

# Restoration Plan for Sand Creek, Great Sand Dunes National Park, Colorado



By:

David J. Cooper, Ph.D. and Jeremy Shaw, M.S.  
Department of Forest, Rangeland and Watershed Stewardship  
Colorado State University, Fort Collins, CO 80523

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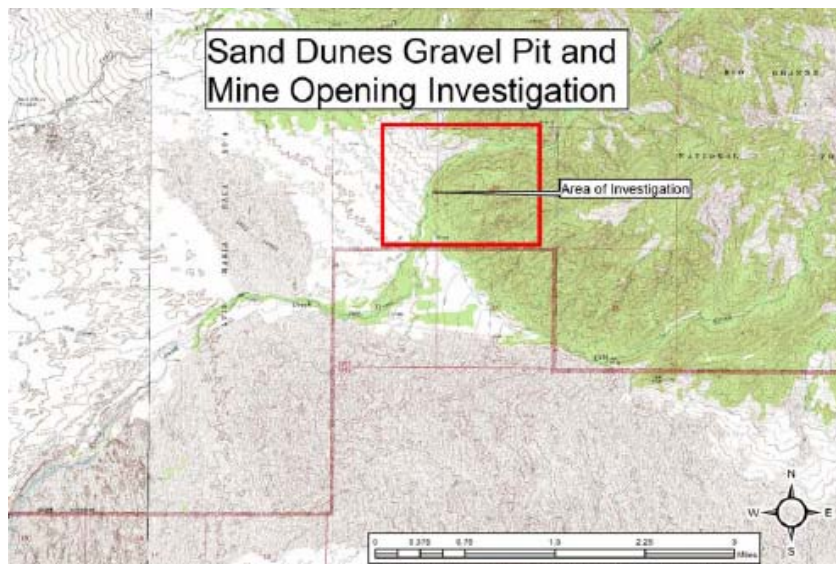
## Introduction

Thirteen man-made pits occur along Sand Creek, on the western flank of the Sangre de Cristo Mountains, in Great Sand Dunes National Park, Colorado (Figure 1). The land currently is owned by the United States and managed by the National Park Service, but prior to the year 2000 when Great Sand Dunes National Monument became Great Sand Dunes National Park and expanded in size, the land was in private ownership. The pits were created prior to the year 2000 by the previous landowner (Figure 2). An unknown quantity of sediment from the local Sand Creek floodplain and terraces was excavated and used for road construction and road maintenance in the area. The remaining material was reshaped to form ponds surrounded by dikes and levees to support recreational fishing. Some dikes are relatively small, 3-6 ft high, while a few are substantial, and up to 18 ft high (Graves 2008).

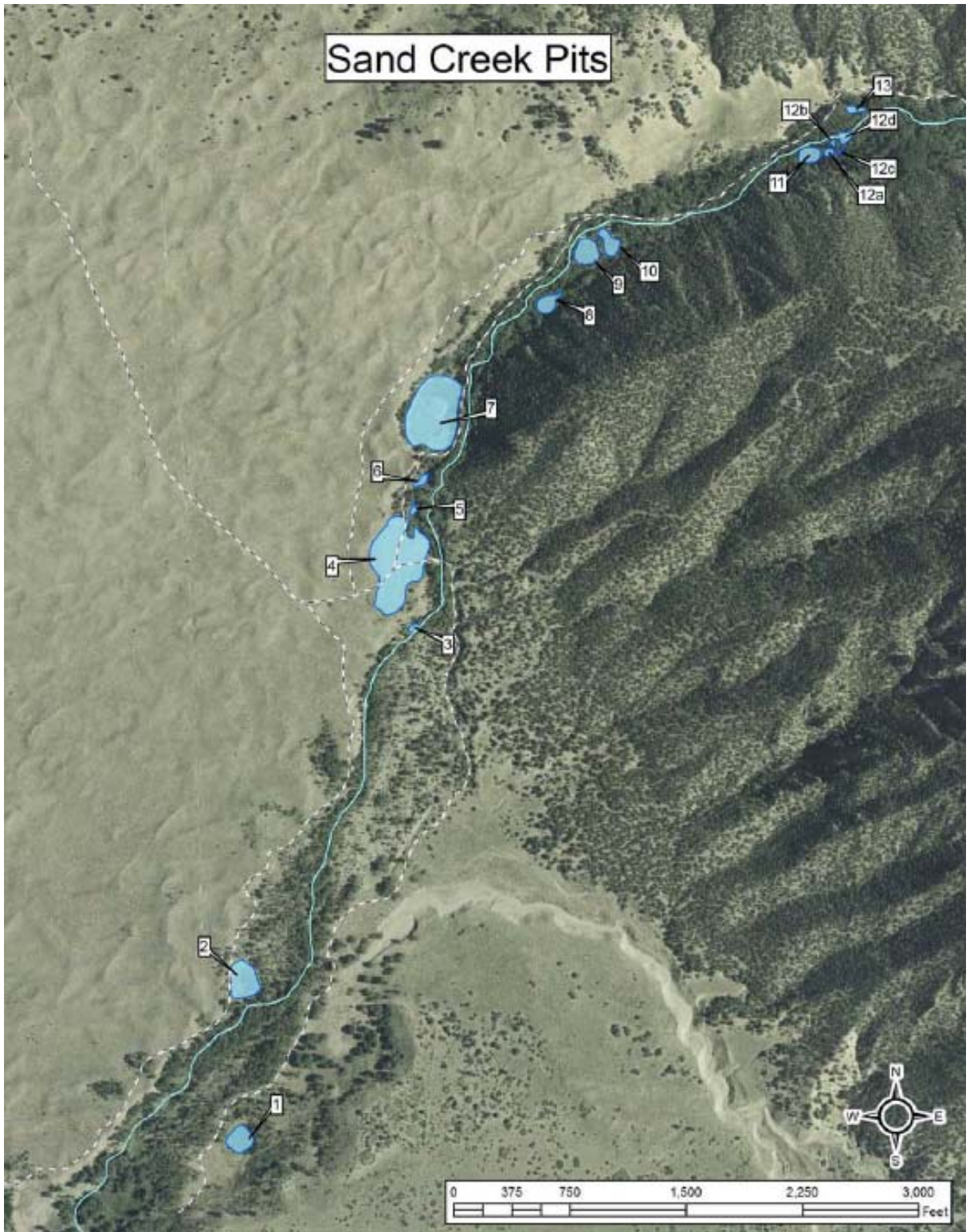
The proposed project has two goals. First, NPS wishes to remove the artificial pits, dikes and levees, fill man-made channels, and restore the natural floodplain landforms, hydrologic regime and vegetation. Second, the NPS wishes to restore native cutthroat trout to the Sand Creek watershed, and to do so, must eradicate whirling disease from the creek. Whirling disease is an exotic disease spread by a parasite (*Myxobolus cerebralis*) that has a two-host lifecycle involving trout and an alternate host, commonly a bottom-dwelling (benthic) tubifex worm. When an infected trout dies, large numbers of hard spores are released. The spores are hardy, resist freezing and drought and can remain viable for decades. After release from the host fish, they can be ingested by the tubifex worm. The worms are then parasitized by the organism, with the end result being a delicate, water-borne spore. When released from the worm, water-borne spores can infect susceptible fish by attaching to their bodies, by eating infected worms. Most native trout species have little or no natural resistance to whirling disease, having only recently been exposed to the parasite. Young fish are at greatest risk because the parasite attacks their soft cartilage, causing nerve damage, skeletal deformities and in some cases death. Once a fish

reaches three to four inches in length, cartilage forms into bone and the fish is much less susceptible to effects from whirling disease. However, they remain carriers of the parasite. To eliminate the host tubifex worms in their habitat along Sand Creek, the ponds and wetlands with standing water created by the recreational fishing ponds must be removed. This stagnant pond habitat type never existed naturally along the high gradient, rocky, and dynamic Sand Creek corridor. Thus, the removal of these standing water habitats is essential to both goals of the NPS. The Sand Creek channel was apparently not moved or manipulated by the pit construction project, and no changes to the channel are proposed.

This document provides a complete restoration plan that details the current and proposed grades for all 13 pits, as well as a revegetation plan. A detailed topographic survey was conducted to determine the size and volume of dikes and depressions, and was used to develop both a sediment volume calculation and restoration plan. This area has been analyzed previously by Graves et al. (2008 with the Colorado Division of Reclamation, Mining and Safety under contract to the National Park Service), and we retain their pit numbering (Figure 2).



**Figure 1.** Location of Sand Creek study area located north of the dune field, and just south of the abandoned town-site of Liberty.



**Figure 2.** Location of 13 pits identified and discussed in this report. Dotted lines are roads or trails.

## Methods and Approach

A detailed topographic survey was conducted in the fall of 2009, including all pits and the surrounding landscape. The land surface shape was used to identify areas where sediment was pushed from the floodplain to create pits, levees, dikes, and other features, including stream water diversion channels. We were not able to excavate holes into the areas of sediment to verify their exact thickness, and therefore the sediment volumes presented are approximate. It is possible that sediment was deposited into existing depressions or onto hills, and the volume of sediment could be slightly greater or lesser than the volumes presented. However the volumes of fill in the identified landforms, and the volume of each pit, are balanced and we feel that the existing survey accurately identifies the volumes to be moved into each pit.

The topographic survey included the undisturbed floodplain and hillslopes surrounding each pit. These natural grades were used as a baseline for proposing future grades for the restoration project so that the restored and natural areas blend seamlessly. This restoration plan proposes to move all sediment from the fill piles back into the pits. The proposed grades are based on recreating natural floodplain contours that slope from upstream (East) to downstream (West), and generally are perpendicular to Sand Creek, to allow natural flood dynamics and connections between Sand Creek and its floodplain to be restored.

In this plan, we present the existing and proposed grades, and fill volumes for the 13 pits proposed for restoration. We then present an overall revegetation plan, including cottonwood pole plantings and seeding for all areas where sediment would be moved from or to, and bare sediment exposed.

