland area in the westernmost arm of Taylor Creek marsh creating a very wet area in the vicinity of this ditch (LTBMU 2000). The excavation of this ditch, which occurred prior to 1940, likely served to create drier conditions for grazing livestock.

4.3.9 EFFECTS OF RECREATIONAL USE

In general, visitor use of the marsh system is concentrated on the beaches and paved interpretive trails through Taylor Creek marsh. Baldwin Beach and Kiva Beach (Exhibit 4.3-1) are two of the few beaches along the shores of Lake Tahoe that are open to the public and they attract many visitors during the summer months. Records show that a total of 12,104 vehicles entered the Baldwin Beach recreation area in 2002 and a total of 12, 594 vehicles entered in 2003. The Taylor Visitor Center and Stream Profile Chamber are also significant attractants.

Infrastructure development has indirectly affected vegetation and wetland function by introducing and supporting a high volume of recreational use. Providing access to natural areas can lead to the trampling of native vegetation, the development of volunteer trails, and the compaction of soils in more heavily used areas. In turn, vegetation trampling/destruction and soil compaction diminishes the wetland's hydroperiod and the ability to process nutrients. Once vegetation has been removed and water is no longer able to infiltrate the compacted soils, nutrients cannot be processed to the same extent. Additionally, this loss of vegetation and reduction of density and cover could have consequences for wildlife. Please refer to Appendix

F for wildlife species that may be affected. Detailed field studies would be required to understand more about the direct and indirect effects of these disturbances.

Access provided by the eastern parking lot and the pedestrian causeways to Baldwin Beach may be partially responsible for some degradation of the surrounding beach ridge meadow and wet swales. The sparsely vegetated beach ridge meadow directly adjacent to the parking lot receives substantial foot traffic, which appears to be destroying existing vegetation and limiting further plant establishment. Pedestrian causeways funnel visitors using the eastern parking lot across Swale 1 to the beach (Exhibit 4.3-1), but if conditions are dry, the banks and bottoms of this swale system receive foot traffic. Impacts associated with foot traffic include trampled wetland vegetation, impaired plant establishment, and erosion of unconsolidated and unvegetated sandy banks. The erosion of sand into the bottoms of the swales from the tops of these unvegetated banks has raised surface elevation levels and decreased the length of time the swale is inundated. In addition, the culverts underneath the pedestrian causeways are undersized and not maintained. These culverts restrict water flow resulting in increased sedimentation.

A primary concern for Baldwin Beach is the protection of Tahoe yellow cress populations. Enclosures have been constructed around the main populations currently found on the higher elevations of the beach, but establishment was observed outside of the protected areas. Tahoe yellow cress individuals establishing outside of the enclosure are subject to trampling. The potential to expand these populations depends on lake levels (regeneration of Tahoe yellow cress is closely tied to the fluctuations in lake level that open up large expanses of beach for colonization) and protection by fencing.

4.4 GRAZING HISTORY AND EFFECTS

Approximately 200 acres of the focal study area is currently grazed annually from mid summer to late fall. Livestock grazing has a 300-year plus history in the Sierra's, but it reached significant levels around the mid 1850s. Cattle ranchers from the foothills and the Central Valley commonly used the Lake Tahoe Basin during the Gold Rush era. Heavy utilization by livestock during this time had significant detrimental effects on sensitive habitats in the Lake Tahoe Basin such as wet meadows and riparian areas. Some of the detrimental effects of overgrazing include altered vegetation composition and loss of vigor, compacted soils, trampled and eroded streambanks, decreased water quality, and degraded wildlife habitat. The records for the Baldwin allotment are scant, and little information is available about its grazing history. Therefore, it is assumed that the Baldwin allotment experienced a similar grazing history as the Sierra's and the Lake Tahoe Basin.

4.4.3 BALDWIN GRAZING ALLOTMENT

The Taylor, Tallac, and Spring Creek watershed has been grazed by sheep, cattle, or horses for approximately 100 to 150 years (Muskopf, pers. comm., 2005). The Baldwin Allotment, located in the Tallac Creek Watershed, is the last active allotment in the Tahoe basin. The Baldwin allotment encompasses approximately 200 acres (Exhibit 4.4-1) and includes aspen groves,

upland pine communities, montane meadow communities, riparian communities, beaver ponds, lagoon, and Tallac Creek (Exhibit 3.3-2). A 20-acre private in holding is present within the middle of the wet meadow system, which is owned by the adjacent landowner and permit holder. There are six pastures in the allotment, five of which are managed and monitored by the Forest Service. One of these pastures, the beach pasture, was not permitted for grazing in 2004. In previous years, the allotment was permitted for 50 horses for a six-month period that extended from July 1 through December 1. In 2004, the permit was amended to allow grazing for up to four months from July 1 to October 15 with 45 horses. The current stocking rate is approximately 40 horses, and horses typically graze the allotment in the evening.

4.4.4 BALDWIN ALLOTMENT MANAGEMENT AND MONITORING

The wetland and riparian complex of Tallac Creek is a managed as a riparian conservation area by the Forest Service. Monitoring standards for riparian conservation areas are based upon standards and guidelines in the Sierra Nevada Forest Plan (Standards and Guidelines Associated with Riparian Conservation Objectives #2 and #5) (Forest Service 2001). These Forest Service monitoring standards limit utilization to the following:

- no more than 20% streambank disturbance (includes trampling, bank sloughing, chiseling and other means of exposing bare soil);
- no more than 40% herbaceous consumption;
- no more than 20% browsing of shrub growth; and
- parcels unoccupied by willow flycatcher (*Empidonax traillii*) (if willow flycatcher nests are known to be present in the allotment, then only late season grazing is allowed or a site specific management plan is prepared for the allotment).

Monitoring of the Baldwin allotment is conducted by Forest Service staff and includes the following:

- Range readiness inspections to determine when the horses should be initially permitted on the allotment, and when they are allowed to enter the pastures. These inspections evaluate the cover of tufted hairgrass (*Deschampsia caespitosa*), Kentucky bluegrass (*Poa pratensis*), and clover (*Trifolium* spp.);
- Routine monitoring assessments while the horses are on the allotment to determine levels of overall resource conditions and streambank disturbance. Herbaceous utilization is measured when a pasture in the allotment is closed for the season. Vegetation consumption data is generally collected along two transects in pastures B and C, but there is a third transect that is not regularly monitored. In 2004, data was collected along four monitoring transects in pastures B, C, D, and E (Exhibit 4.4-1). Streambank trampling data is collected along one transect in pasture B (Exhibit 4.4-1);
- Annual surveys for willow flycatcher, a species state-listed as endangered; and

- Fecal coliform counts at two (Site 1 and 2) to three (Sites 1, 1.5, and 2) monitoring stations (Exhibit 4.4-1). Fecal coliform monitoring is initiated prior to July to collect baseline conditions and continues on a biweekly basis throughout the monitoring period. These counts must comply with Lahontan Regional Water Quality standards.

4.4.5 EFFECTS OF GRAZING ON VEGETATION AND WETLAND FUNCTION IN THE BALDWIN ALLOTMENT

Proper management of livestock grazing can potentially benefit wet meadows and riparian habitats. Some of the potential benefits include increased plant diversity, enhanced wildlife habitat, and reduced fire hazards. Moderate grazing may enhance riparian and meadow habitat by preventing decadent or stagnant plant communities and by promoting herbaceous vegetation growth (Anderson 1993; Sedgwick and Knopf 1991; Huber et al 1995). Research indicates that moderate grazing can elevate soil microbial counts and produce more fertile soil conditions that support lush vegetation (Singh and Rai 2004). The removal of thatch and thinning of tree and shrub seedlings promotes the growth of some species (e.g., grasses and sedges), reduces fuel loads, and increases plant diversity.

However, grazing can be detrimental to ecosystem health when improperly managed. Livestock grazing in wetland and riparian habitats has been linked to the degradation of several ecosystem components through soil compaction and erosion, reduced groundwater levels, alteration of species composition in wetland and riparian plant communities, alteration of stream channel morphology and hydrology, and the degradation and removal of in stream and riparian vegetation.

Livestock grazing has been observed to significantly alter soil structure (the arrangement of soil particles) and function by compacting the soils, inducing erosion, and reducing long-term productivity (Roberson 1996). Repeated trampling by livestock compacts soils, which impedes the infiltration of water and air into the soil and inhibits root growth. Heavy use by large livestock is particularly damaging to wet soils that are more vulnerable to compaction (Roberson 1996). As soils become compacted, they lose the spaces available to store air and water and support root growth, thereby causing an overall reduction in productivity.

In addition, repeated trampling and soil disturbance can lead to the formation of rills and gullies within a meadow. Soft, wet soils offer little physical resistance to livestock hooves and are easily disturbed if bare, sparsely vegetated, or vegetated by species susceptible to damage (Murray 1997). During spring snowmelt and summer precipitation events, exposed soils are subject to erosion. Gullies form in meadows as a result of soil compaction and erosion of denuded areas, and these gullies then drain the surrounding meadow soils and lower the groundwater table (Hagberg 1997). When soils are compacted and infiltration rates are diminished, groundwater recharge and storage is diminished. A sustained low water table no longer supports many wetland species, and the meadow's species composition typically shifts to those adapted to drier conditions.

Heavy grazing may induce changes in the species composition of montane meadows. Studies of montane meadows in the Sierra's have found that the dominance of forbs such as buttercup

(*Ranunculus* spp.), yarrow, lupine (*Lupinus* spp.), and penstemon (*Penstemon* spp.) can be correlated to heavy grazing (Crane 1950; Murray 1997; USDA 2003; Menke et al. 1996). Certain wetland species, such as mannagrass (*Glyceria elata*), Nevada rush (*Juncus nevadensis*), and primrose monkeyflower (*Mimulus primuloides*), are especially susceptible to damage by overgrazing while nonnative graminoids such as common timothy (*Phleum pratense*) and Kentucky bluegrass (*Poa pratensis*) persist and possibly increase under heavy grazing pressures (Potter 2003, Menke et al. 1996). Grazing can also significantly reduce and possibly eliminate some sedge species (Murray 1997). Less desirable or unpalatable species eventually replace the more palatable grasses, sedges, and rushes. Montane meadows in particular are more sensitive than other habitats because of short growing seasons, colder temperatures, and somewhat shallow soils that limit productivity and recovery of vegetation (Murray 1997). Generally, drier montane meadows supporting a good cover of rhizomotous grasses or sedges provide greater resistance to grazing-induced change but have lower resilience to reach pre-grazing conditions than wetter meadows (Murray 1997). Greater resistance can be attributed to the thick mat of roots typical of rhizomotous species that are less susceptible to damage. However, when heavy grazing damages soils and vegetation in drier meadows, the reduced water availability from soil compaction hinders plant productivity and reduces the rate of recovery (Murray 1997). Additionally, trampling and overgrazing by stock animals can be conducive for the establishment of nonnative species and pest plants by exposing bare mineral soils, reducing interspecific competition, and introducing nonnative seeds from their feed.

Streambank trampling damages root systems, weakening and eventually killing plants. Loss of creekside vegetation can lead to increased bank erosion and channel widening, adding sediment to streams. As riparian soils and vegetation structure are altered by trampling or direct consumption, the process of trapping sediments to build soils is diminished, thereby reducing the ability of the soils to support vigorous riparian vegetation. In addition, because the riparian vegetation has been removed or damaged, the erosive force of water is not absorbed to the same degree resulting in channel incision or widening. In Tallac Creek meadow it appears that aggradation rather than channel incision has played a larger role in recent years due to the presence of the sewer line crossing. The presence of beaver dams in the upper watershed probably reduces the amount of sediment passing to the lower watershed on a regular basis but during episodic events the backwater created by the sewer crossing will encourage deposition. Since insufficient existing data is presently available it is difficult to assess the level of aggradation and the impact of the aggradation on water temperature, habitat, groundwater and vegetation. However, aggradation of the lower Tallac Creek would encourage overbank flows, enhancing wetland features.

