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Title: Sandia Wetland Evaluation

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SANDIA WETLAND EVALUATION

by

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I. PROJECT DESCRIPTION

A wetland evaluation has been conducted in upper Sandia Canyon for changes in discharge flows in relation to the size, extent, and quality of the wetlands. As part of the Department of Energy Orders for Wetland Protection, the Clean Water Act, and the general federal philosophy to reduce the loss of our Nation's wetlands, a wetland evaluation was needed to determine if mitigation measures should be applied to Sandia Canyon to prevent reduction in wetland size and in wetland quality. This evaluation was prepared as a technical evaluation for project planning within the Technical Area (TA) 3 area. This evaluation includes

- description of Sandia Canyon,
- wetland importance,
- historical summary or background information on the wetlands,
- photographic comparison, 1990 vs 2000,
- wetland evaluation of size and extent and mapping,
- stream velocity measurements, industrial effluent discharges, and wetland observations,
- results from a wetland functional assessment model, and
- evaluation of different flow scenarios (zero discharge, 35% reduction, 75% reduction, no change, and 20% increase).

II. DESCRIPTION OF SANDIA CANYON

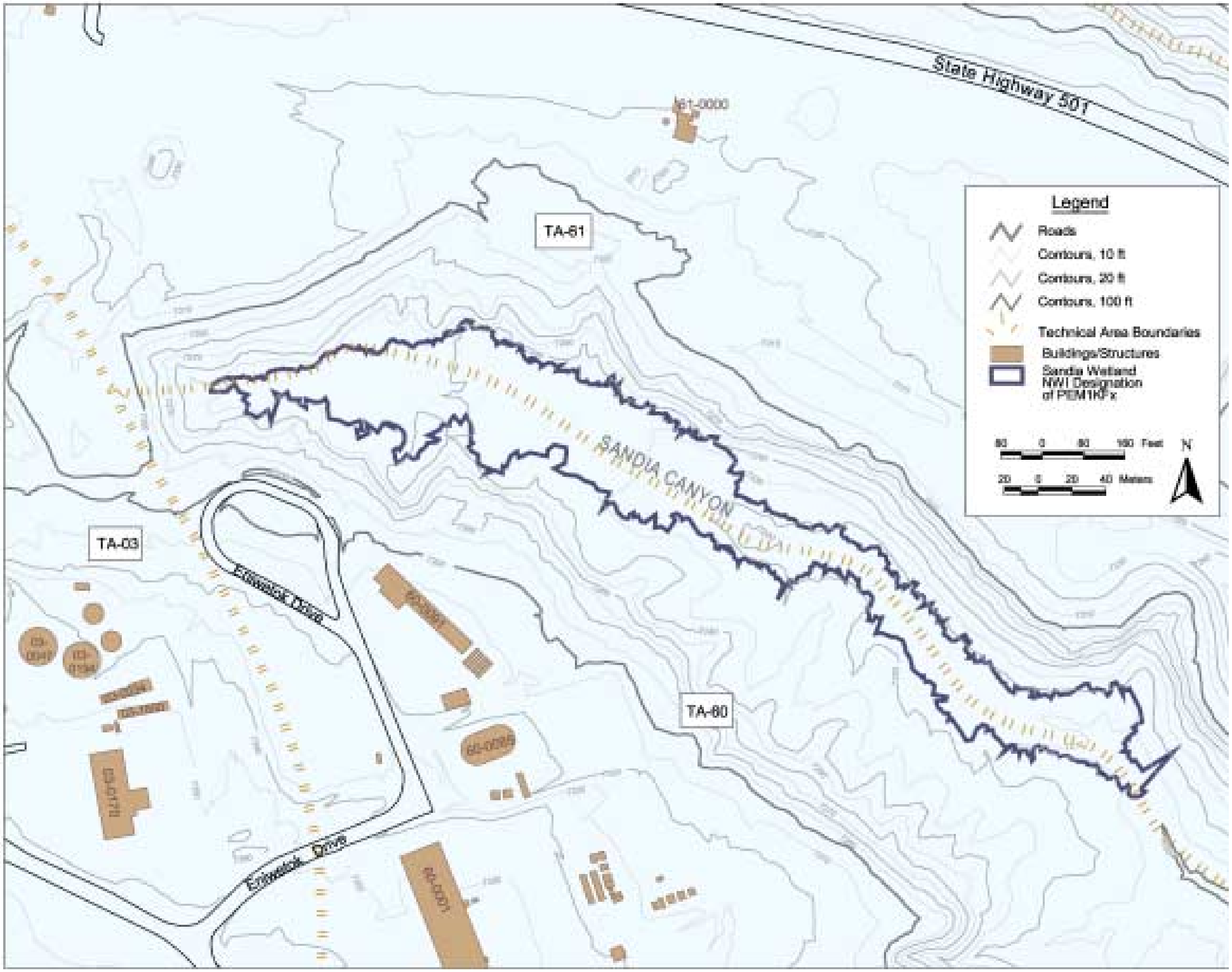
The head of Sandia Canyon is near the University House in TA-3. The canyon extends southeastward to the Rio Grande. The drainage basin is approximately 5.6 square miles. Industrial effluents from Los Alamos National Laboratory (LANL) activities maintain a year-round streamflow through the bottom of the canyon. The upper stream reach has received effluent discharge since the early 1950s. Storm water runoff and snowmelt also contribute seasonally to the stream.