## Results

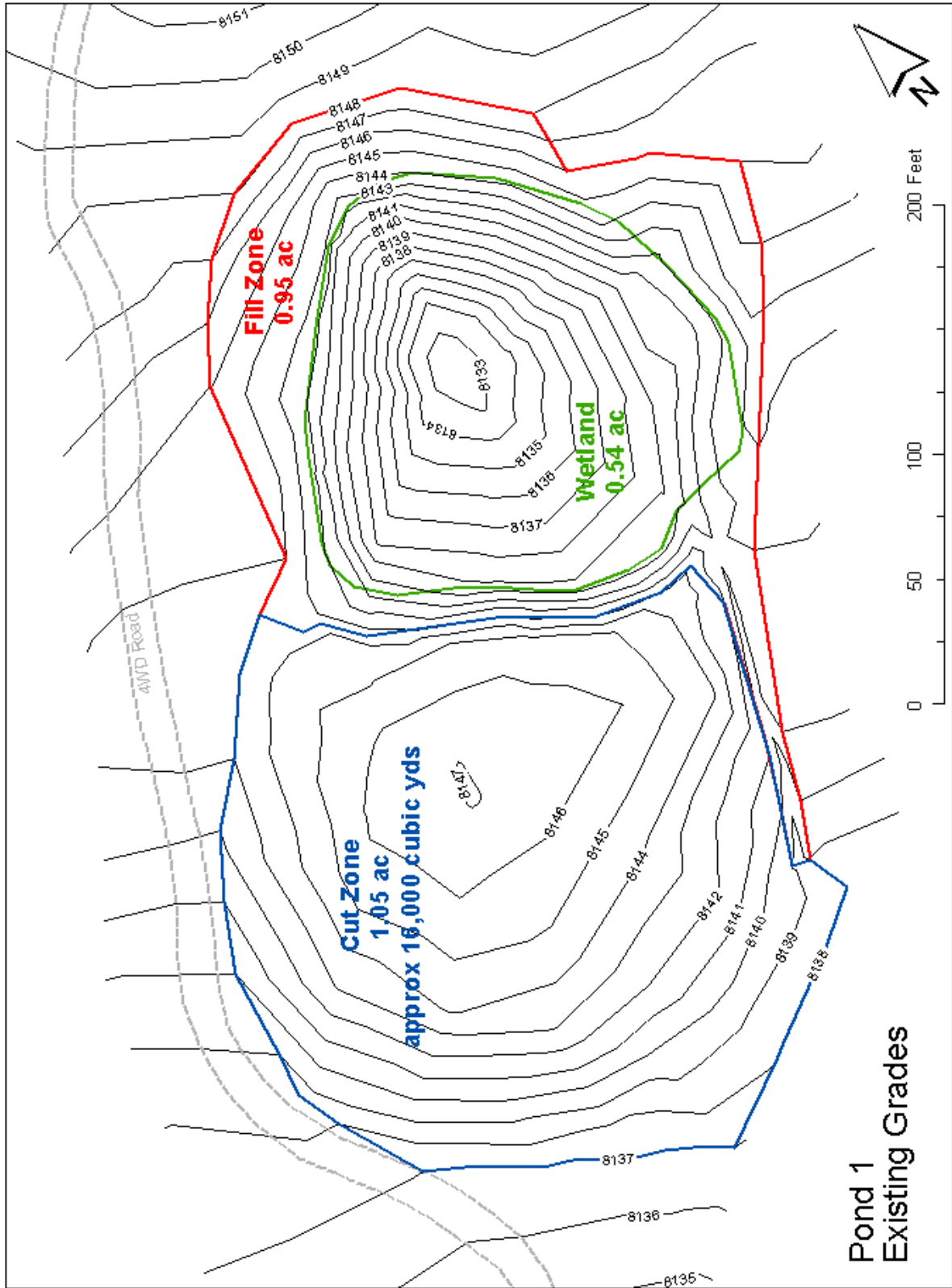
A total of 94,380 cubic yards of sediment should be moved from levees, dikes and other fill piles into the 13 pits to recreate the natural landscape contours. The largest volume of sediment to be moved, 39,460, cubic yards, is associated with Pit 7, where large levees, a dike and an island were created. Pit 4, which was never finished to hold water, is a large disturbed area and requires the movement of 17,500 cubic yards for restoration. Pit 1 requires the movement of 16,000 cubic yards. The other pit restoration efforts require the movement of smaller amounts of sediment. The total area of pit that should receive sediment is 8.68 acres, most of which is associated with pits 7 and 4.

**Table 1. Total area (acres) of cut and fill for each pit area, and total volume to be moved.**

<b>Pond</b>	<b>Cut Area (acres)</b>	<b>Cut Volume yd<sup>3</sup></b>	<b>Fill Area (acres)</b>
1	1.05	16,000	0.95
2	0.76	7,400	0.58
4	1.76	17,500	1.80
5, 6	0.62	5,250	0.38
7	1.24	39,460	3.09
8	0.20	2,000	0.32
9,10	0.54	3,430	0.99
11, 12a, 12d	0.21	2,140	0.39
13	0.11	1,200	0.18
<b>TOTAL</b>	<b>6.49</b>	<b>94,380</b>	<b>8.68</b>

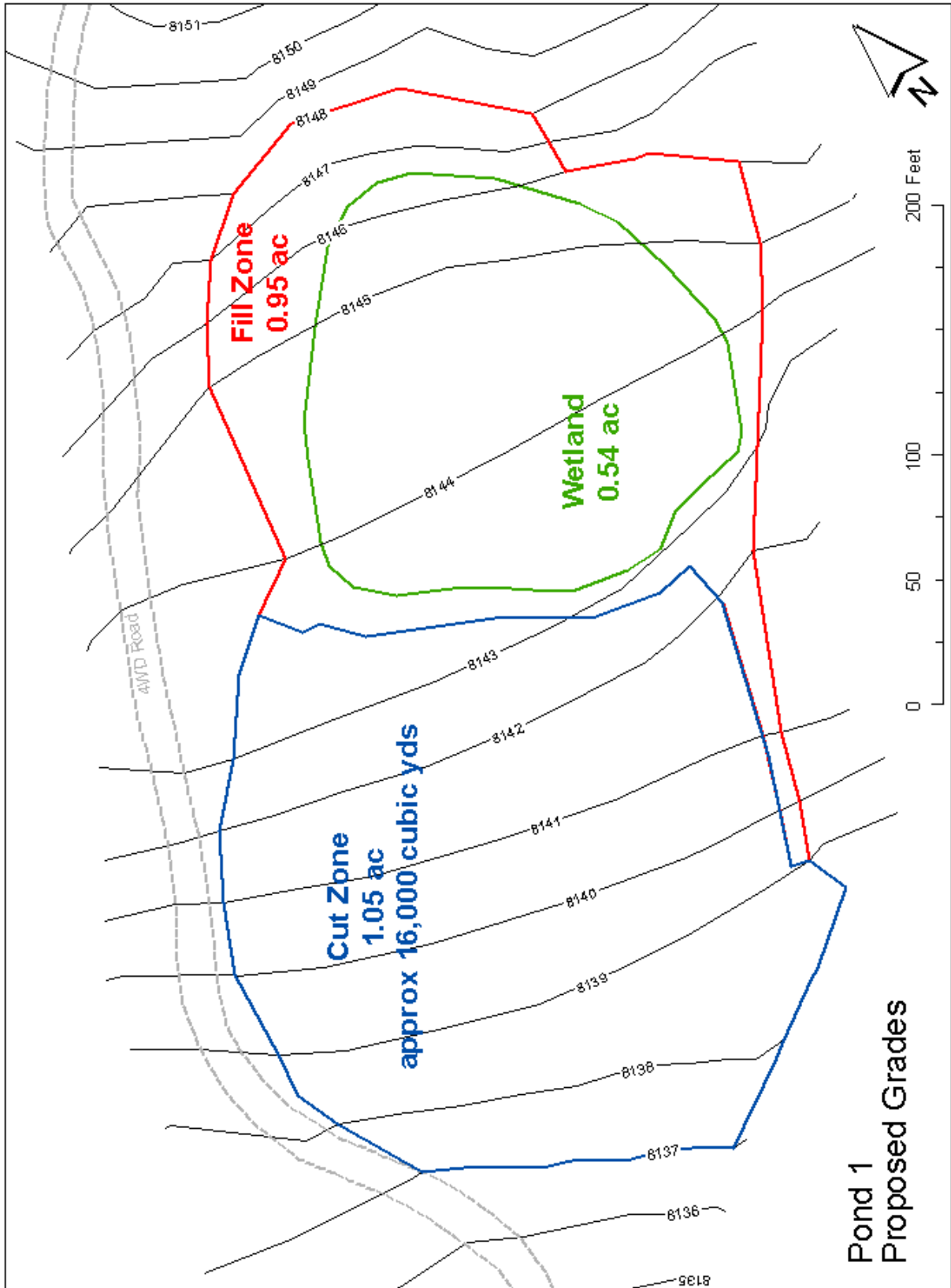
**Pit 1:** This restoration requires the movement of 16,000 cubic yards of sediment from 1.05 acres into a pit area of 0.95 acre. The elevation of the upper wetland boundary currently averages 8,142 feet, and the ground surface of the proposed grade will be approximately 8,144 to 8,145, indicating that a seasonal ground water maximum depth will be 2-3 feet below the ground surface. This water table depth will allow narrowleaf cottonwood pole plantings to be introduced here and should provide conditions suitable for their survival. The area will not have water tables sufficient to support wetlands, and upland grasses will be seeded across this surface. Winter and summer views of this pit are shown below.





Existing topography of Pit 1. The area with fill is shown in blue, the existing jurisdictional wetland in green, and the area to receive fill in red.





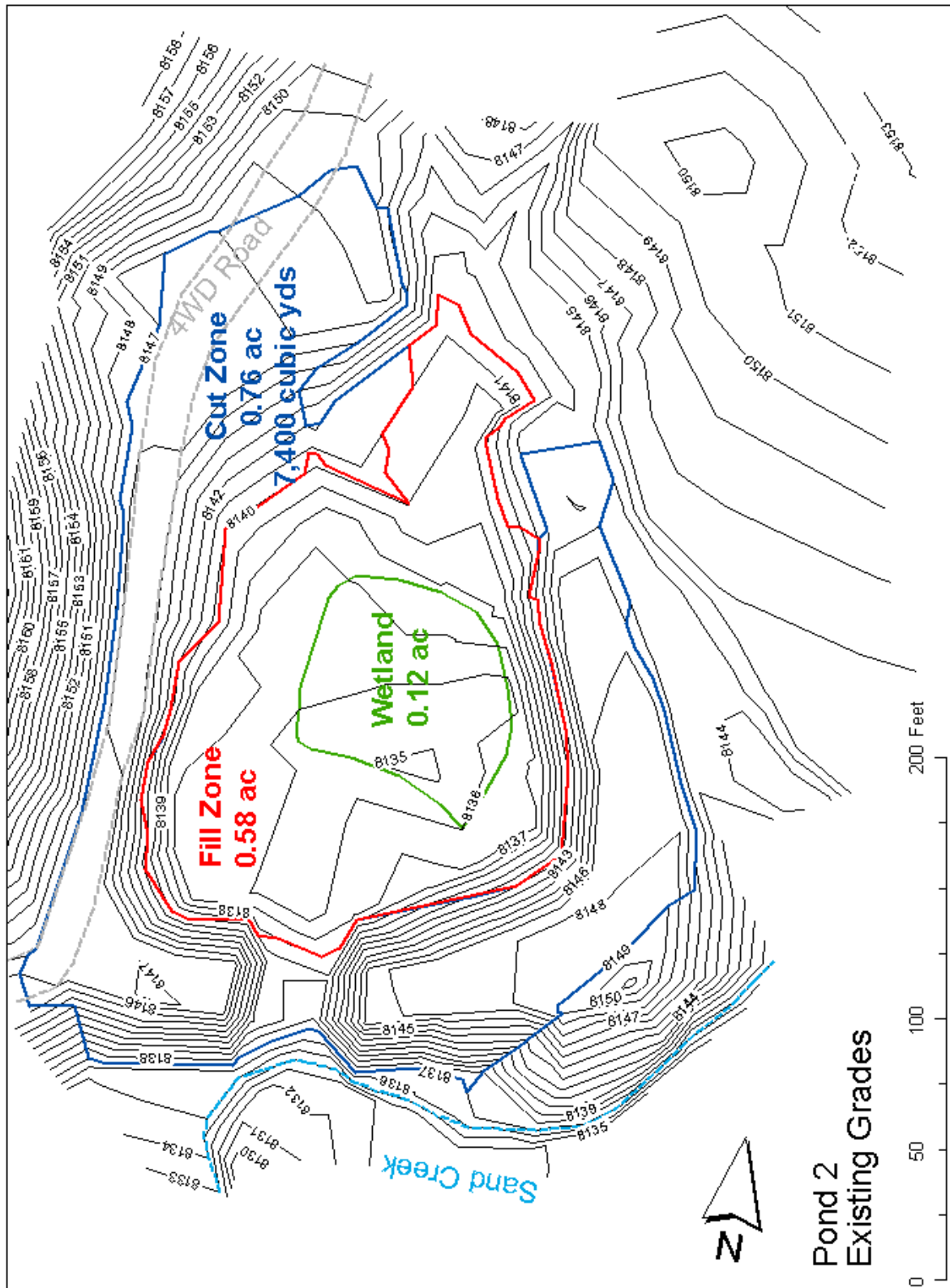
Pit 1 proposed grade. The outlines of the cut, fill and wetland are retained.