Some of the specific characteristics of horses intensify some of the detrimental effects of grazing. These characteristics include the following: horses graze vegetation very close to the ground because they have both top and bottom teeth, they tend to dung and urinate in the same areas and concentrate waste, and they are herd animals and tend to concentrate their use in areas (Dalton 2002).

Observed habitat modifications and fecal coliform data collected by Forest Service staff indicate that horse grazing in the Baldwin allotment may be causing an overall decrease in habitat

quality. Observable impacts to the grazing allotment include overgrazed and denuded areas, a predominance of herbaceous species that are common in overgrazed meadows, bank trampling, trail development, wetland soil disturbance, and gully formation. Other impacts include decreased water quality from high bacteria counts and accelerated soil erosion and degraded wildlife habitat.

The horses tend to utilize the allotment unevenly, and some areas are more heavily browsed than others. In general, the drier meadow and the understory of some aspen plant communities (Exhibit 3.3-1) seem particularly over-utilized. In other areas not as heavily used, thick layers of thatch underlie wetland vegetation. As illustrated in the photographs in Exhibit 4.4-2, the ungrazed portions of the meadow appear to have greater willow establishment and more vigorous vegetation growth.

The large drier meadow depicted on Exhibit 3.3-1 appears to be particularly degraded by the horse grazing. This drier meadow, which is underlain by well-drained gravelly soils, was significantly denuded during the October 2003 reconnaissance surveys and its observed vegetation composition the following spring appears to indicate heavy utilization (Exhibit 4.4-3). In fall, this meadow had large bare patches and severely overgrazed graminoids. The following spring, the meadow was a carpet of smooth buttercup (*Ranunculus alismafolius*) interspersed by yarrow (*Achillea millefolium*) and goldenrod (*Solidago* sp.), and little growth of common meadow graminoids was apparent. It is assumed that this meadow would be dominated by graminoids in the absence of grazing.

More heavily utilized portions of the meadow appear to be experiencing some soil compaction and volunteer trail development. One of the meadows along Tallac Creek, east of the large beaver dam complex, has several small gullies and the soil appears to be more compacted in comparison to some of the other portions of the Tallac Creek marsh. Horse grazing is causing Tallac Creek to widen and it appears that the wetland is increasing in size due to grazing issues in general. The horses are also heavily utilizing some of the aspen stands, especially those along the uppermost reach of Tallac Creek within the focal study area. While heavy grazing of terminal branches on aspen saplings can limit regeneration and lead to even-aged stands, the consumption of young aspen by horses was not detected during reconnaissance surveys at the site. However, Forest Service staff has observed bushier growth forms of aspen in the allotment, evidence that the horses are grazing on aspen saplings (Muskopf, pers. comm., 2005). A network of denuded volunteer trails has developed throughout these stands (Exhibit 4.4-4) and some of the more heavily utilized areas have an understory dominated by corn lily (*Veratrum* sp.). The abundance of corn lily in aspen stands can indicate overuse by livestock; these areas should be more diverse with other species (Nichols, pers. comm., 2004). Ideally the understory should be more diverse with less corn lily. These denuded trails are concentrating sediment-laden runoff, which drains into the adjacent streams and wetlands, and may be creating drier conditions by accelerating the drainage of these soils (Exhibit 4.4-4).

Several areas along the stream corridor and the shorelines of ponded water features have experienced severe trampling, which has produced bare, hummocky soils. As mentioned previously, streambank trampling destroys vegetation and exposes and disturbs the underlying

soils. The exposed and unconsolidated soils are highly erodible and contribute fine sediment to the stream as water flows over them. Photos in Exhibit 4.4-5 illustrate the extent of vegetation removal and soil disturbance in the wetland portions of the grazing allotment. The main stream crossing for horses on the allotment is along a reach of Tallac Creek near SR 89. The stream is significantly wider at this crossing as a result of bank trampling and soil erosion. The eastern approach to the stream crossing is steep and the once shallow gully formed by the crossing may have concentrated water runoff from the adjacent aspen stand and increased bank erosion. Wooden bars have now stabilized this approach. However, and the channel within this reach is still on the alluvial/debris fan apex where gradients are steeper and the channel is likely naturally incised to some degree. The effects of overwidening/incision at this site likely would be localized and not affect areas downstream. In the Tallac marsh, the stream may be widening, as the gradient is low along this reach, and channel incision is less likely.

Channel widening would cause an increase in the creek's cross section area, and reduce out of bank flow frequency. However, during the geomorphic reconnaissance of this area, it appeared that overflow occurred quite frequently and the floodplain and stream were still highly connected. It may be that widening has caused aggradation, resulting in more frequent out of bank flow and flooding.

Some of the wetter meadows and the understory of some aspen groves are have a significant number of nonnative dandelion (*Taraxacum officinale*). The dandelion may have been introduced by the elimination of contaminated feed in the meadows. Repeated grazing, which keeps grasses short and reduces competition, is likely perpetuating the presence and abundance of the dandelion. The dandelion is displacing natives, but it is not apparent whether this species is out competing native vegetation to the point of causing habitat degradation.

4.4.6 EFFECTS OF LIVESTOCK ELIMINATION ON WATER QUALITY

The release of livestock waste products into aquatic systems decreases water quality by both increasing the concentrations of nutrients, such as nitrogen and phosphorus, and increasing fecal coliform bacteria levels. Wetland vegetation may not be able to assimilate the high concentrations of nitrogen and phosphorus or process the influx of fecal coliform bacteria. The buildup of these nutrients in aquatic/wetland systems can lead to algal blooms and the proliferation of aquatic weeds. High fecal coliform counts in aquatic environments can be detrimental to human health. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal matter of animals. Pathogens or disease-producing bacteria or viruses can also exist in fecal material, and the presence of fecal coliform bacteria indicates the potential presence of other pathogens or disease-producing bacteria.

While nutrient concentrations are not measured, fecal coliform counts are conducted as part of the allotment's monitoring requirements. Monitoring of fecal coliform bacteria numbers by the Forest Service staff indicate an overall pattern of higher counts once the horses enter the allotment or following large precipitation events (Appendix G). The fecal coliform numbers

measured during monitoring generally exceed water quality standards and have reached excesses of 654 per milliliter. Other wildlife may be contributing to these numbers, but the pattern of increased numbers when the horses are on the allotment seems to indicate that their presence significantly elevates fecal coliform bacteria numbers.

4.4.7 EFFECTS OF LIVESTOCK ON WILDLIFE

In general, grazing degrades wetland meadow habitat and in turn decreases its wildlife habitat value (Borgmann and Morrison 2005). In particular, the structure of willows is an important component of nesting habitat for many birds. Grazing of willows on the site may be preventing the growth of young willows. The monotypic structure of even-aged willow stands decreases the suitability of this habitat to support breeding songbirds. However, two active willow flycatcher nests were observed during 2004 monitoring surveys at the Baldwin allotment (Exhibit 4.4-1). These nests were found near beaver activity, in an area that is thicketed by willows and surrounded by two feet of ponded water. Horses are secluded from this area due to these natural barriers.

Willow flycatchers are migratory songbirds that nest in shrubby, wet habitats. The presence of this species will require changes in management for the subsequent grazing season, in accordance with the Sierra Nevada Forest Plan Amendment Record of Decision standards and guidelines 57 and 58. These standards and guidelines require that grazing allotments in meadows with occupied willow flycatcher nests permit only late-season grazing (after August 15) in the entire meadow. However, this guideline may be waived if a site-specific meadow management strategy is developed by an interdisciplinary team in partnership with the affected permittee (Forest Service 2001).

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Source: US Forest Service, EDAW 2004

7-13-40

EXHIBIT 4.2-1

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004

8-14-52

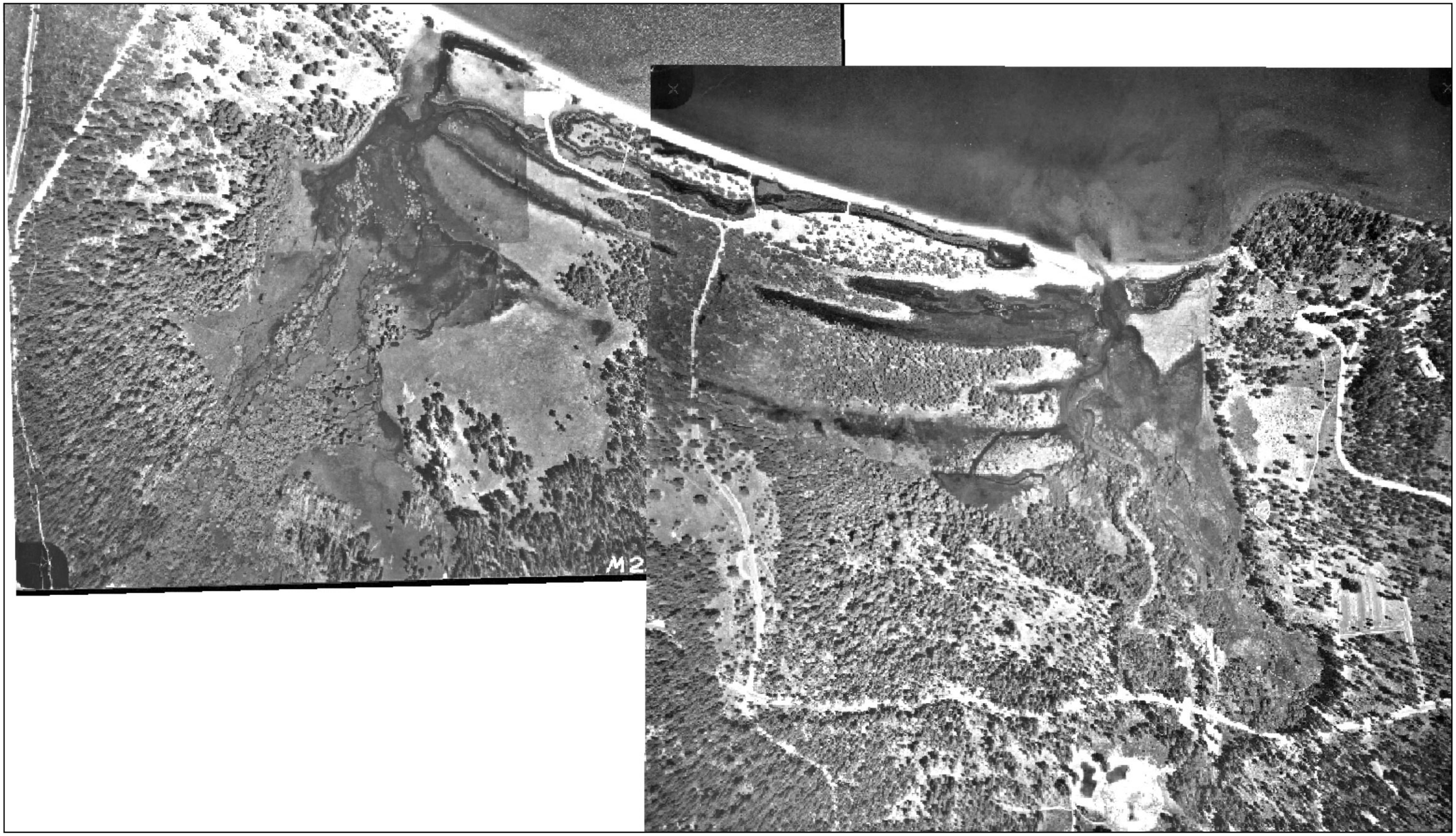
EXHIBIT 4.2-2

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Source: US Forest Service, EDAW 2004

1967 (5-2-67 and undated)