The National Wetlands Inventory (NWI), conducted by the U.S. Fish and Wildlife Service, identified three types of wetlands or water systems in Sandia Canyon (USFWS 1990):

- persistent, artificially flooded, palustrine wetland (NWI designation PEM1KFx),
- temporarily flooded, palustrine wetland (NWI designation PSS1A), and
- intermittent, temporarily flooded, riverine streambed (NWI designation R4SBA).

The focus of this evaluation is on the first stream reach (Figure 1), which is classified as persistent, artificially flooded, palustrine wetland. This wetland area is the largest contiguous wetland on LANL lands. However, the size of this wetland has not remained constant during the last five years. From a 1990 orthophoto of the Sandia wetland, we created a digital image

Figure 1: Location of Sandia wetland evaluation area.



to measure the total area. We determined the size of the wetland to be approximately 5 acres, which is probably underestimated since not all areas were clearly visible from the photograph. In 1996, we mapped the wetland using a geographic positioning system (GPS) and determined its size to be 6.14 acres. During this current evaluation, we mapped the wetland with GPS and estimated the size to be 3.54 acres, which represents a size reduction of 48% from 1996.

III. WETLAND IMPORTANCE

Wetlands are slow-moving hydrological systems and transitions between fully terrestrial and fully aquatic ecosystems. Wetlands need sufficient hydrology to maintain soils capable of supporting plants suited for growing in saturated, anaerobic conditions. Functional wetlands offer a wide array of benefits including

- erosion control,
- storm and flood abatement,
- water retention,
- sediment and contaminant trapping,
- water quality enhancement through bacterial metabolism, filtration, and sedimentation,
- wildlife habitat,
- aquatic productivity,
- aquifer recharge,
- aesthetic benefits, and
- educational and research opportunities.

IV. HISTORICAL REFERENCES TO A WETLAND IN SANDIA CANYON

There are several historical accounts of a wetland in Sandia Canyon. However, the exact location and extent of the wetland is not well documented. Peggy Pond Church, who lived on the Pajarito Plateau during the days of the Ranch School, referred to the "place of the cattails (*Typha latifolia)*" (*agua pah*) in Sandia Canyon. Harrington in 1914 published interviews with Native Americans living in the area that would one day be Los Alamos. The local Native Americans referred to a place in Sandia Canyon where cattails grow. In 1986, Colleen Olinger wrote "data seem to indicate there were some natural wetland areas on the Pajarito Plateau prehistorically and *agua pah* may be about where the 'Selected Rubble Landfill' site [at the head of Sandia Canyon] is proposed." A map of the Wheeler expedition of the 1870s confirms this general location (Cross 1996).