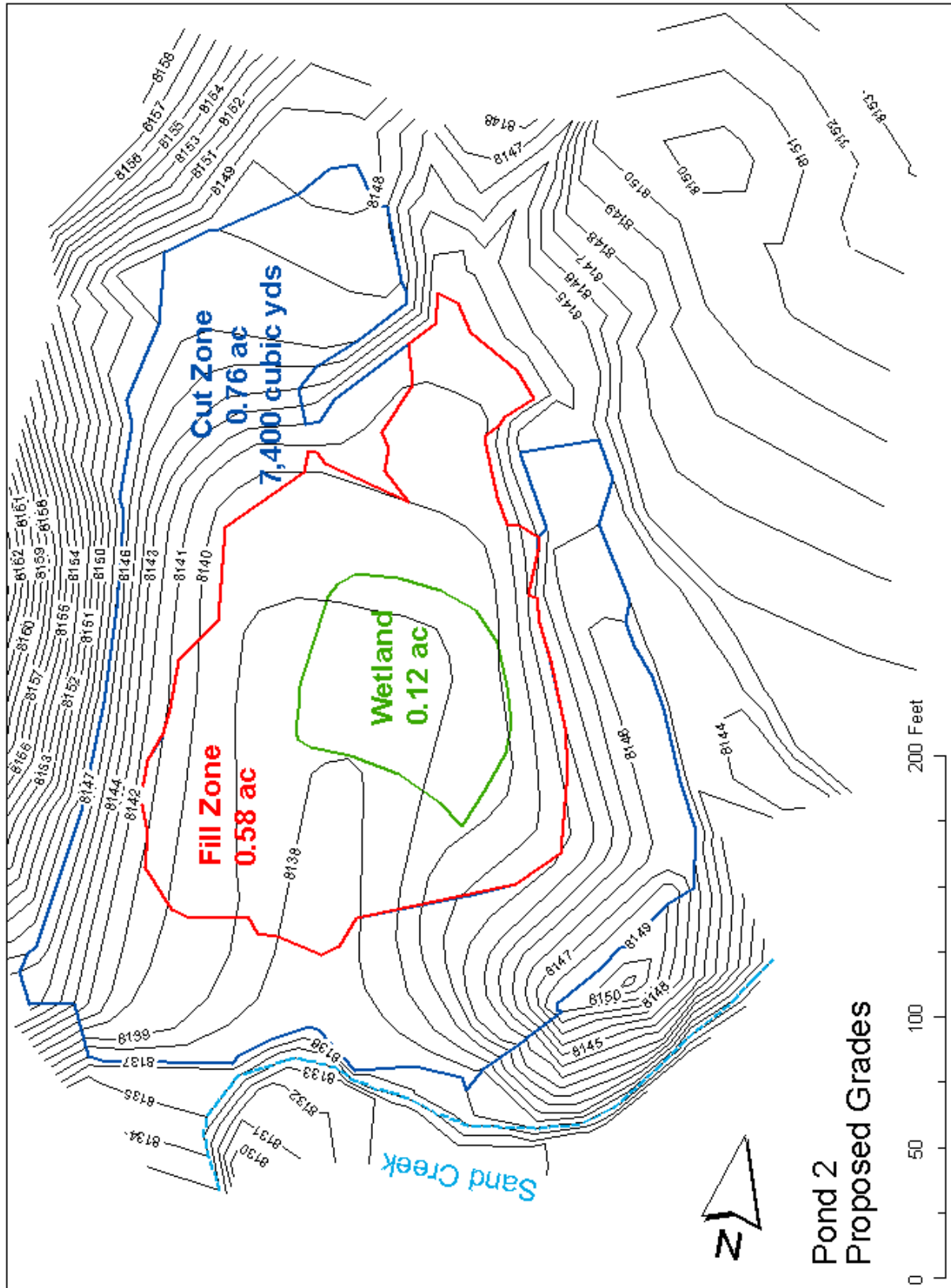
**Pit 2:** This pit has approximately 0.76 acre of dike and levee area, containing 7,400 cubic yards of sediment that should be pushed into the existing pit area of 0.58 acre. This will result in the filling of 0.12 acre of jurisdictional wetland. The large dike on the south side of this pond apparently breached and the pond has held little water. The current wetland upper boundary, indicating the seasonal water table high is at 8,136 feet, and the proposed land surface is 8,138 to 8,140 feet, indicating that the seasonal water table high will be 2-4 feet below the ground surface. This depth is suitable for supporting cottonwood pole plantings, but not wetland plants. The area will be seeded with native upland grasses.



Looking southeast across Pit 2. A small wetland area occurs in the pit bottom, surrounded by levees and dikes of material pushed from the pit.

Existing topography of Pit 2. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.





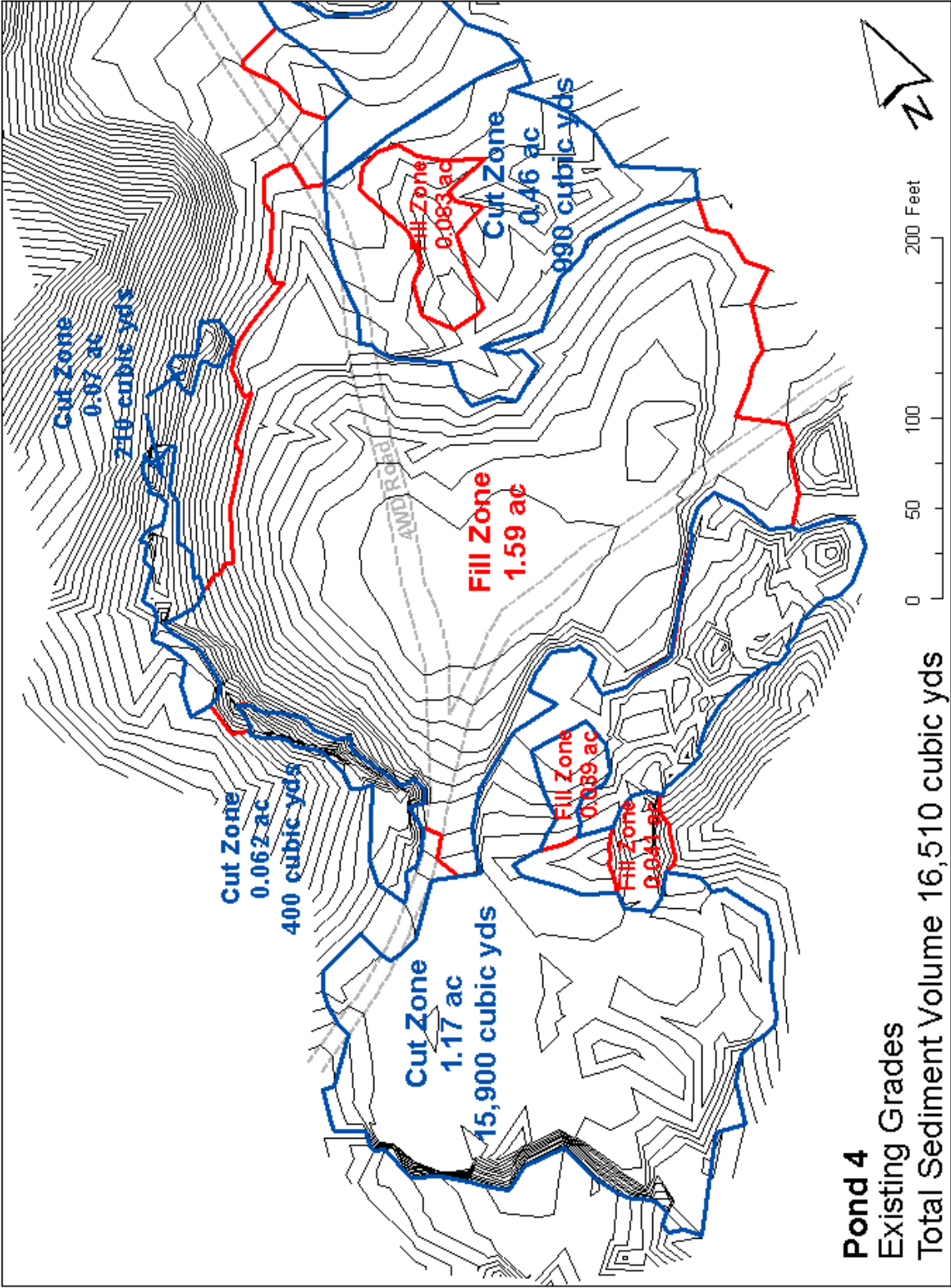
Pit 2 proposed grade. The outlines of the cut, fill and wetland are retained.

**Pit 3:** This is a small depression that apparently never held water. It has very minor disturbance, and detailed grading plans were not developed. The area will require the movement of only tens of cubic yards of sediment movement to restore.