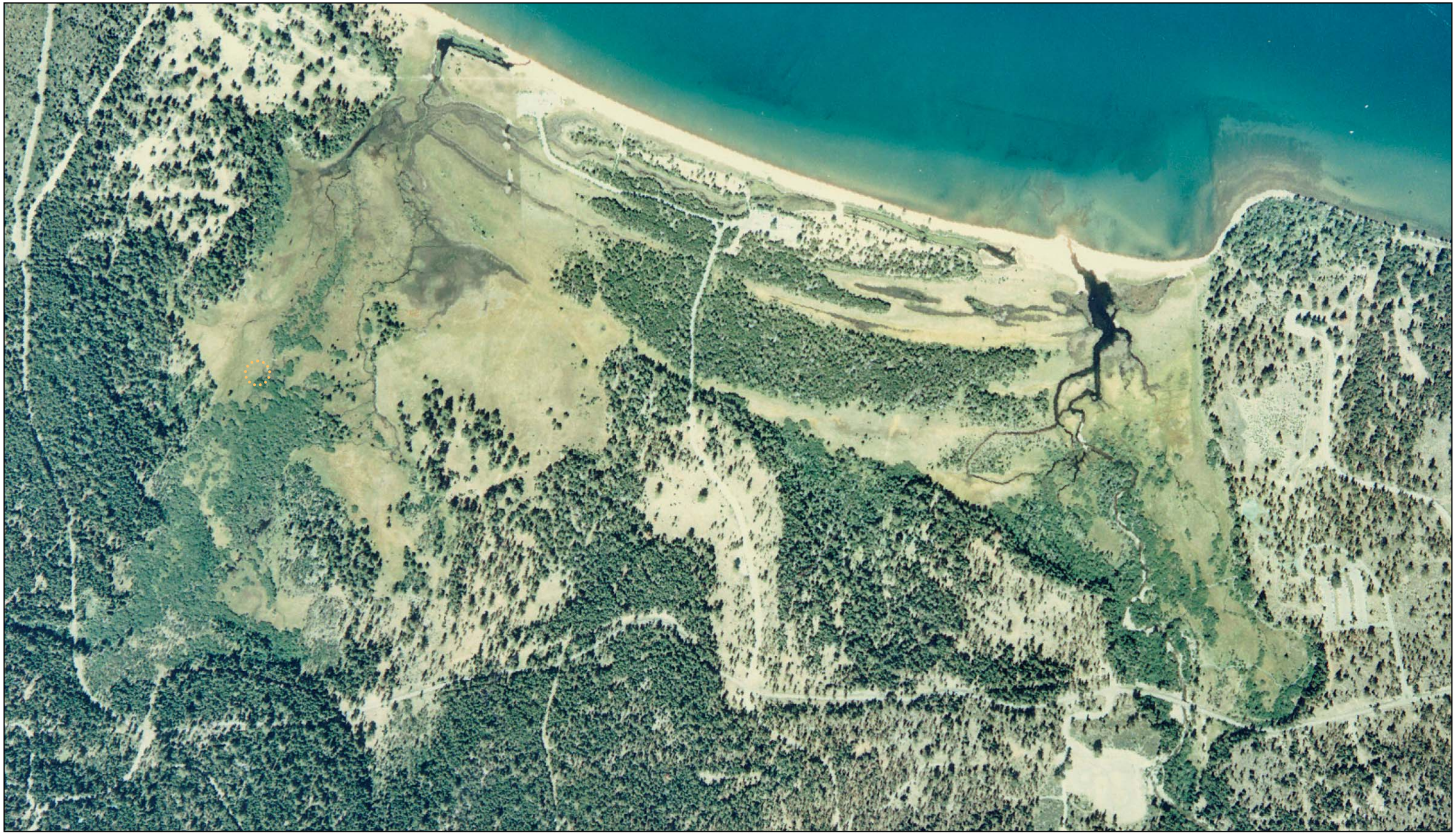
EXHIBIT 4.2-3

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Source: US Forest Service, EDAW 2004

8-24-76

EXHIBIT 4.2-4

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004:

9-10-83

EXHIBIT 4.2-5

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004

8-19-95

EXHIBIT 4.2-6

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004

8-14-97

EXHIBIT 4.2-7

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004

7-12-00

EXHIBIT 4.2-8

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: NA Mapping 2003, EDAW 2004

10-9-03

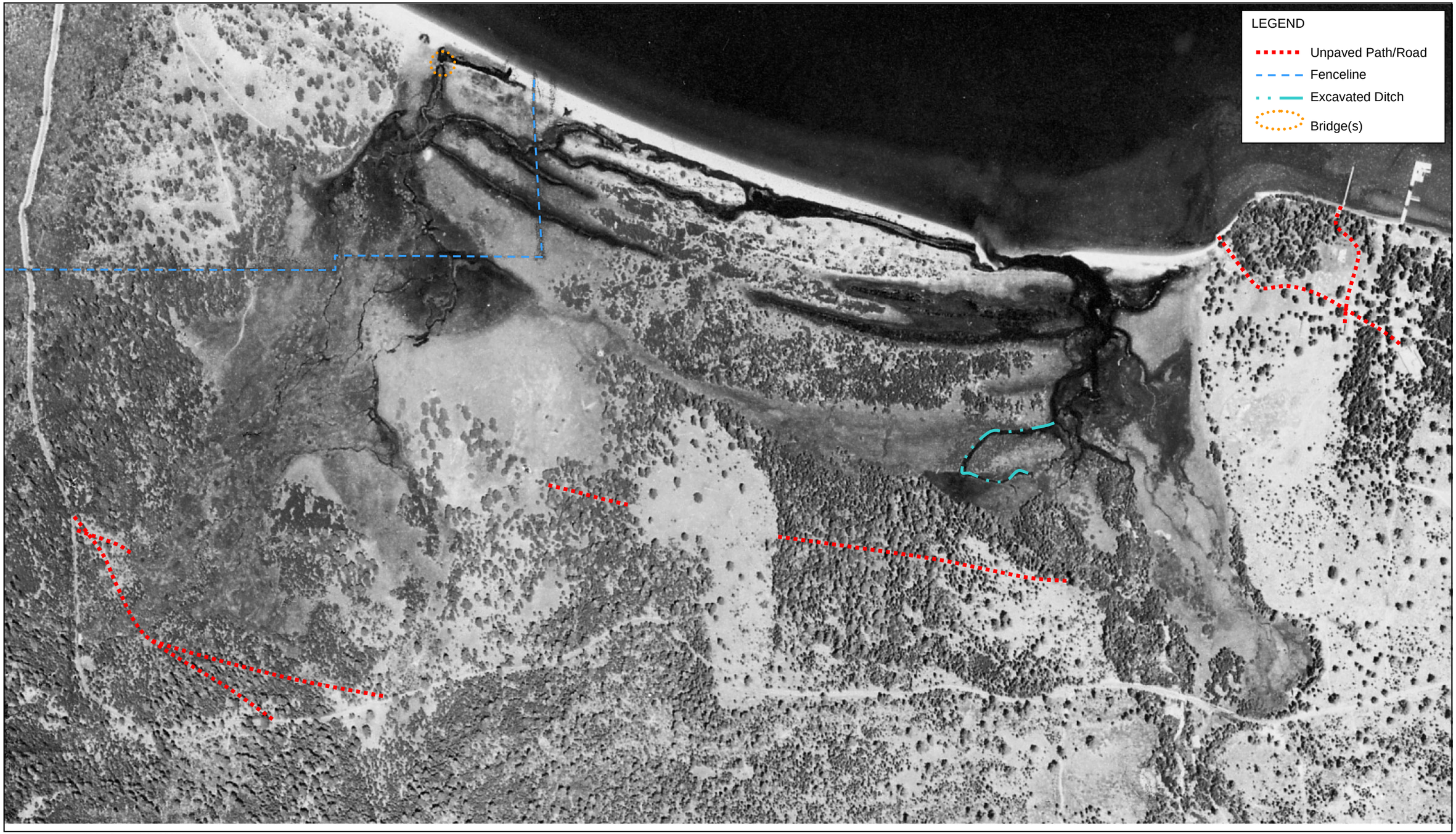
EXHIBIT 4.2-9

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Source: US Forest Service, EDAW 2004

Infrastructure 7-13-40

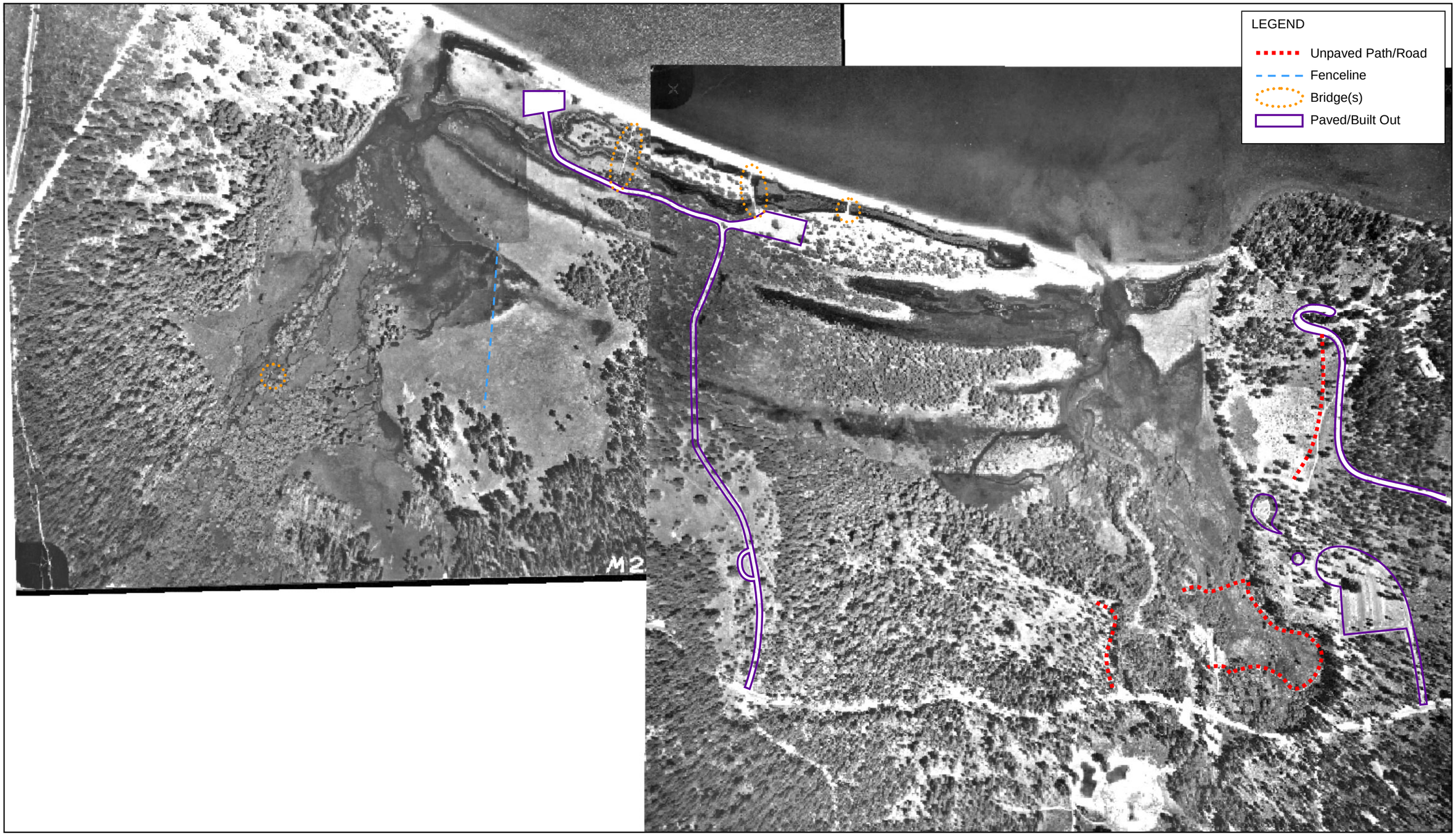
EXHIBIT 4.2-10

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Source: US Forest Service, EDAW 2004