LANL operations have most certainly increased and changed the historical hydrology of the area. However, the change of hydrology now represents normal circumstances in the canyon.

V. RECENT STUDIES WITHIN SANDIA CANYON

The Biology Team of the Ecology Group (ESH-20) has conducted aquatic invertebrate studies in upper Sandia Canyon from 1990 to 1995. These studies have shown an increase of biodiversity and in stability of macroinvertebrate communities downgradient of the headwaters of Sandia Canyon. These downstream communities and taxa resemble those of natural streams of the area, suggesting that any impacts attributed to upstream effluent discharges are mitigated by the intervening cattail marsh (Bennett 1994, Cross 1994).

In 1991, Foxx and Edeskuty surveyed 133 National Pollutant Discharge Elimination System (NPDES) outfalls at LANL (Foxx and Edeskuty 1995). The purpose of the survey was to determine the use of these wastewater outfalls by wildlife. The outfalls that discharge into Sandia Canyon were evaluated. Survey results indicated that the Sandia Canyon wetland area was being used by a variety of fauna and was rated as 'probable' for wildlife watering. Water flow was sufficient to support aquatic macroinvertebrates and wetland vegetation. The length of stream flow was approximately two miles and was permanent in nature.

During the summer of 1992, Raymer and Biggs (1994) compared nocturnal small mammal communities at wet areas created by wastewater outfalls with communities in naturally created wet areas and dry areas. The Sandia wetland area was evaluated in this study and the nocturnal small mammal community was found to be similar to a community in naturally wet sites.

Bennett and Biggs (1996) conducted a study of small mammals in Sandia Canyon in 1994-1995. The purpose of the study was to gather baseline data of small mammal populations and compare small mammal characteristics within three areas (Web 1, Web 2, and Web 3) of Sandia Canyon. The first two areas were located within the wetland. The third area was immediately below the wetland. Webs 1 and 2 had the highest species diversity and Web 1 had the highest overall density estimates. Many factors contribute to species composition and density. An important factor is habitat. Wetland areas provide habitat for a higher diversity of species as well as a variety of food sources and shelter. This study indicates the importance of the wetland habitat to the small mammal community.

During the summer of 1996, concerns developed about polychlorinated biphenyls (PCBs) within Sandia Canyon. Bennett et al. (1999) submitted 1995 and 1996 archived small mammal adipose tissue and internal organs for analysis of PCB mixtures known as Aroclors. In 1998, they sampled a reference site in the Jemez Mountains for small mammals and submitted samples for PCB analysis. Detectable limits of PCBs were found in the 1995 and 1996 Sandia samples. No samples from the reference site had detectable levels. Aroclor-1260 concentrations found in the samples ranged from 49 to 19,000 g/kg. Preliminary evaluation of the data indicated the maximum levels of Aroclor-1260 approached minimum levels for which effects have been noted.

Beginning in 1998, surveys were conducted annually to determine the occupancy status of Sandia Canyon for a federally protected species, Mexican spotted owl. The canyon is surveyed during April and May of each calendar year. To date, the habitat has been found to be unoccupied (Keller, unpublished).

Katzman (2000) summarized investigations being conducted by the Environmental Restoration Program in upper Sandia Canyon. The wetland area was included in the investigation. Geomorphic units were mapped for the area and sediments were investigated for PCB contamination. Detectable levels of PCBs were found in 78% of the sediment samples within the wetland area. The most commonly detected PCB was Aroclor-1260. The highest concentration reported in sediment was 2.0 mg/kg. The Environmental Protection Agency action level for PCBs in a water course is 1.0 mg/kg. The 2.0 mg/kg measurement previously mentioned is one of 70 samples taken in the Sandia wetland water course. The investigation of this area is ongoing. Surface water was also investigated and surface water samples were collected quarterly. No PCBs were detected in any of the quarterly samples.