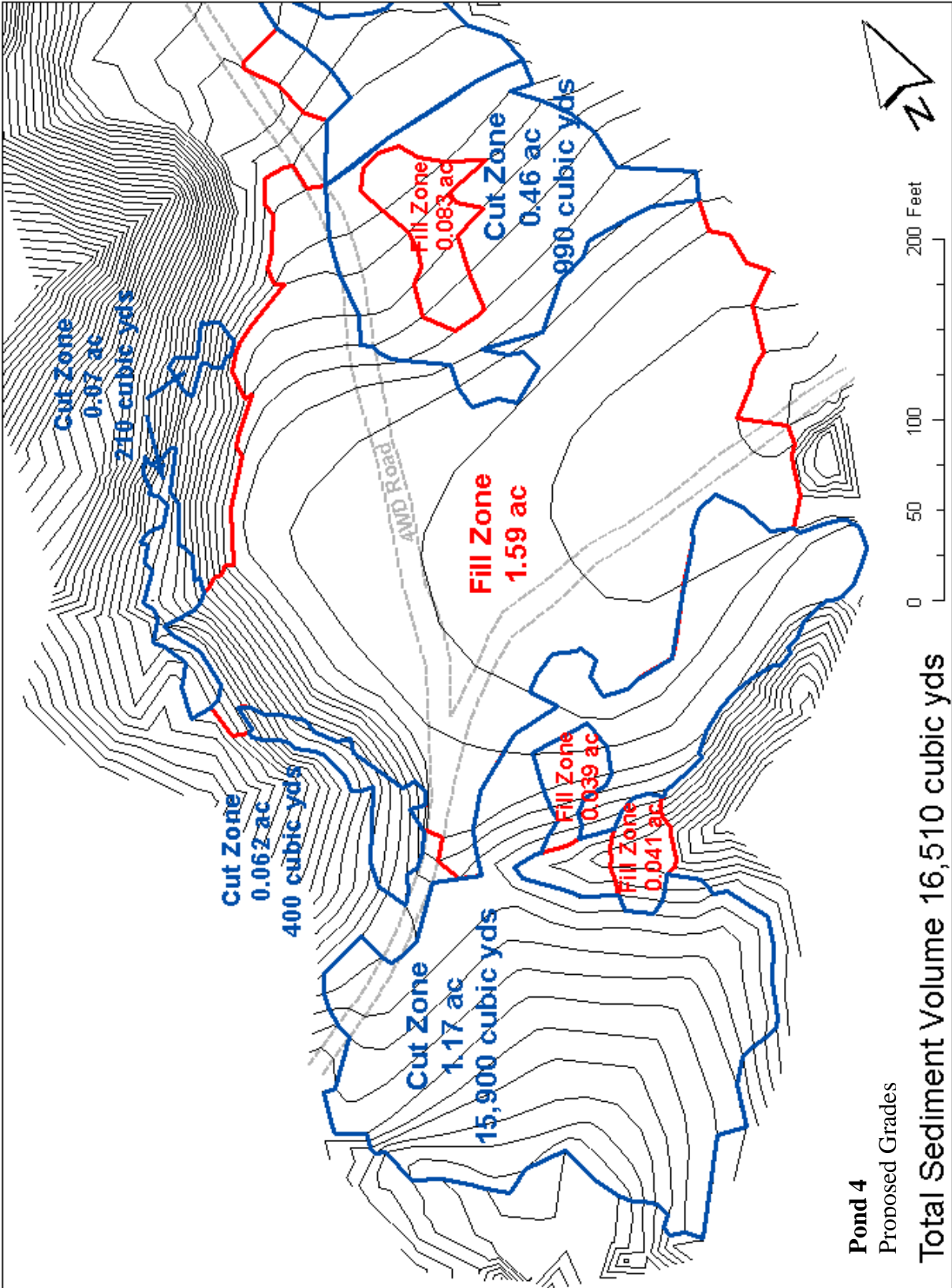


**Pit 4:** This pit, shown below, is a large disturbed area located where the Liberty road reaches Sand Creek. The area was roughly graded, but does not have defined dikes or levees. The entire area will need to be regraded to restore natural contours. Most sediment from this pit was pushed to the south. This sediment as well as sediment from several other fill piles should be used to regrade the area. A total of 17,500 cubic yards of sediment must be moved to restore the natural contours. After regrading the area will have a water table too deep for cottonwood pole plantings, and will be seeded with native upland plants.





Existing topography of Pit 4. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



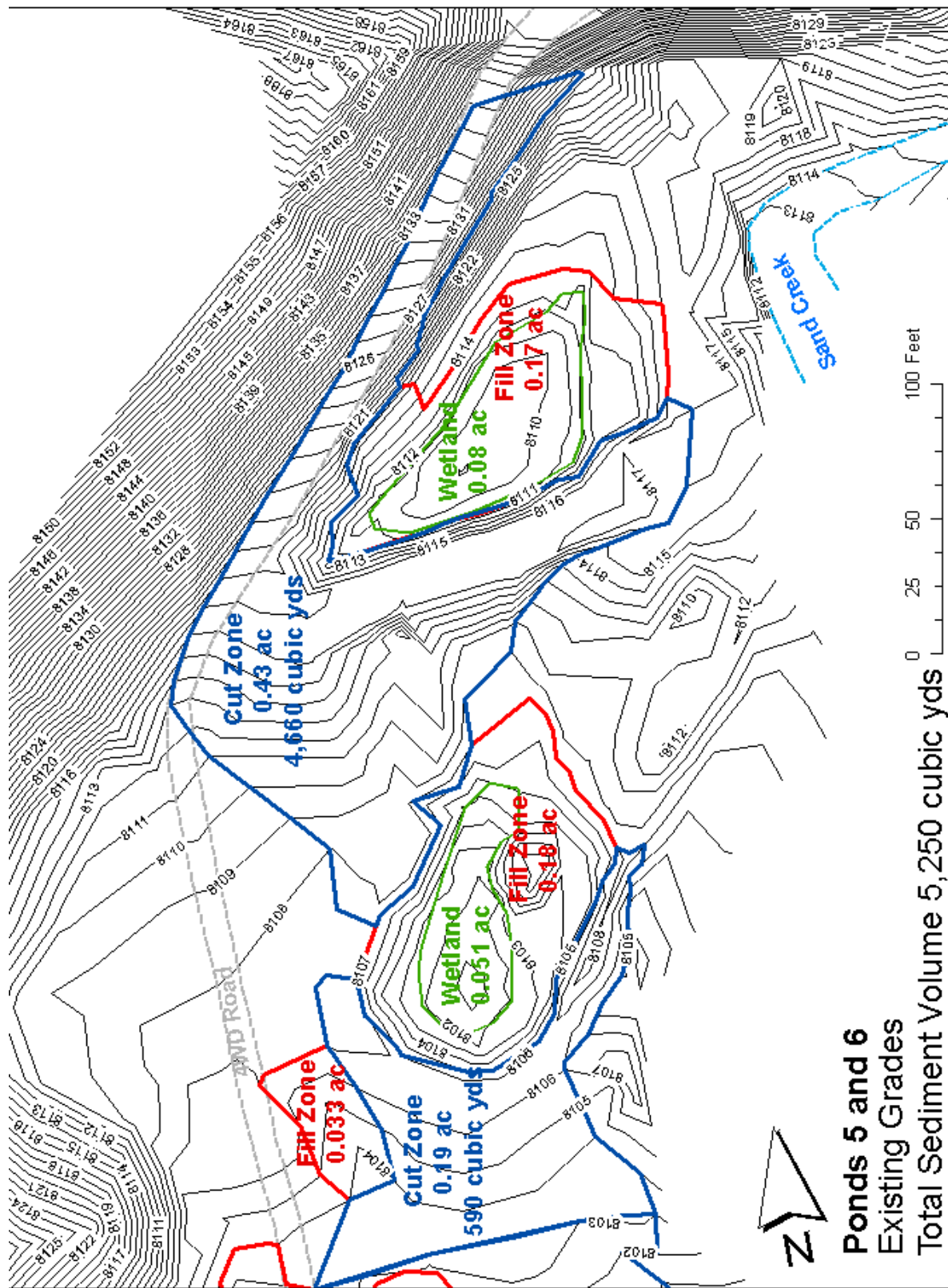
Pit 4 proposed grade. The outlines of the cut, fill and wetland are retained.



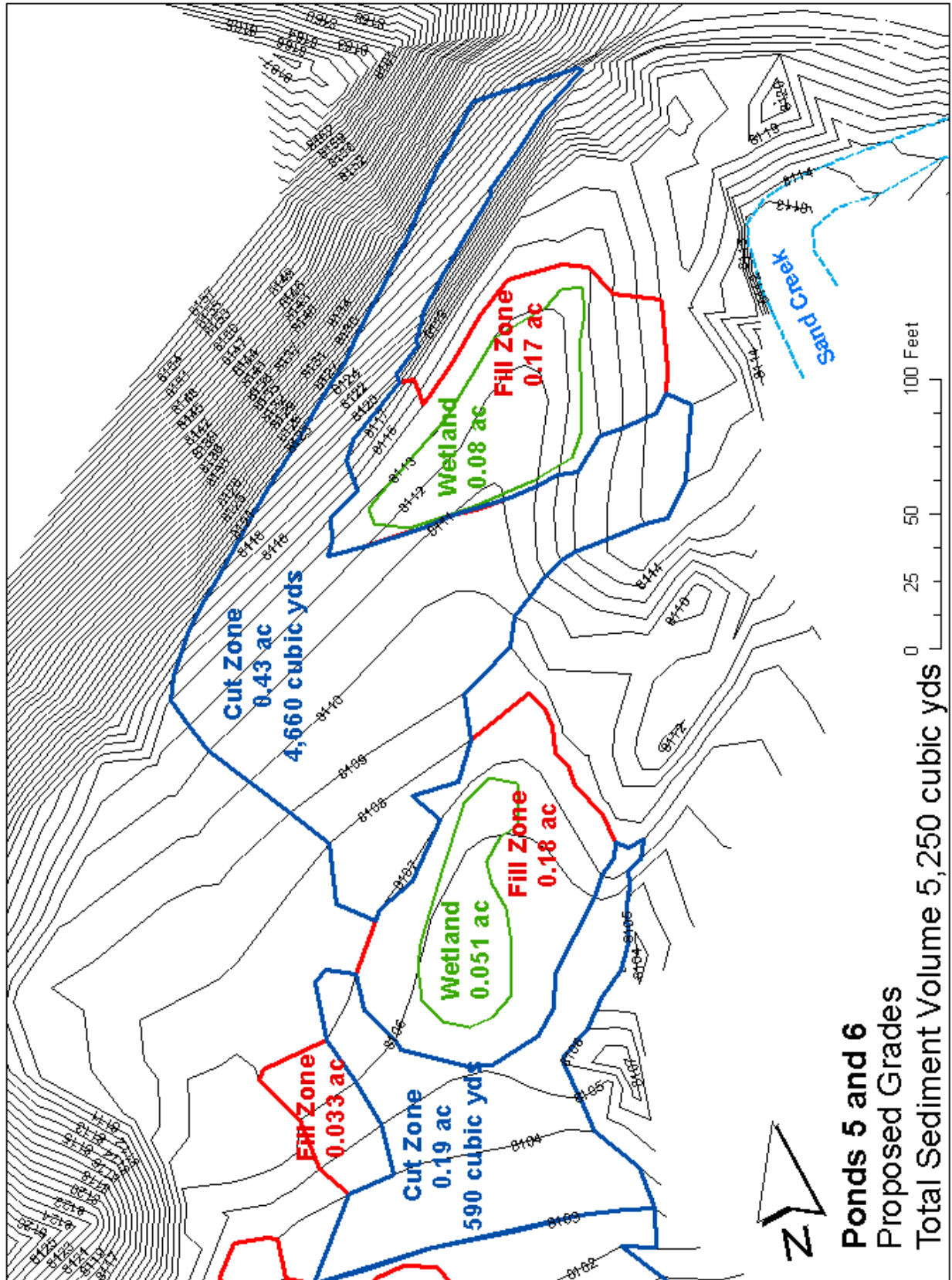
**Pit 5:** Pit 5 is a small pond area. Fill surrounds the pond on 0.19 acre, and the pond area of 0.213 acre should be filled, requiring a volume of 590 yd<sup>3</sup>. The current pit water table high supporting wetlands is at 8,102 to 8,103 feet elevation. The filled surface will be at 8,107, and will likely have a water table depth of 4-5 feet. This may support cottonwood pole plantings, and the area will be seeded with native upland plants.



Summer photo of Pit 5.



Existing topography of Pits 5 (left) and 6 (right). The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



Pits 5 and 6 proposed grade. The outlines of the cut, fill and wetland are retained.

**Pit 6:** This pit has fill material surrounding a small pond, particularly on the south and west sides. A total of 4,660 yd<sup>3</sup> of fill must be moved from 0.43 acres to fill the 0.17 acre pond. The current pond supports wetlands up to an elevation of 8,112-8,113 feet. The filled ground surface will have an elevation ranging from 8,111 to 8,114, and would be suitable for cottonwood pole plantings. There may be a small area with a water table within 1 foot of the ground surface that could support wetlands. However, the area should be seeded with native upland plants.



Summer photos of Pit 6 showing small perennial pool with emergent vegetation, and dry gravel slopes within the pit boundary.