Infrastructure 1967

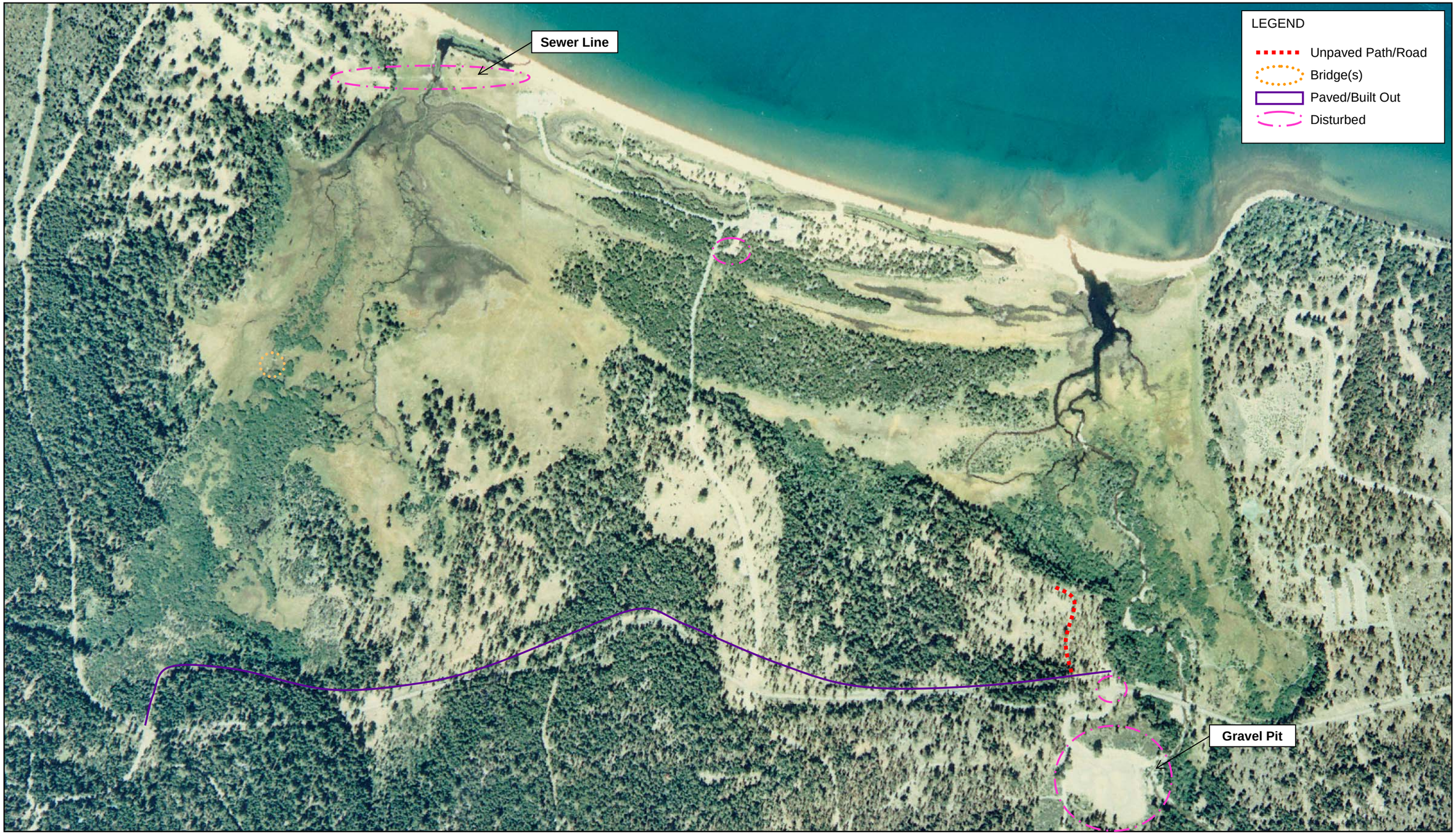
EXHIBIT 4.2-11

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Source: US Forest Service, EDAW 2004:

Infrastructure 8-24-76

EXHIBIT 4.2-12

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004:

Infrastructure 9-10-83

EXHIBIT 4.2-13

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW

Source: US Forest Service, EDAW 2004

Infrastructure, Disturbance, and Fire 8-19-95

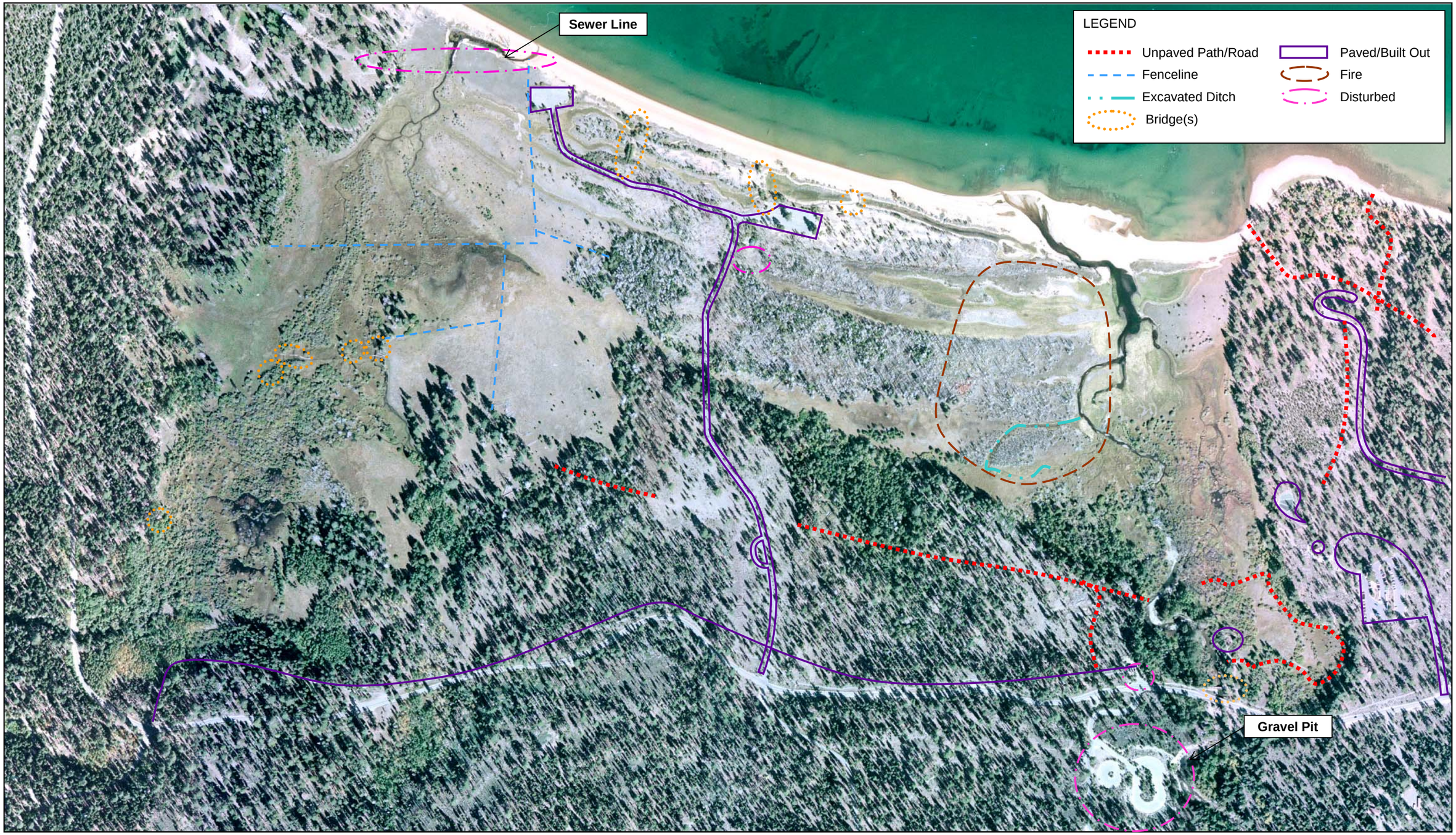
EXHIBIT 4.2-14

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Source: North American Mapping Company

Infrastructure, Disturbance, and Fire 10/9/03

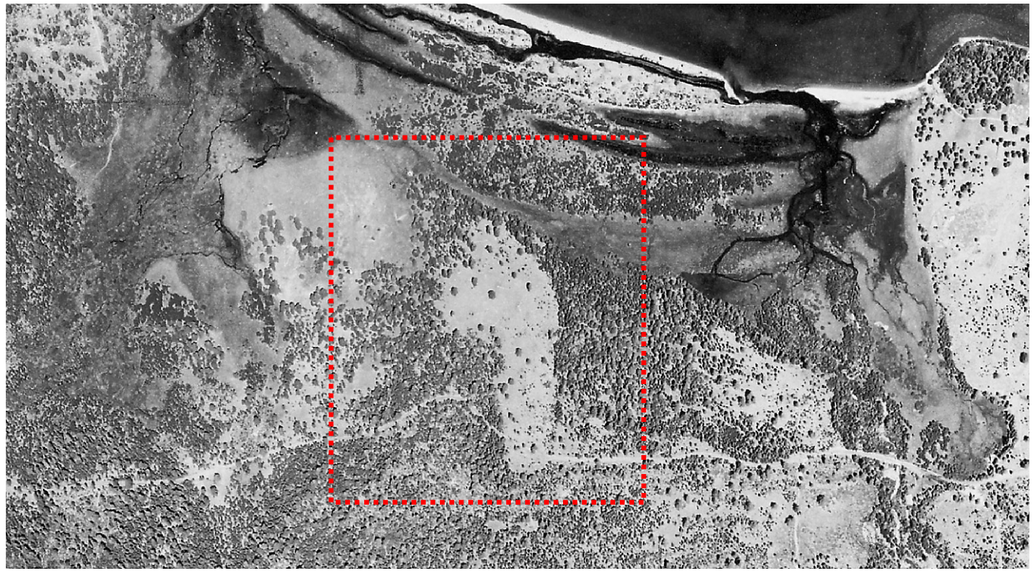
EXHIBIT 4.2-15

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

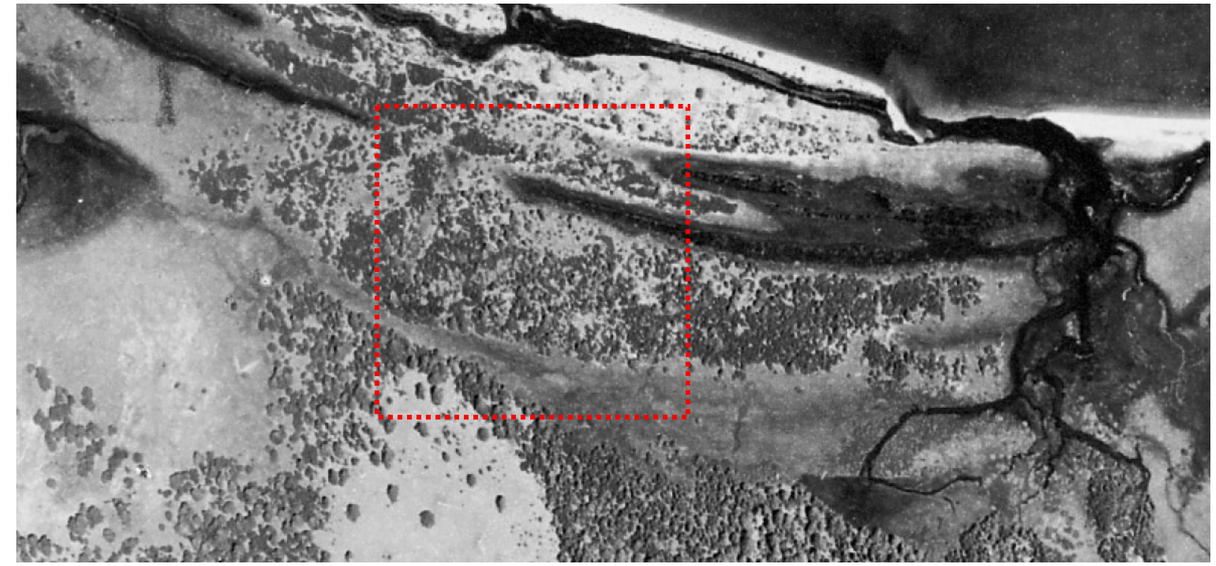
0 265 530
FEET

NORTH

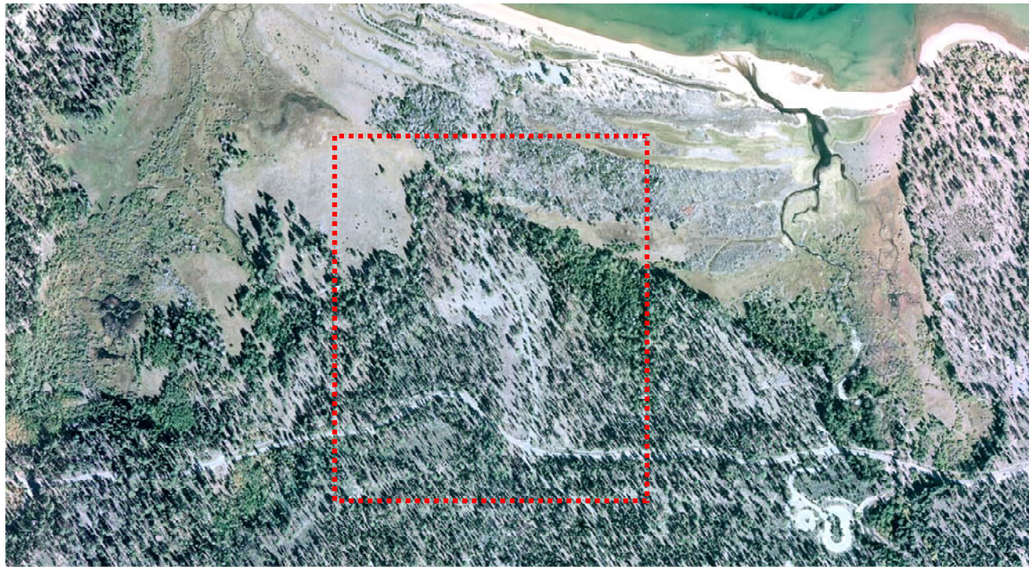
EDAW



(a) Jeffrey Pine 7/13/40

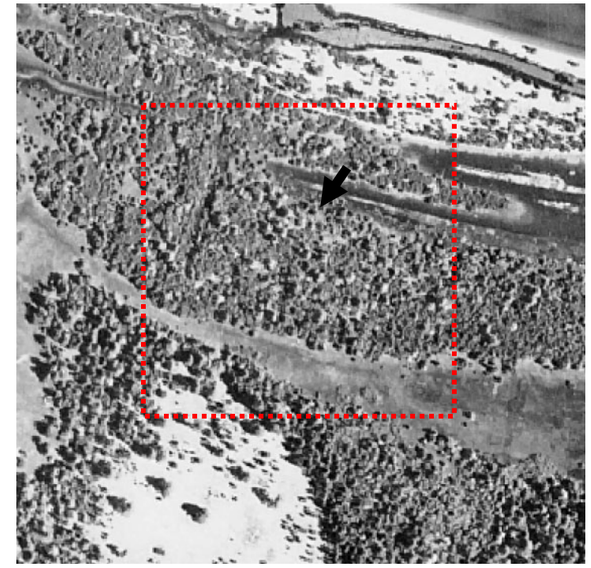


(c) Lodgepole Pine 7/13/40



(b) Jeffrey Pine 2003

0 530 1060
FEET



(d) Lodgepole Pine 8/14/52

(e) Lodgepole Pine 8/24/76

0 265 530
FEET

Source: US Forest Service, EDAW 2004

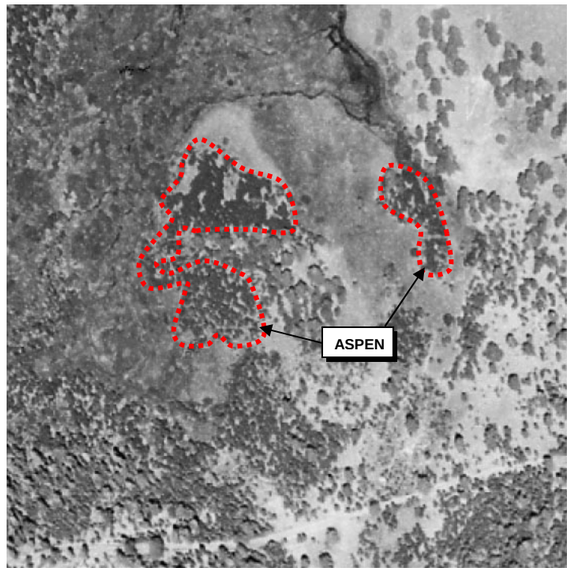
Jeffrey Pine and Lodgepole Pine

EXHIBIT 4.2-16

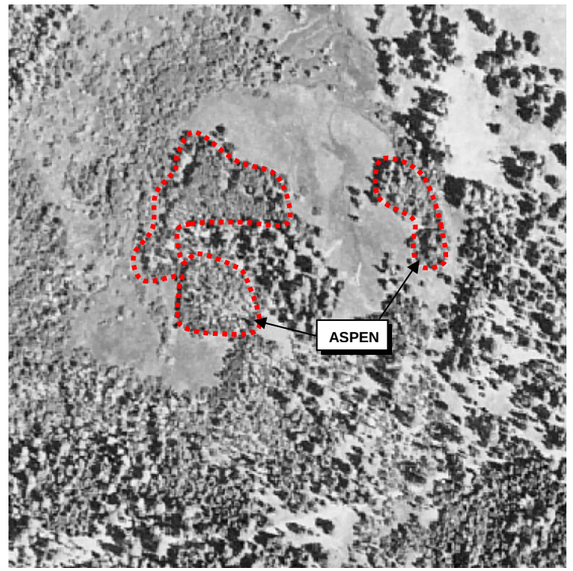
Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