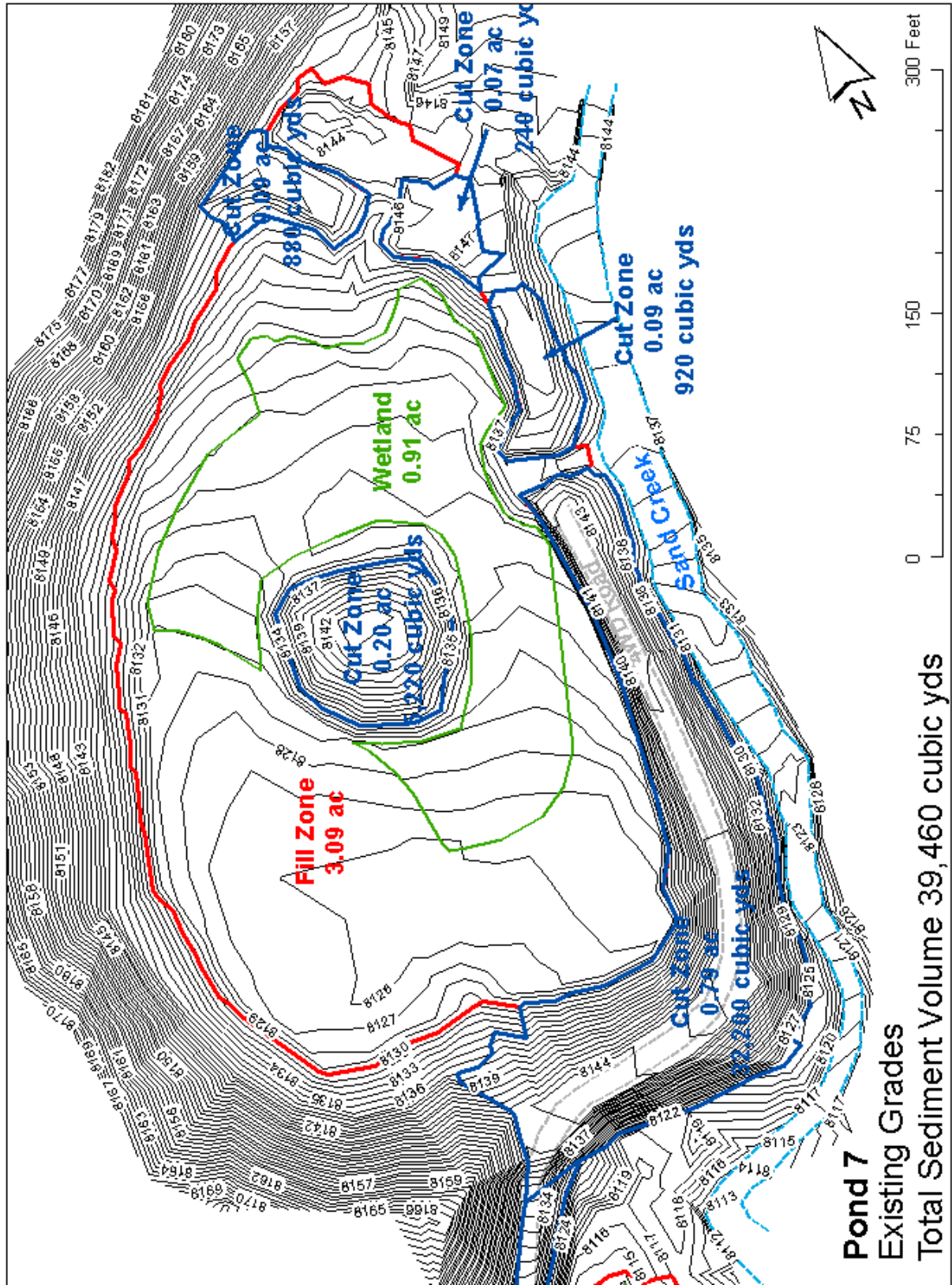
**Pit 7:** This is by far the largest basin in the study area and has the largest dikes and levees. This pit was scraped from a terrace of Sand Creek and sediment piled up as dikes on the south and west. The south side material forms a levee against the Sand Creek channel and the western dike is a dam 18 feet above the basin. Water was diverted from Sand Creek into the basin from its eastern side. A pond is present in the center of the basin. A total of 39,460 yd<sup>3</sup> is present in 1.24 acres of levee and dike on the south and western sides, and should be used to fill 3.09 acres of basin. The basin receives water from the east, but a strongly losing ground water gradient will create a deep water table in most areas, making them unsuitable for cottonwood pole plantings. However, plantings should occur in the eastern 1/3 of the site, and upland plant seeding should be done throughout. A large number of narrow leaf cottonwood (*Populus angustifolia*) saplings are present here which should be collected for pole plantings.



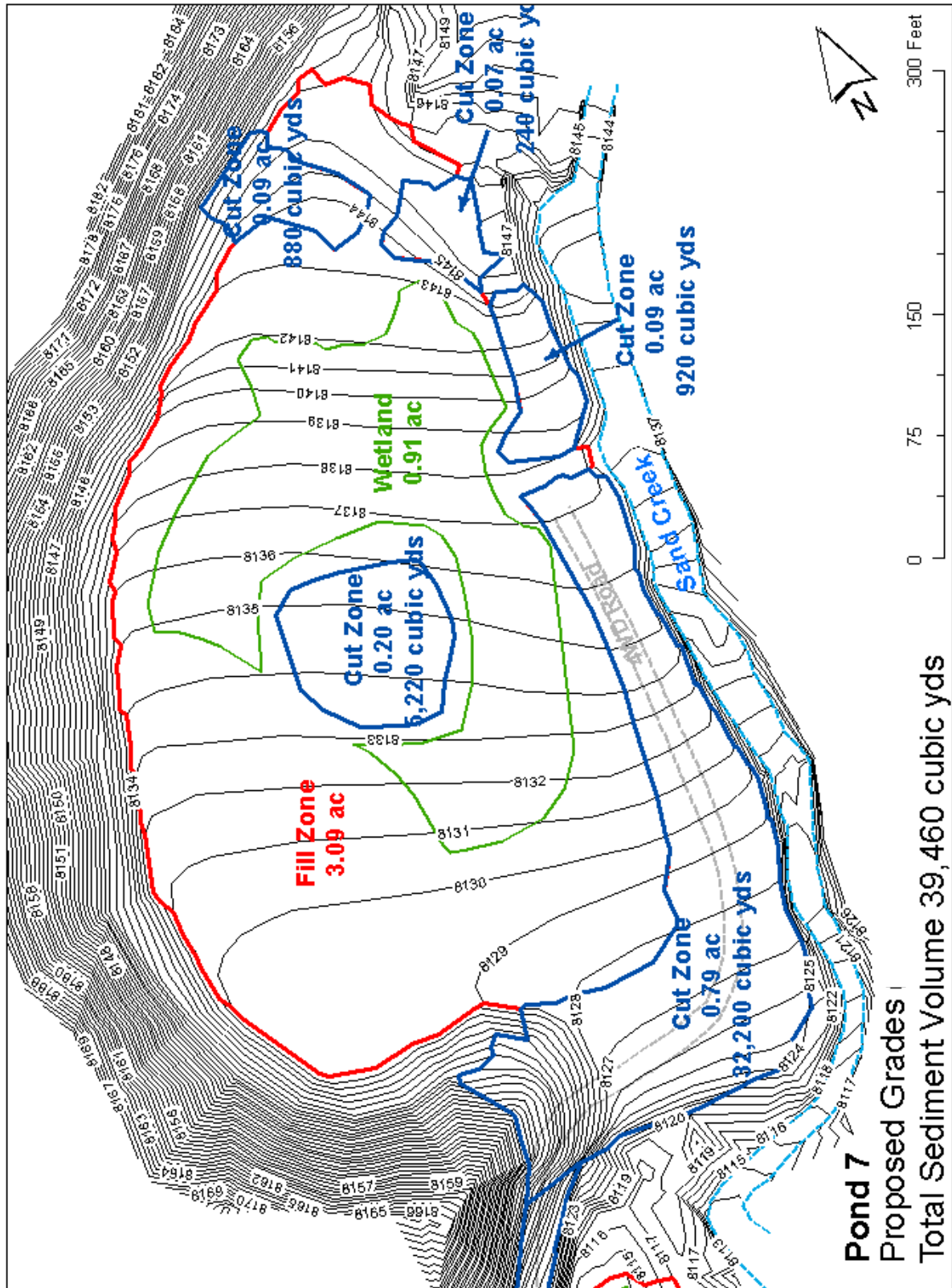
Pit 7 (above) looking east. Levee is on right below trees, dike is the vantage point from which photo is taken, and island can be seen as gravel area within green vegetation. Sand Creek is to right of levee.



Looking southwest across Pit 7, showing levee (on left) adjacent to Sand Creek.



Existing topography of Pit 7. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



Pit 7 proposed grade. The outlines of the cut, fill and wetland are retained.

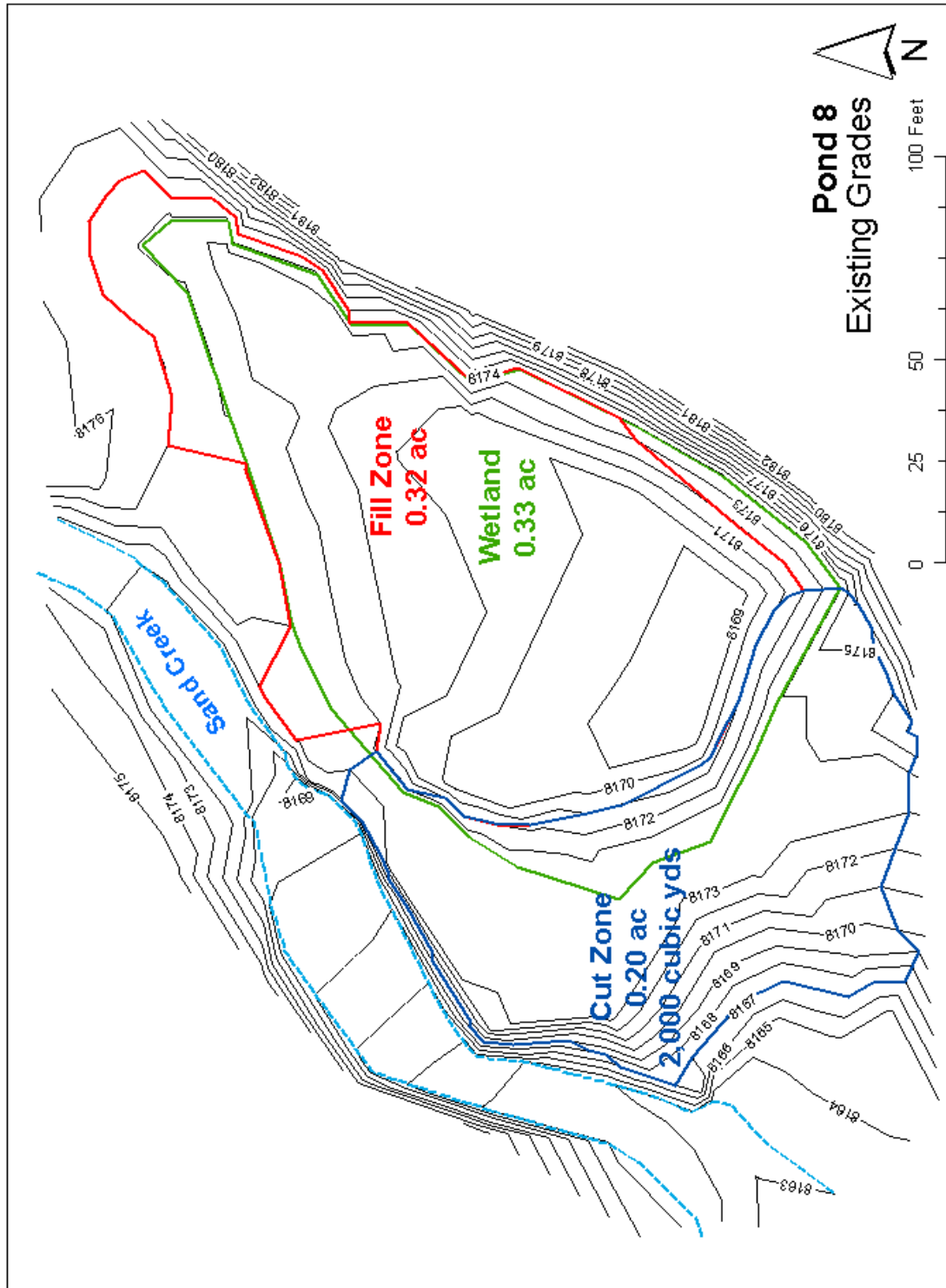
**Pits 8, 9, 10.** These three excavated basins are separated by dikes of pushed gravel material. The pits hold water to near their tops because they are occupied by beavers which have built dams and are actively managing and maintaining the high water levels (see photos below and on p. 27). Each pit was excavated into the Sand Creek floodplain, among mature narrow leaf cottonwood forests (bottom right photo p. 27 – arrows point to pits).