NORTH

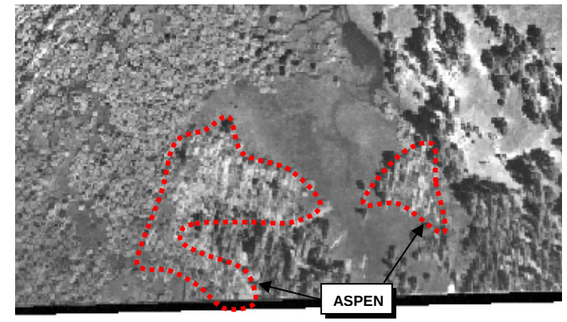
EDAW



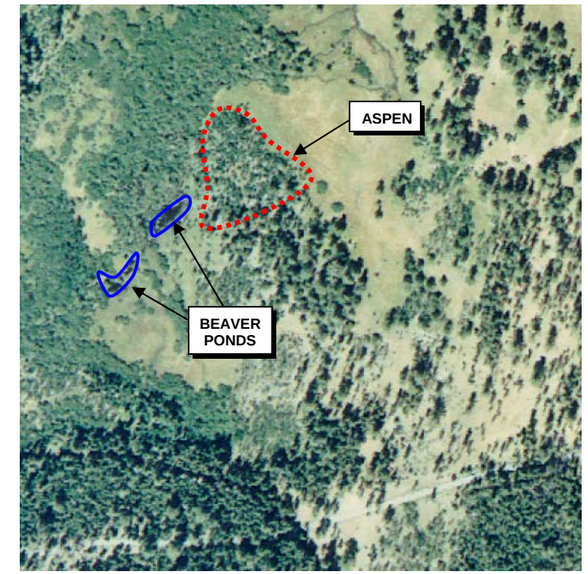
7/13/40



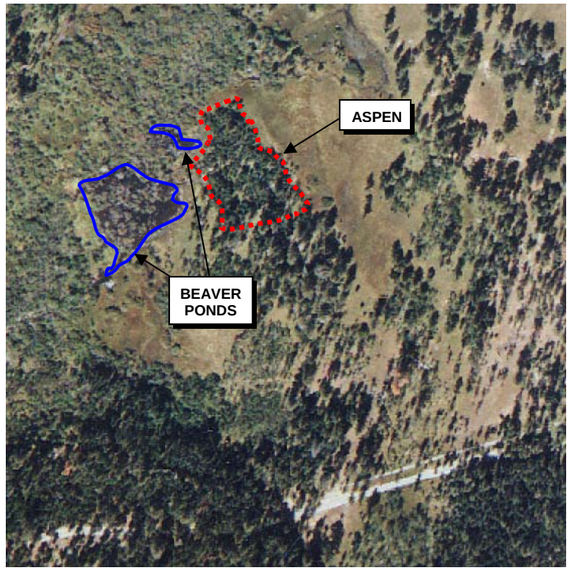
8/14/52



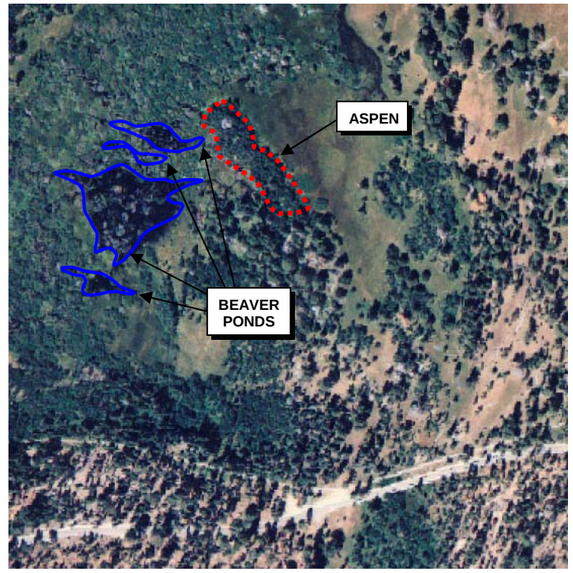
5/2/67



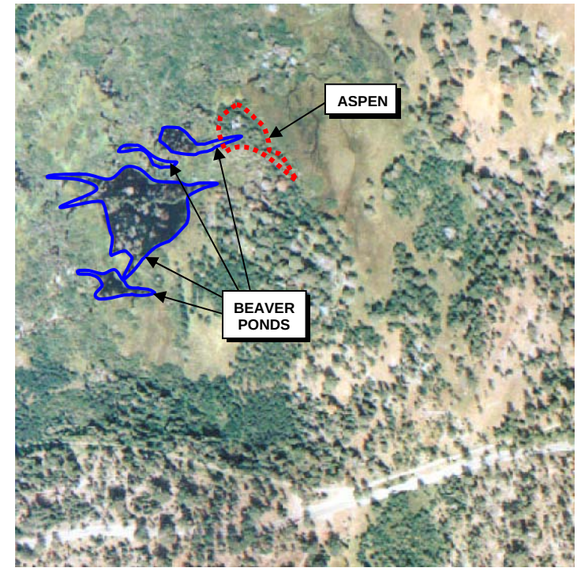
8/24/76



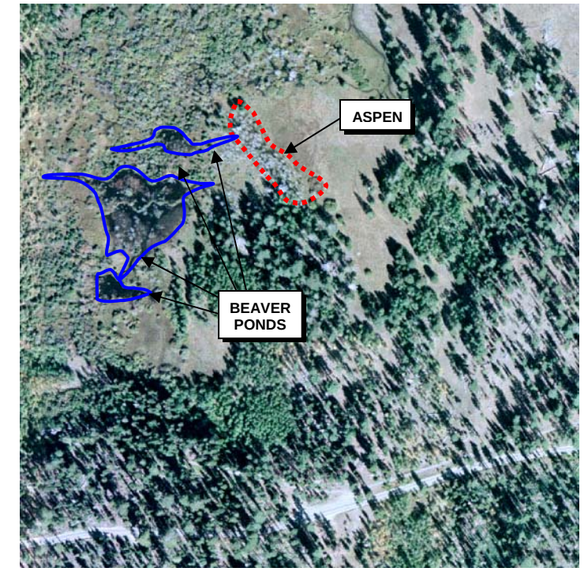
9/10/83



8/19/95



8/14/97



8/10/03

Source: US Forest Service; NA Mapping 2003; EDAW 2004

Aspen and Beaver

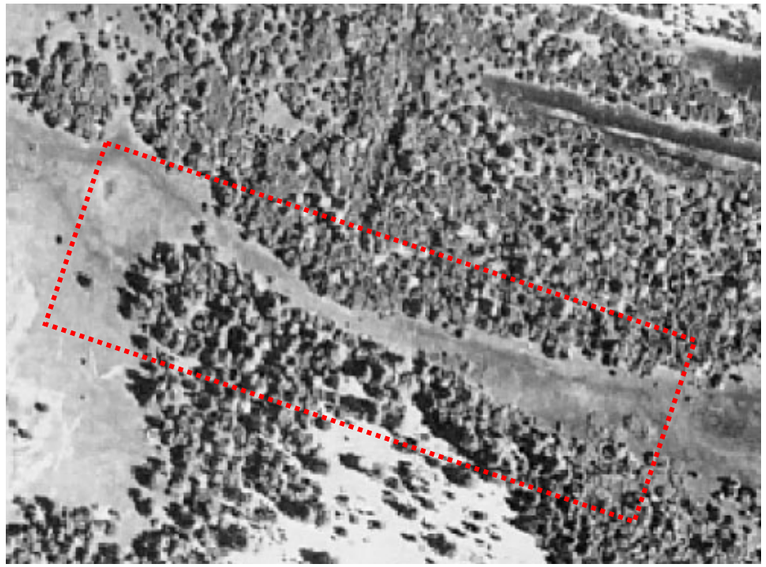
EXHIBIT 4.2-17

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

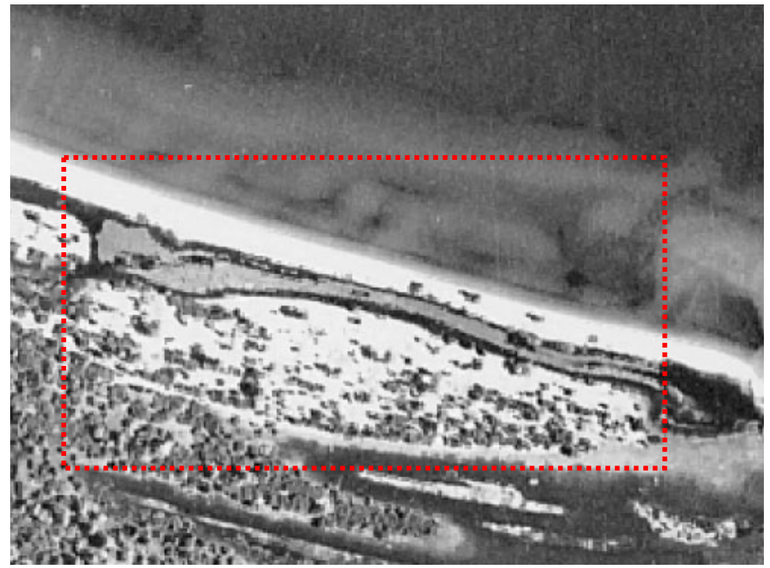
0 265 530
FEET

NORTH

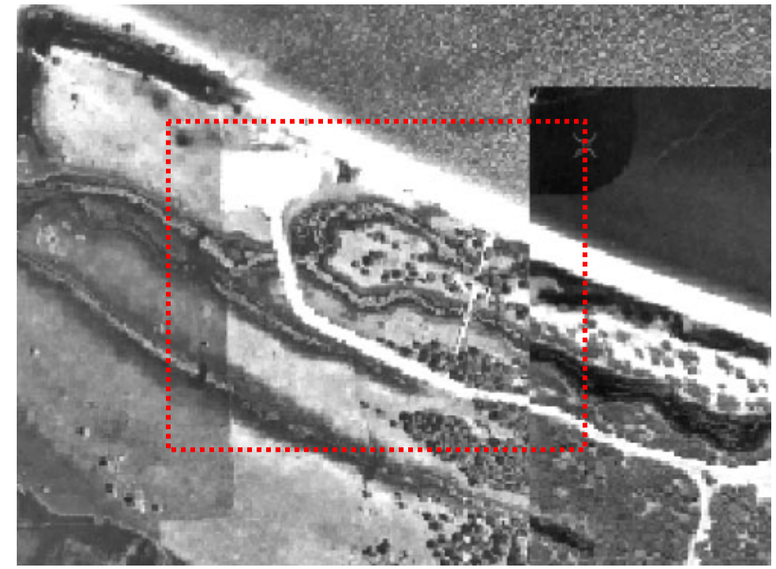
EDAW



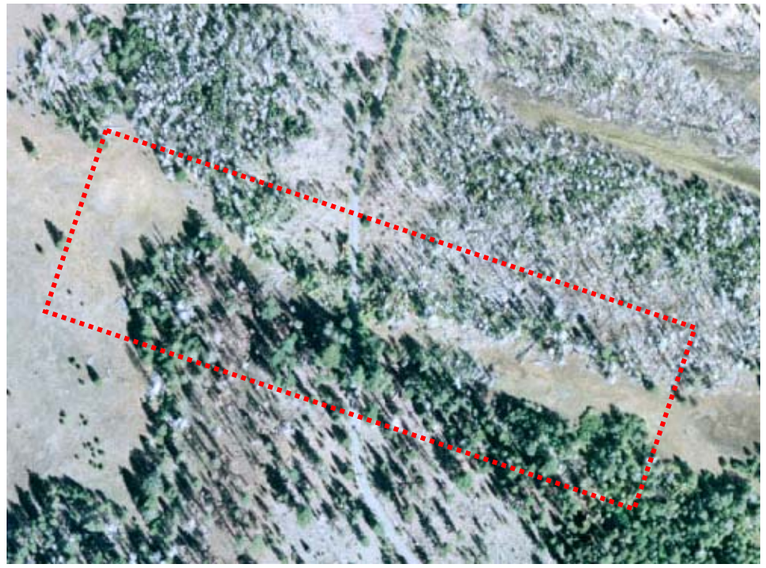
(a) Meadow swale 8/14/52



(c) Near shore wet swale 8/14/52

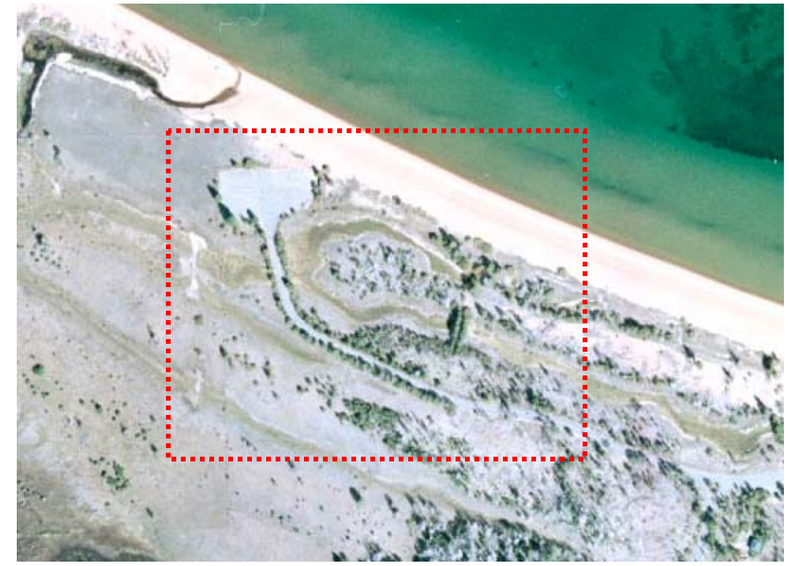


(e) Path across meadow 5/2/67



(b) Meadow swale 9/10/03

(d) Near shore wet swale 9/10/03



(f) Path across meadow 9/10/03

Source: US Forest Service; NA Mapping 2003; EDAW 2004

Wetland System

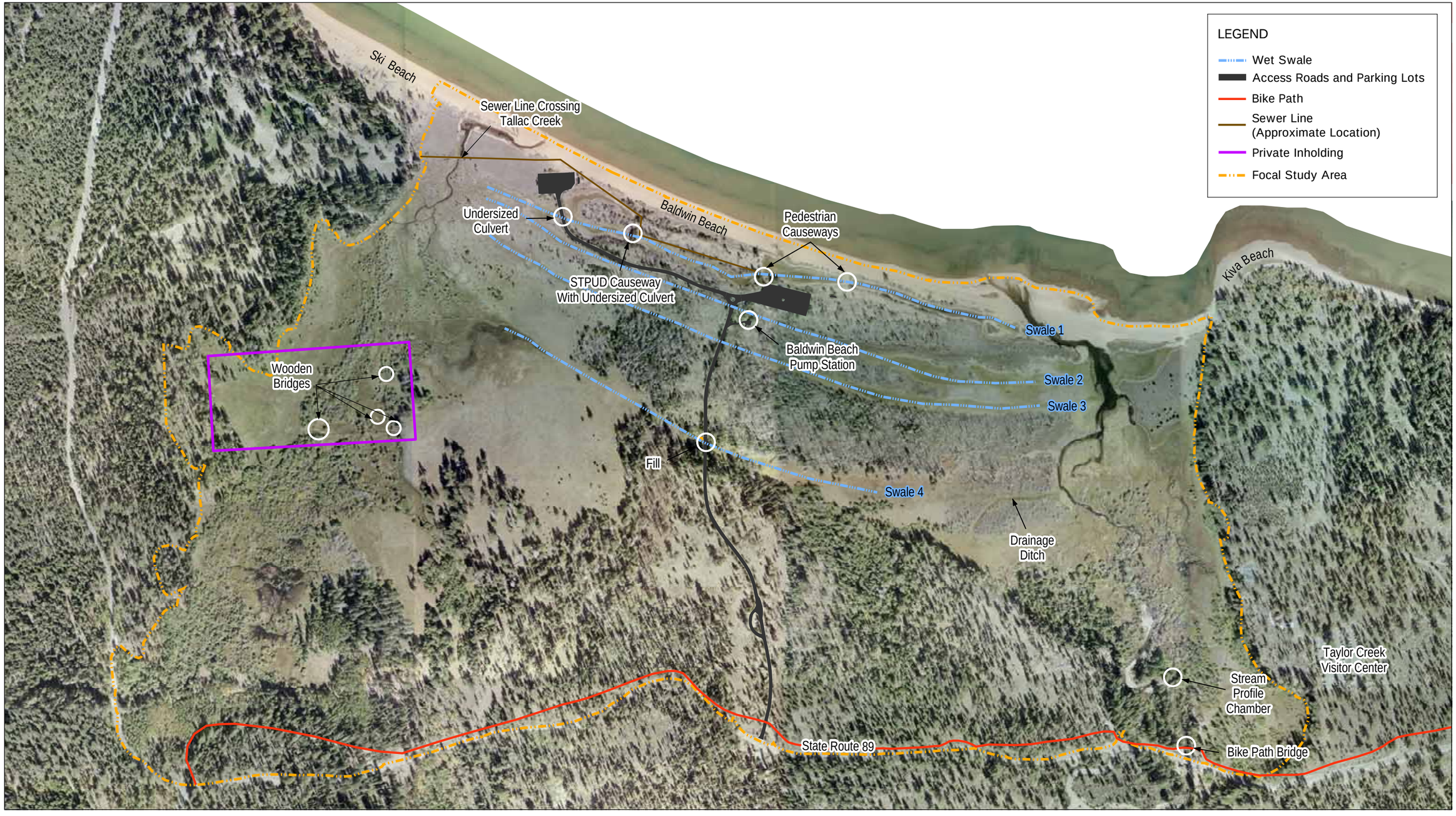
EXHIBIT 4.2-18

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

0 265 530
FEET

NORTH

EDAW



Sources: North American Mapping Company 10/9/03, EDAW 2004

Infrastructure

EXHIBIT 4.3-1

Taylor, Tallac, and Spring Creek Watershed EAR

X 0311058.01 1/26/04

0 500 1000 FEET

NORTH

EDAW

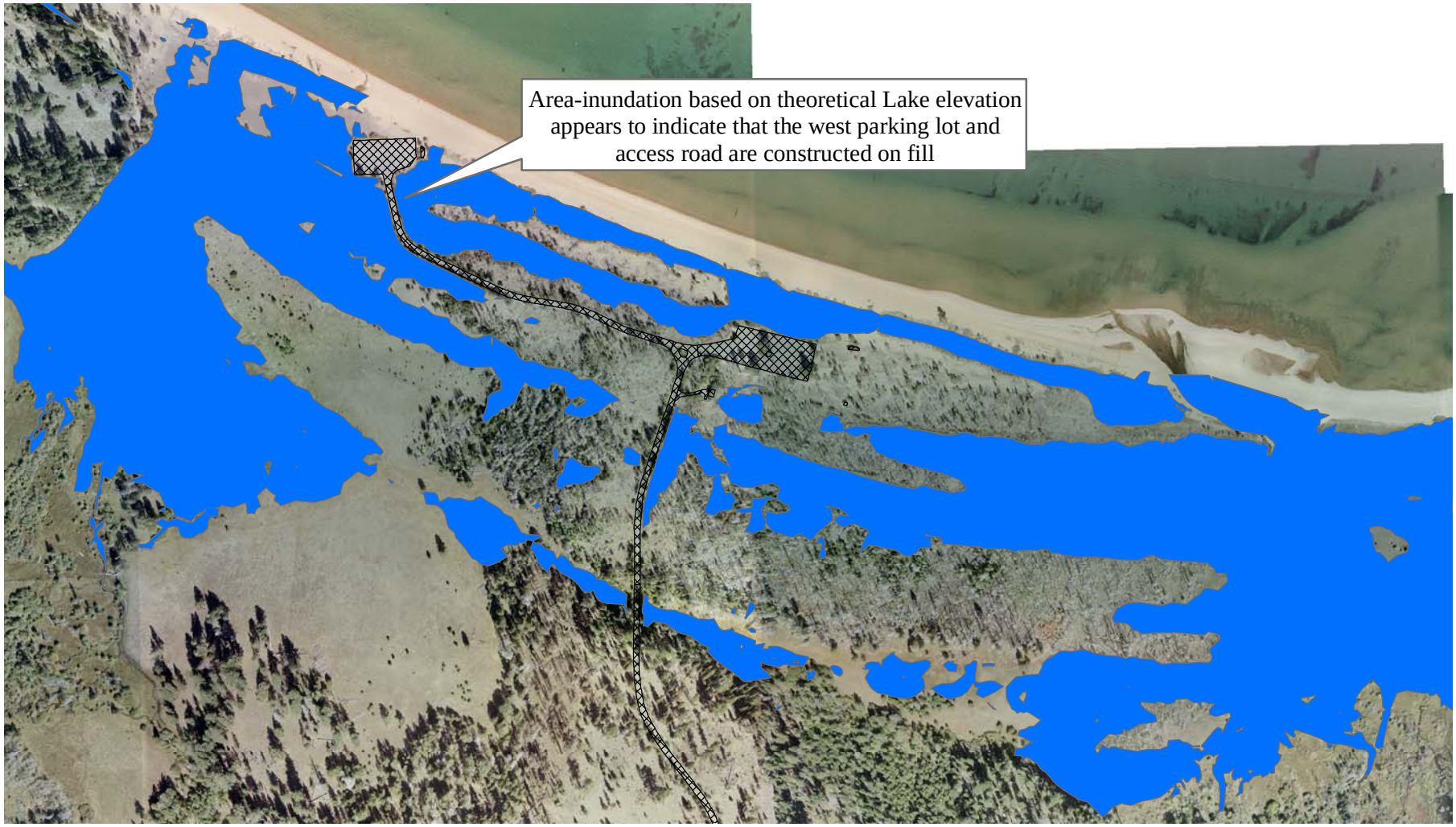
Southernmost wet swale looking west from the Baldwin Beach access road (October 2003).

Southernmost wet swale looking east from the Baldwin Beach access road (October 2003).