Pit 8 has a 0.2 acre area of fill which contains 2,000 yd<sup>3</sup> of material, and should be spread into an area of 0.32 acre. The existing pond surface is at 8,173 feet, and after filling, the ground surface may be near 8,174 making the entire area suitable for cottonwood plantings, as well as upland seeding.

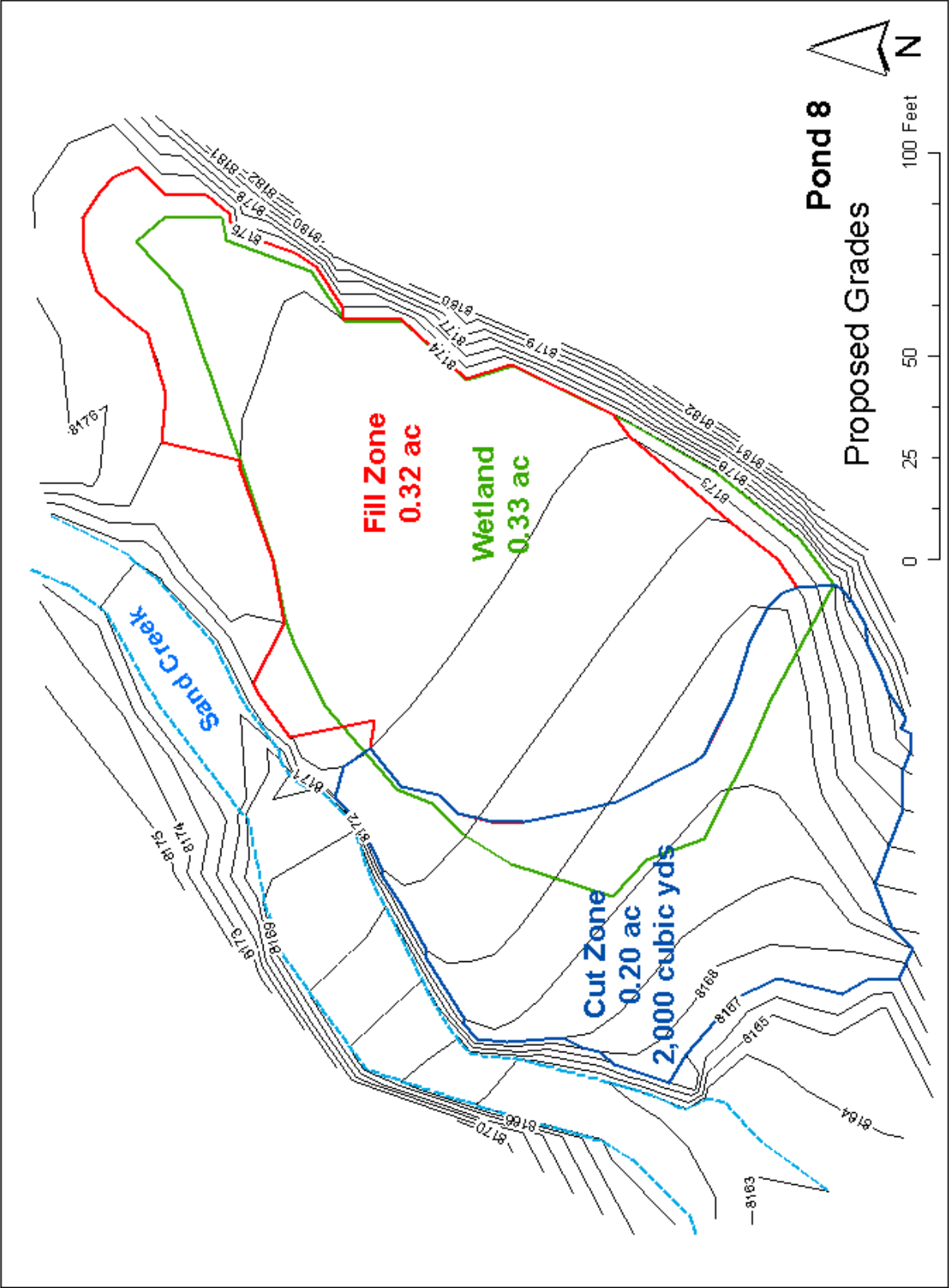


Pit 8, above, has little wetland vegetation.





Existing topography of Pit 8. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



Pit 8 proposed grade. The outlines of the cut, fill and wetland are retained.

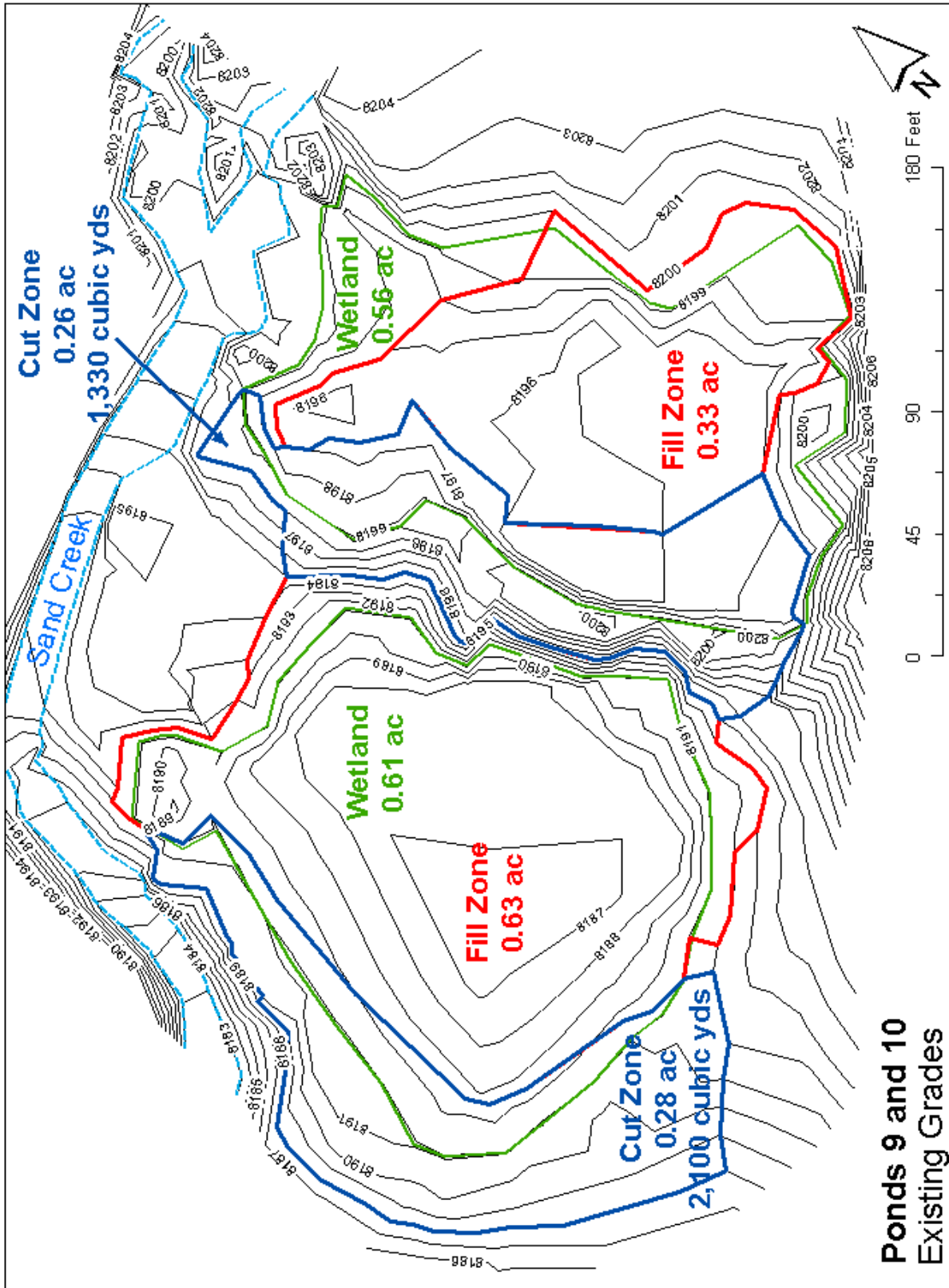
**Pits 9 and 10.** These ponds are dammed by dikes created by fill on their western sides. Pond 9 has a fill area of 0.28 acre and the 2,100 yd<sup>3</sup> of material should be pushed into the 0.61 acre pond. Pond 10 has a fill area of 0.26 acres, containing 1,330 yd<sup>3</sup> of material, which should be pushed into the pond area of 0.33 acre. Current elevation of pond 9 is 8,190 feet and the proposed land surface is 8,190-8,194, and some wetland area would remain. Sites where the land surface is more than 1-2 feet above the water table should receive cottonwood pole plantings. Pond 10 current elevation is 8,199 and proposed grade ranges from 8,196-8,199, and the wetland area would not change.



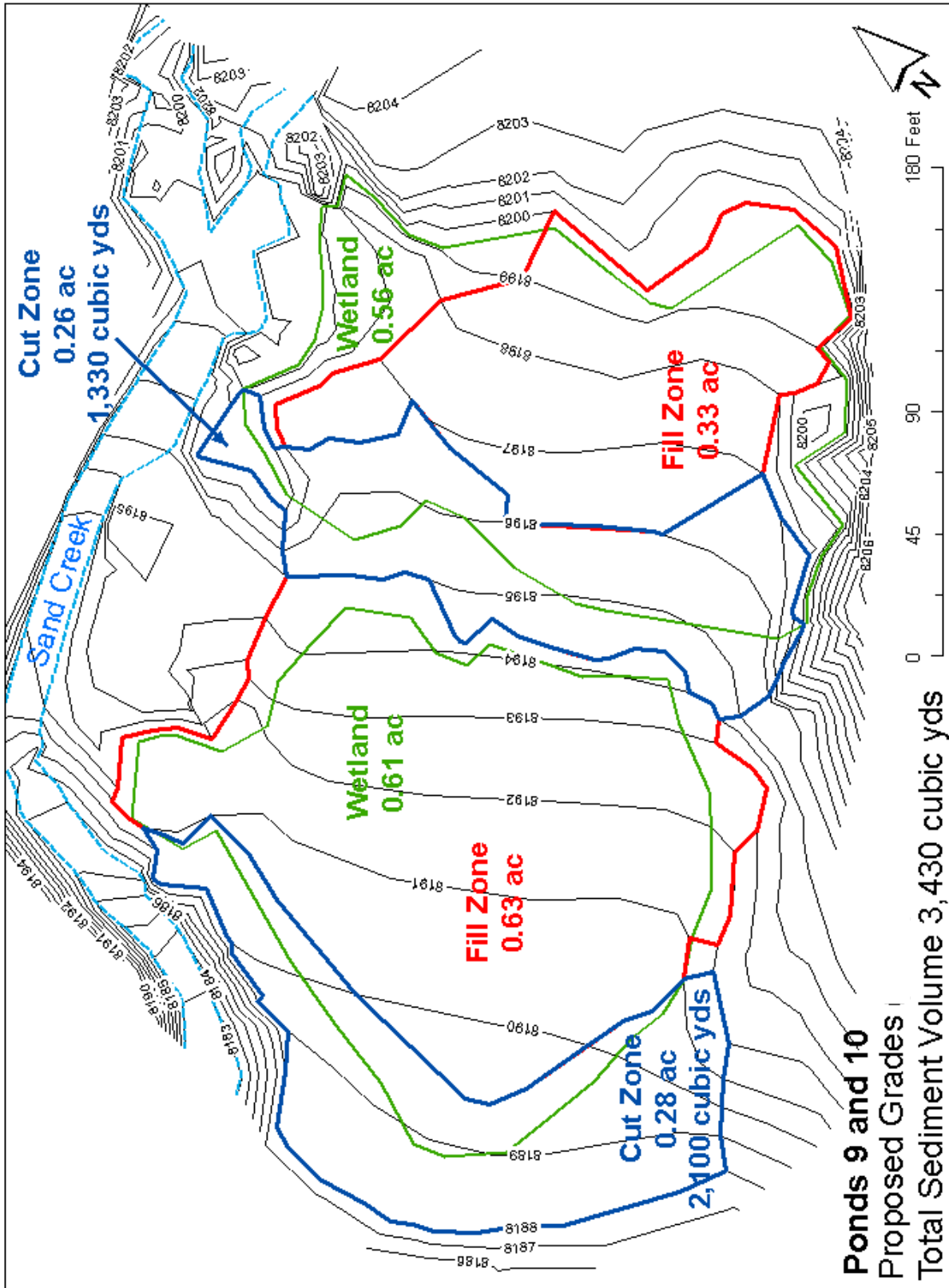
Pits 9 and 10. These ponds support a well developed fringe of emergent wetland vegetation, but have little submerged aquatic vegetation. Photo on bottom right shows ponds 9 and 10 located within mature cottonwood forest. Beavers and their dams help maintain the water levels in these ponds.



Pit 10, above, with dike in foreground, and limited wetland vegetation.



Existing topography of Pits 9 and 10. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



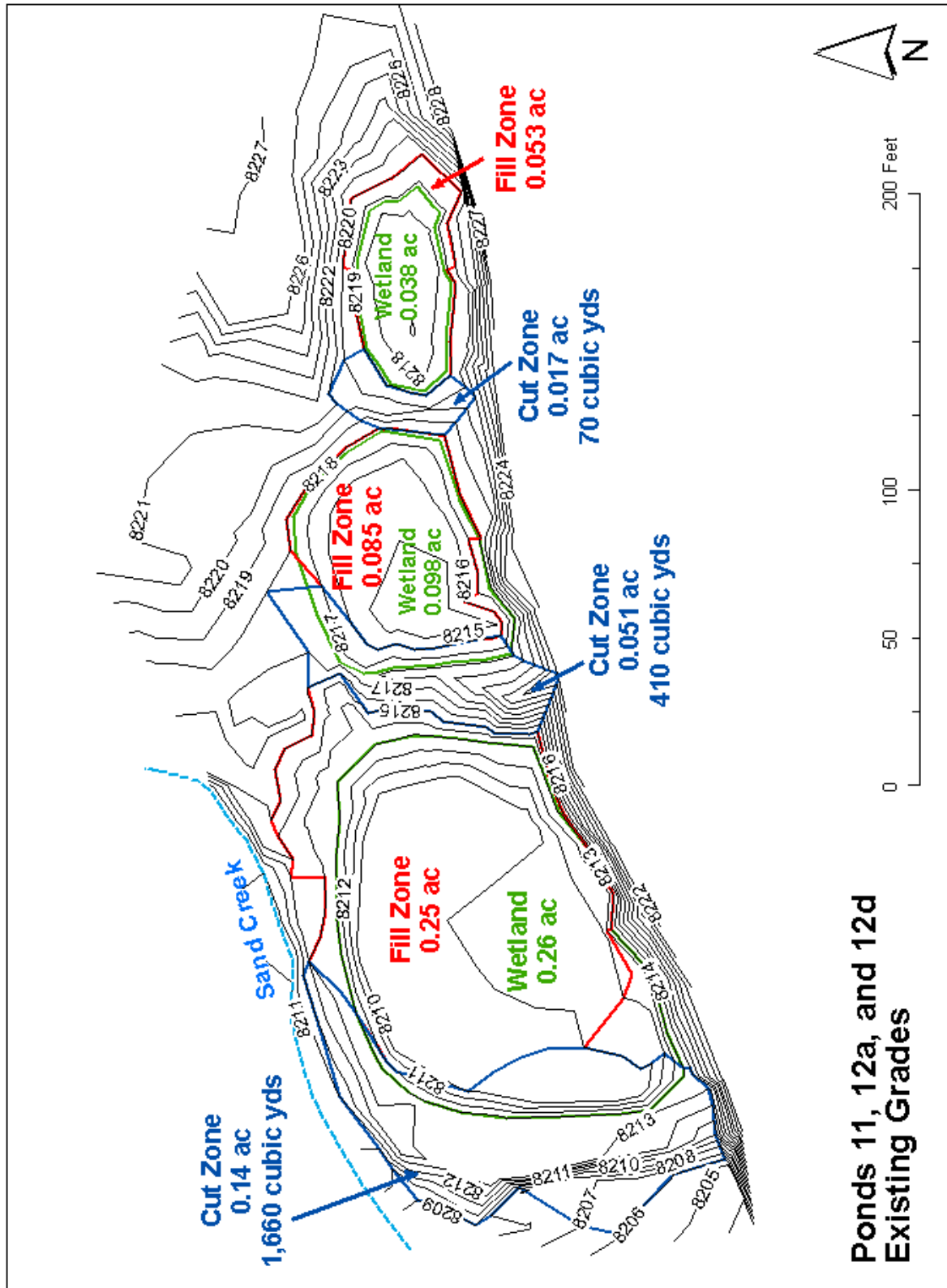
Pits 9 and 10 proposed grade. The outlines of the cut, fill and wetland are retained.

**Pits 11 and 12:** These pits are small, and occur on the south side of Sand Creek in a difficult to access portion of the study area. A road would have to be made to implement these restoration activities. Pit 11 has fill material covering 0.14 acre adjacent to its west side, containing 1,660 yd<sup>3</sup>. The current pond elevation is 8,213 feet and the proposed grade would be at 8,209-8,214 feet and considerable wetland area would remain.

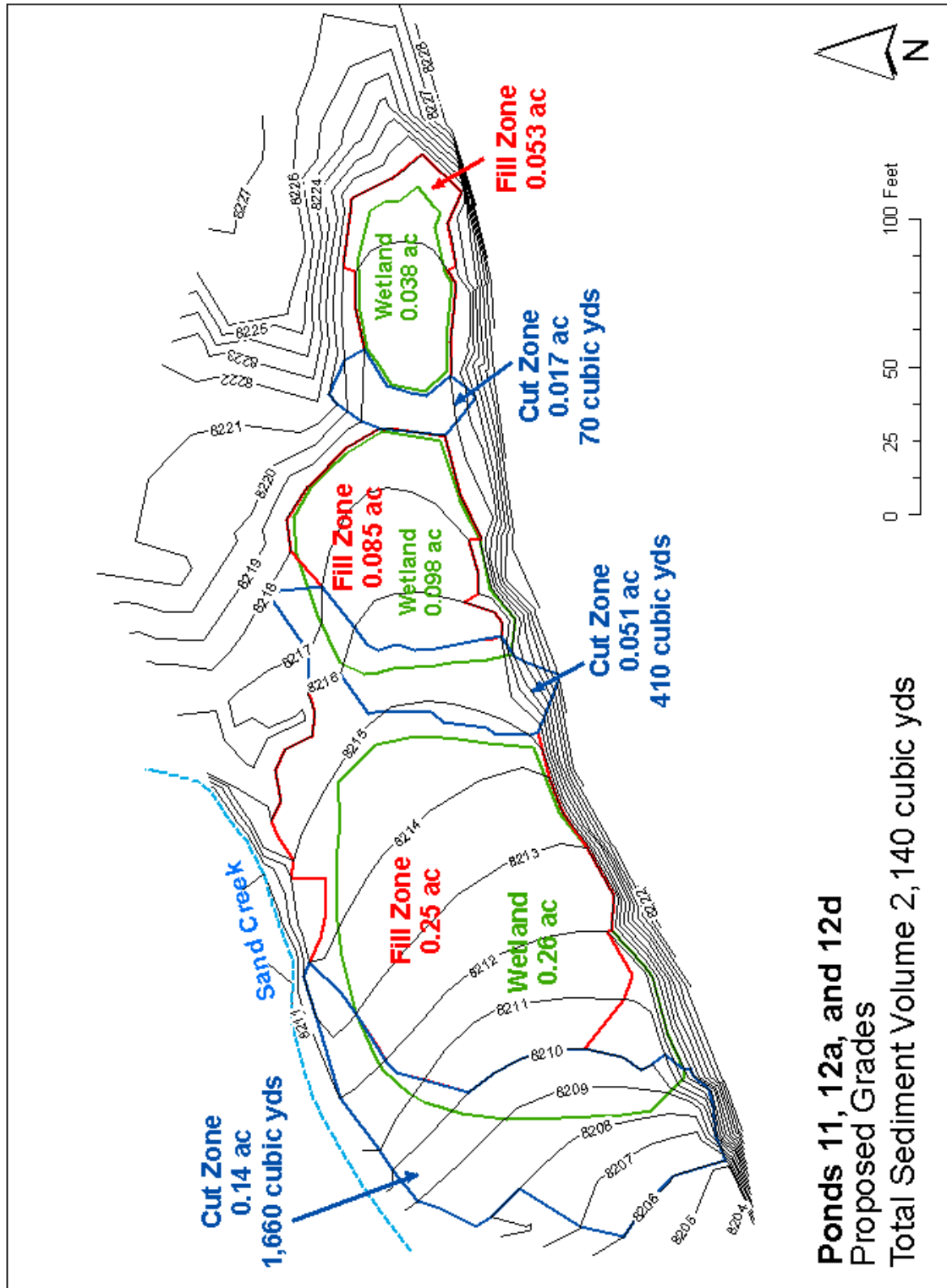
Pit 12a contains 0.051 acre of fill material on its west side containing 410 yd<sup>3</sup>. This material should be pushed into the pit area of 0.085 acre. The current pond elevation is 8,218 feet, and the fill will grade this to approximately that elevation, resulting in no loss of wetland.

Pit 12d contains 0.017 acre of fill material on its west side, containing 70 yd<sup>3</sup>. This material should be pushed into the pit area of 0.038 acre. The current pond elevation is 8,219 feet and the proposed elevation is 8,219-8,220, resulting in no net loss of wetland area.