Source: EDAW 2004, USFS 2004

Tree and Shrub Encroachment of Wet Swale

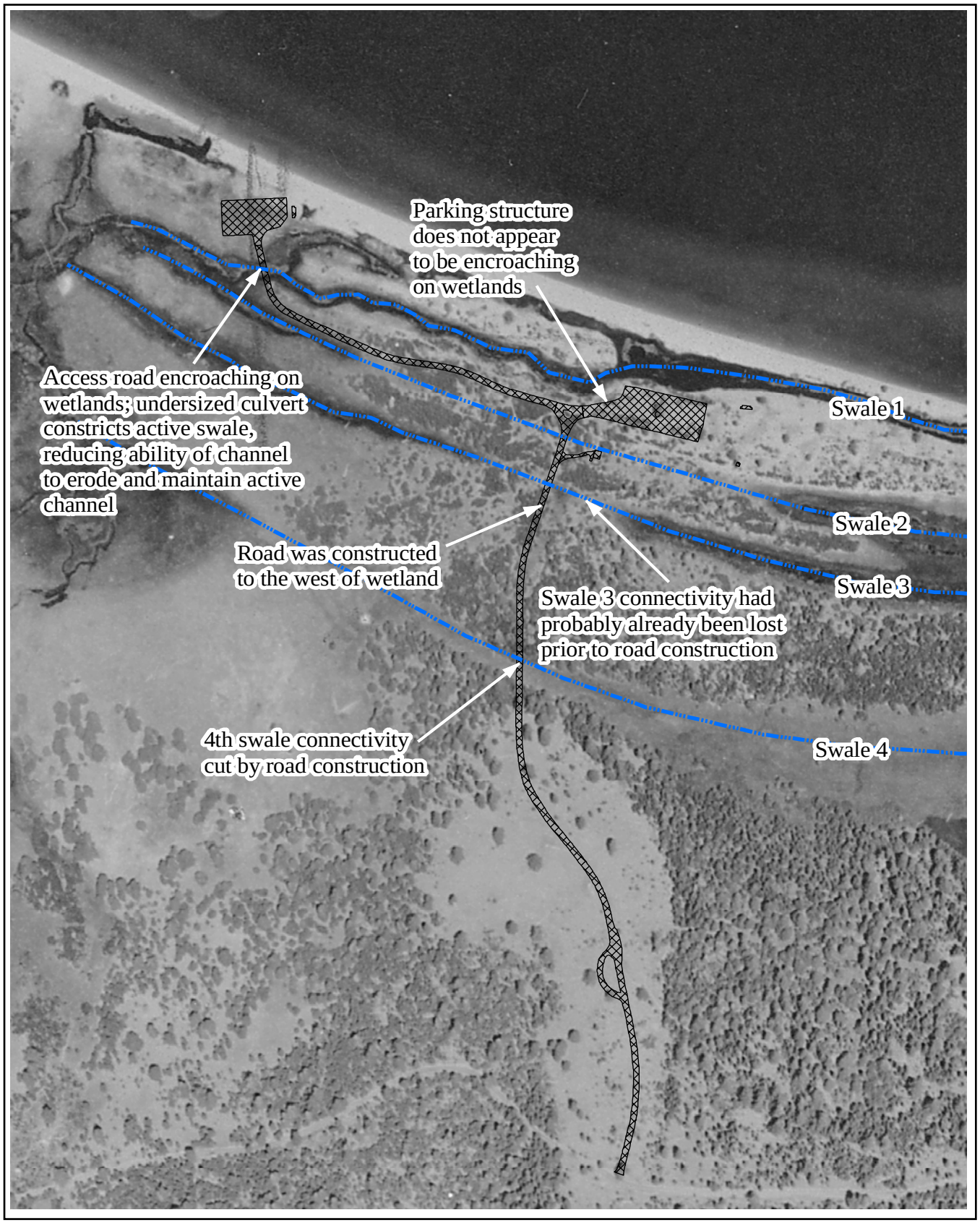
EXHIBIT 4.3-2



Source: PWA

Theoretical Inundation at Legal Maximum Level

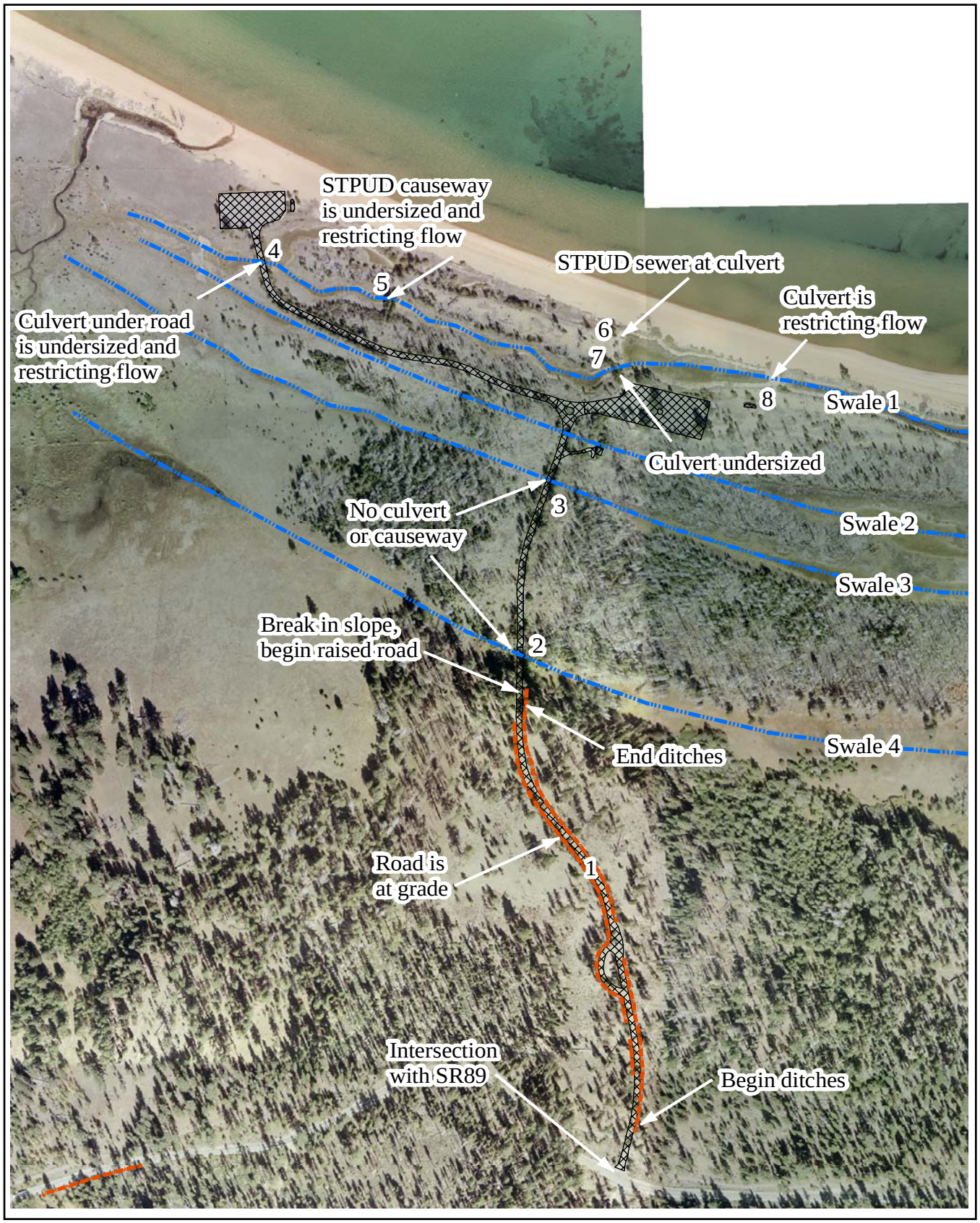
EXHIBIT 4.3-3



Source: PWA

Exhibit 4.3-4

Existing Parking Lots and Roads on 1940 Orthophoto



Source: PWA

Exhibit 4.3-5

Existing Parking Lots and Roads on 2003 Orthophoto

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P ?T???.01 01/04

PWA Philip Williams & Associates Consultants in Hydrology
EDAW

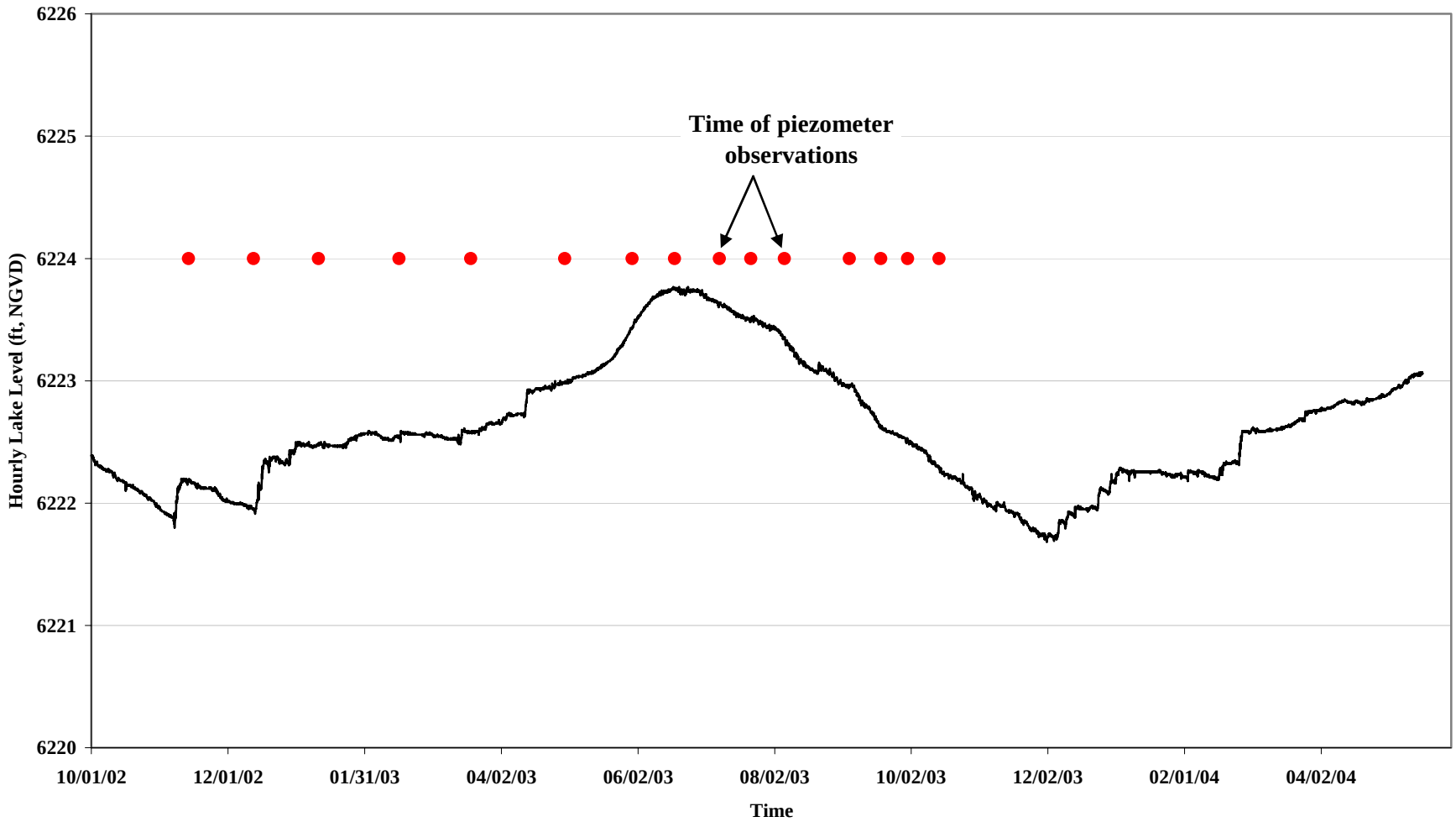
Source: PWA

Exhibit 4.3-6

Piezometer Locations

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P ?T???.01 01/04

PWA Philip Williams & Associates Consultants in Hydrology
EDAW



Time of piezometer observations denoted as red dots

Source: Hourly Lake level from CDEC converted from Lake datum to NGVD; piezometer observations from LTBMU

Piezometer Observations in Relation to Lake Level

EXHIBIT 4.3-7

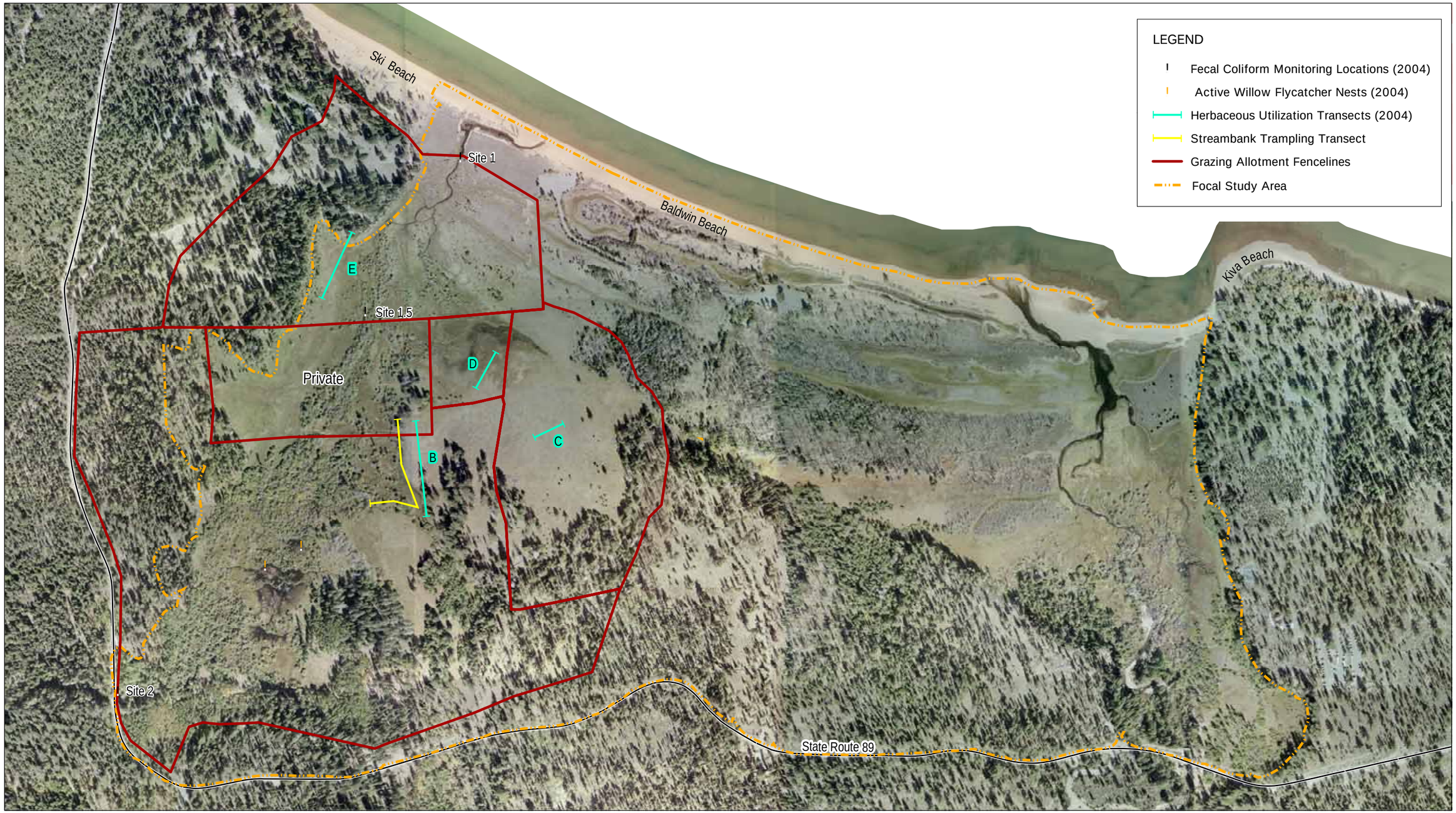
Source: PWA

Piezometer Locations

Exhibit 4.3-8

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P ?T???.01 01/04

PWA Philip Williams & Associates Consultants in Hydrology
EDAW



Sources: North American Mapping Company 10/9/03, EDAW 2004

Baldwin Grazing Allotment

EXHIBIT 4.4-1

Taylor, Tallac, and Spring Creek Watershed EAR

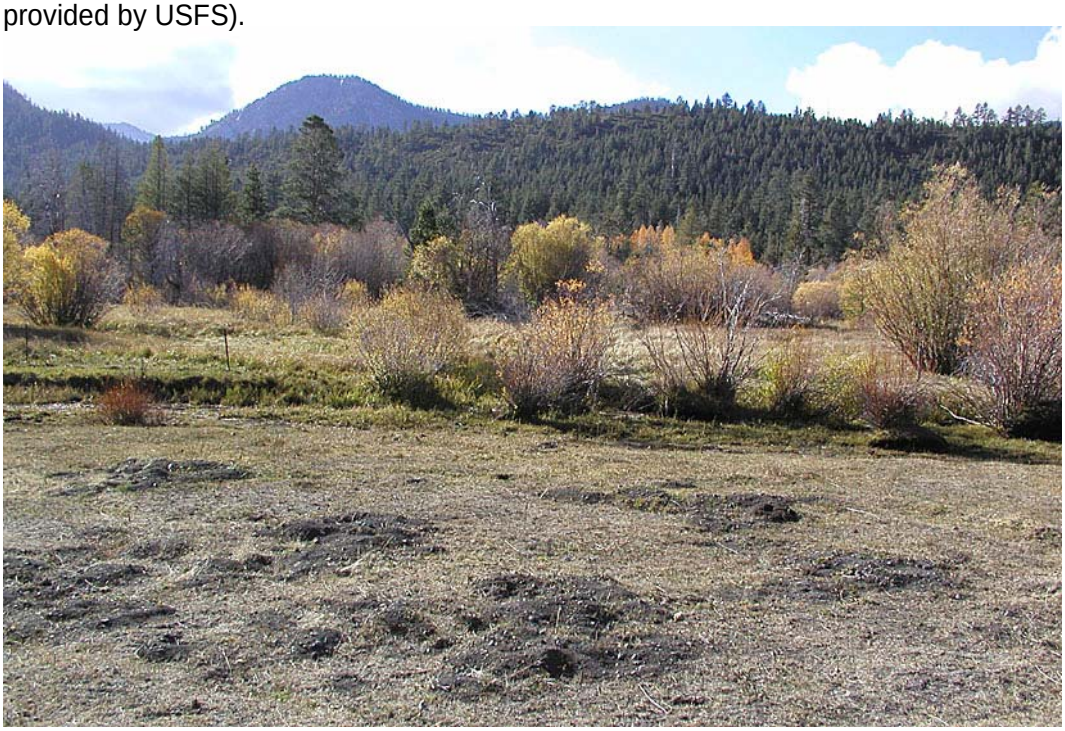
X 0311058.01 1/26/04

0 500 1000
FEET

NORTH

EDAW

Ungrazed area in background has lush herbaceous growth and greater willow establishment compared to grazed area in foreground (2003 monitoring photo provided by USFS).



Vegetation establishment and growth appears to be limited in grazed area in foreground (2003 monitoring photo provided by USFS).

Source: EDAW 2004, USFS 2004

Differences in Vegetation between Grazed and Ungrazed Meadow

EXHIBIT 4.4-2

Drier meadow in May 2004, note dominance of buttercup (yellow flowered plant) (provided by USFS).

Drier meadow in fall, note lack of vegetative cover (2002 monitoring photo provided by USFS).

Source: EDAW 2004, USFS 2004

Grazing Impacts in Drier Meadow

EXHIBIT 4.4-3

Network of trails in grazed aspen stand (October 2003).

Water flowing along trail, photo taken in May 2004 (provided by USFS).

Source: EDAW 2004, USFS 2004

Volunteer Trail Development

EXHIBIT 4.4-4

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 05/04

EDAW

Streambank trampling along Tallac Creek channel (2003 monitoring photo provided by USFS).

Soil disturbance along Tallac Creek channel (2003 monitoring photo provided by USFS).

Source: EDAW 2004, USFS 2004

Streambank Trampling and Soil Disturbance

EXHIBIT 4.4-5