These areas should be suitable for cottonwood and willow establishment from aurally dispersed seed, and likely will form dense cottonwood and willow stands. No pole planting or upland seeding is recommended.



Existing topography of Pits 11 and 12. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



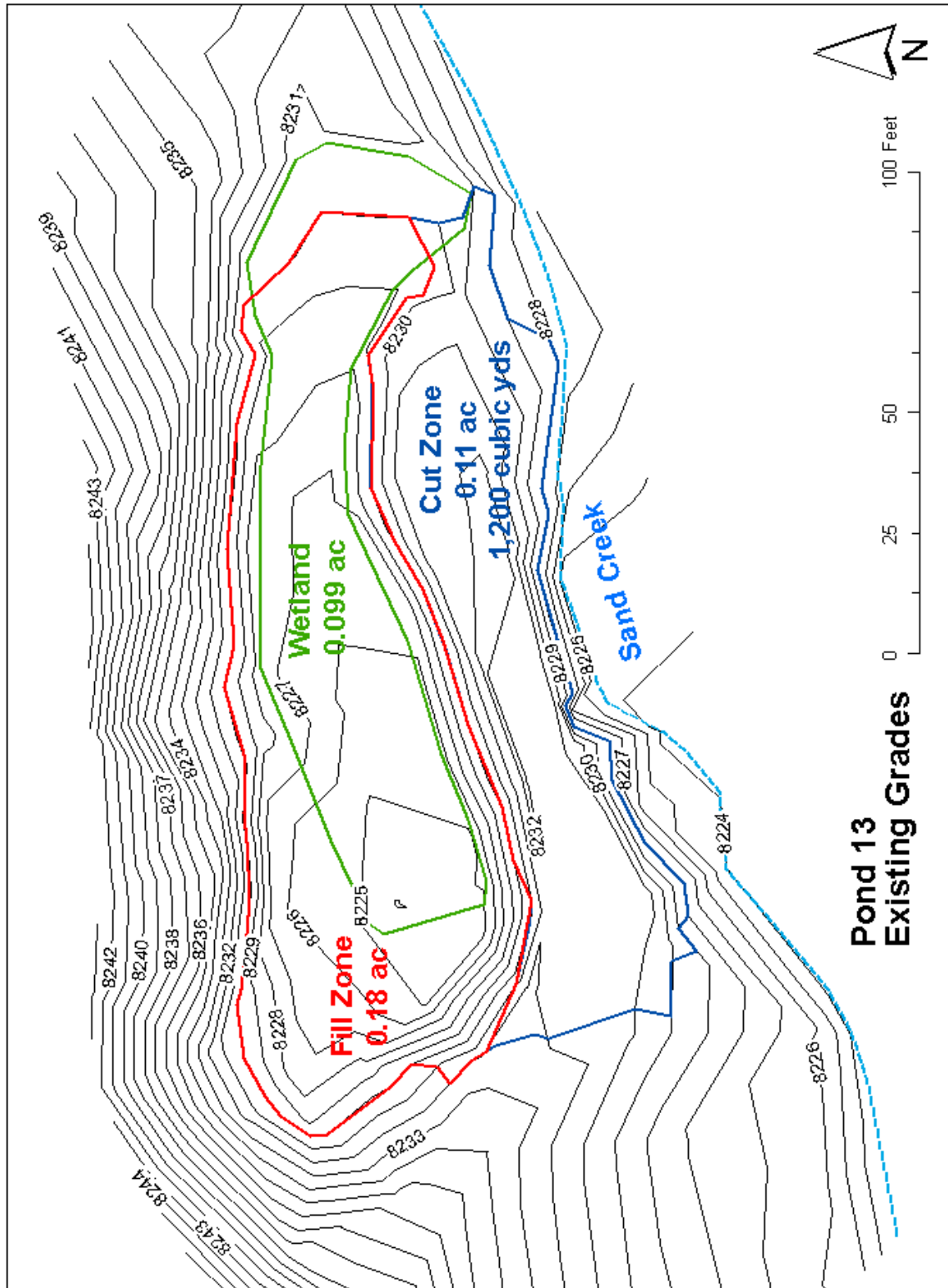
Pits 11 and 12 proposed grade. The outlines of the cut, fill and wetland are retained.



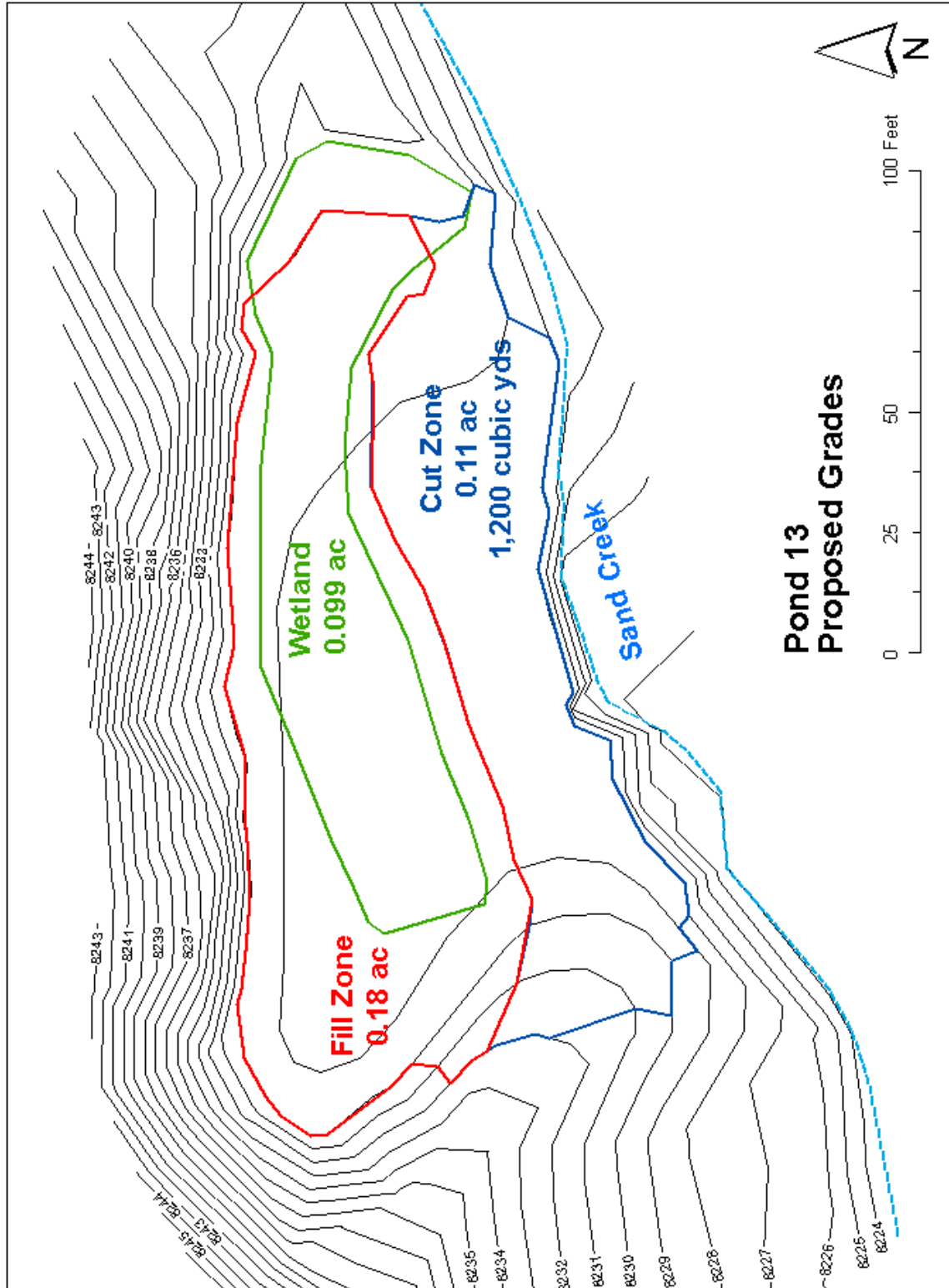
**Pit 13.** Pit 13 is a shallow depression and has a dysfunctional channel on its eastern side that once connected it with Sand Creek. Sediment from this pit area was pushed to the south forming a levee along Sand Creek, over an area of 0.11 acres and containing 1,200 yd<sup>3</sup> of fill. The pond area of 0.11 acre should be filled. The current water level elevation in the pond is at approximately 8,225 feet, and the proposed grade at 8,230 on the west side. It is possible that cottonwood pole plantings could survive here, and the area should be seeded with native upland plants.



Summer photo of pit 13 showing well developed wetland vegetation in pond bottom.



Existing topography of Pit 13. The area with fill is shown in blue, and the existing jurisdictional wetland in green, and the area to receive fill in red.



Pit 13 proposed grade. The outlines of the cut, fill and wetland are retained.

## Proposed Planting Plan

Two main revegetation approaches are suggested for the filled pits, cottonwood pole plantings, and upland grass seeding.

**Cottonwood Pole Plantings.** All members of the family Salicaceae contain adventitious buds along their stems, allowing them to grow roots where buried in wet soil, or stems, where exposed to the atmosphere. Restorationists take advantage of this process by cutting willow or cottonwood stems, burying them vertically in the soil so that the base of the cutting is below the water table. The stems can then root, and a shrub or tree is propagated. For the Sand Creek project, small cottonwoods that established from seed are available in Pit 7 and several other areas. These can be cut, stored in barrels of water during the construction process, and the planted one at a time, into holes drilled with a 5 foot long auger on the back of a tractor or backhoe. The holes must contact the water table, then the wetted pole is slipped into the hole, and the hole backfilled with native soils. Poles can grow into trees and do not need to be closely spaced, and a density of one pole planting per 4 yd<sup>2</sup> (36 ft<sup>2</sup>) is proposed.

**Upland Seeding:** Revegetation of the bare sand and gravel covered floodplain should be done by broadcast of live seed. Since the floodplain and its soils are very sandy and well drained the following species are present, and are recommended for seeding: *Sporobolus cryptandrus* (sand dropseed), *Stipa comata* (needle and thread grass), *Oryzopsis hymenoides* (Indian rice grass). A seed mixture containing these three species, in a mix that contains approximately equal numbers of each, should be purchased and broadcast in the fall after construction is completed. Seed should be applied at a rate of 13.5 pounds of pure live seed per acre. Seed should be broadcast with machines or by hand, and raked into the soil by machine or by hand.

## Stream bank Protection

Silt fencing should be placed prior to any construction activities between all levees and the Sand Creek channel. Standard silt fencing can be purchased commercially, and must be staked properly to insure its stability. No trespass by vehicles between the silt fences and Sand Creek will be allowed.

## **Wetland Impacts**

The goals of this project are to restore floodplain landforms, hydrologic regime and vegetation, and eliminate habitat for tubifex worms that provide one of the hosts for whirling disease. Therefore, removing the unnatural ponded habitats from the floodplain is critical. This project will eliminate wetlands from all but pits 10, 11 and 12. At those three sites the resulting water table will be at the soils surface. These sites will not provide habitat for fish, and therefore the host cycle will be broken.

Of the 3.696 acres of jurisdictional wetlands in the project site, a total of 2.976 acres of wetland will be filled and lost. This is a conservative estimate. A total of 4.1 acre of cottonwood plantings will be implemented, potentially restoring riparian forest on this area of the landscape. In addition, in portions of this area, water tables could be high enough during the summer that the area could be jurisdictional wetland.