VI. PHOTOGRAPH COMPARISON

During the late spring and early summer in 1990, the Biology Team set up photography stations in and around the Sandia wetland. Photographs were taken. In the fall of 2000, we visited the 1990 photography stations and took 34 matching pictures. The pictures were compared to look at changes that had occurred over the last 10 years. Even though the pictures were taken at different seasons, several changes were evident:

1) The stream channel has incised in the upper channel.
2) In some areas, there has been a change of vegetation type, moving from wetland to upland.
3) There has been an increase in sedimentation.

A few example photographs are shown in Figures 2 through 5. The complete photograph comparison is shown in Appendix 1.

VII. WETLAND EVALUATION OF SIZE AND EXTENT

In the summer of 2000, we conducted an evaluation of Sandia wetland to determine the current size and extent. The approach we followed was modeled after the Department of Army, Corps of Engineers Wetlands Delineation Manual (COE 1987). We evaluated the vegetation, soils, and

Figure 2a: A 1990 photograph of upper Sandia wetland showing persistent vegetation that completely surrounds the snag (center of photo).

Figure 2b: A 2000 photograph of upper Sandia wetland showing a change in wetland vegetation. Wetland vegetation no longer completely surrounds the snag (center of photo).

Figure 3a: A 1990 photograph of upper Sandia wetland showing a broad, diffused stream channel with cattails.

Figure 3b: A 2000 photograph of upper Sandia wetland showing an incised channel with a change of vegetation type.

Figure 4a: A 1990 photograph of upper Sandia wetland below the rubble landfill. Cattails can be seen adjacent to the stream channel.

*Figure 4b: A 2000 photograph of upper Sandia wetland below the rubble landfill. Stream channel is incised and vegetation is dominated by false tarragon (*Artemisia dracunculus*).*

Figure 5a: A 1990 photograph of upper Sandia wetland at the culvert by the rubble landfill showing a wide, diffused (braided) stream channel with cattails.

Figure 5b: A 2000 photograph of upper Sandia wetland at the culvert showing an incised stream channel and increased sedimentation below the sediment fence.

hydrology within the wetland complex to determine the boundary of the wetland.

Vegetation

A baseline was established on the outer south side of the wetland that was parallel to the watercourse (Figure 6). Transects were placed every 300 ft perpendicular to the baseline. Vegetation was recorded every 10 ft along the transect. Plant species were recorded, as well as percent cover and wetland indicator status (Appendix 2). For each plot, we determined if greater than 50% of the dominant vegetation was either an obligate wetland plant (plants that occur almost always in a wetland), a facultative wetland plant (plants that usually occur [>67% to 99%] in a wetland), or a facultative upland plant (a plant that sometimes [33% to 67%] occurs in a wetland). If greater than 50% of the dominant vegetation was facultative or wetter, the plot was said to have wetland vegetation. Understory (grasses and forbs) and overstory (shrubs and trees) vegetation were evaluated. Areas representing wetlands were flagged with survey flagging. The Sandia wetland was dominated by understory species with very little overstory species being encountered.

In areas having wetland vegetation, cattails, an obligate wetland plant, was the most common understory species found. In a few areas, coyote willows (*Salix exigua*), a facultative wetland plant, was the most common overstory species found.

Soils

Using the baseline that was established for the vegetation, hydric soils were evaluated. Soils were evaluated at the same 300-ft interval as the vegetation. Hydric soil pits were dug at the furthest extent of wetland vegetation (based on the vegetation plot flags). If the pit did not have hydric soils, another pit was dug at the next plot of wetland vegetation. The pits were dug to 18 inches. Soils were examined for color, texture, moisture, and the presence of mottles (contrasting color areas in the soil representing a reducing soil condition). If sediment fill was observed it was also noted. We determined soil color with a Munsell Soil Color Chart (GregtagMacbeth 1998) and texture and moisture by feel (Appendix 3). After the soils were examined, we determined if the soils were characteristic of hydric conditions (Appendix 4). If so, the pit was said to have wetland soils. If the area did not have wetland soils, the wetland vegetation survey flagging was removed and the next pit dug. In some places, hydric soil pits were also dug in the upland adjacent to the wetland boundary to assure accuracy of the evaluation.

Hydrology

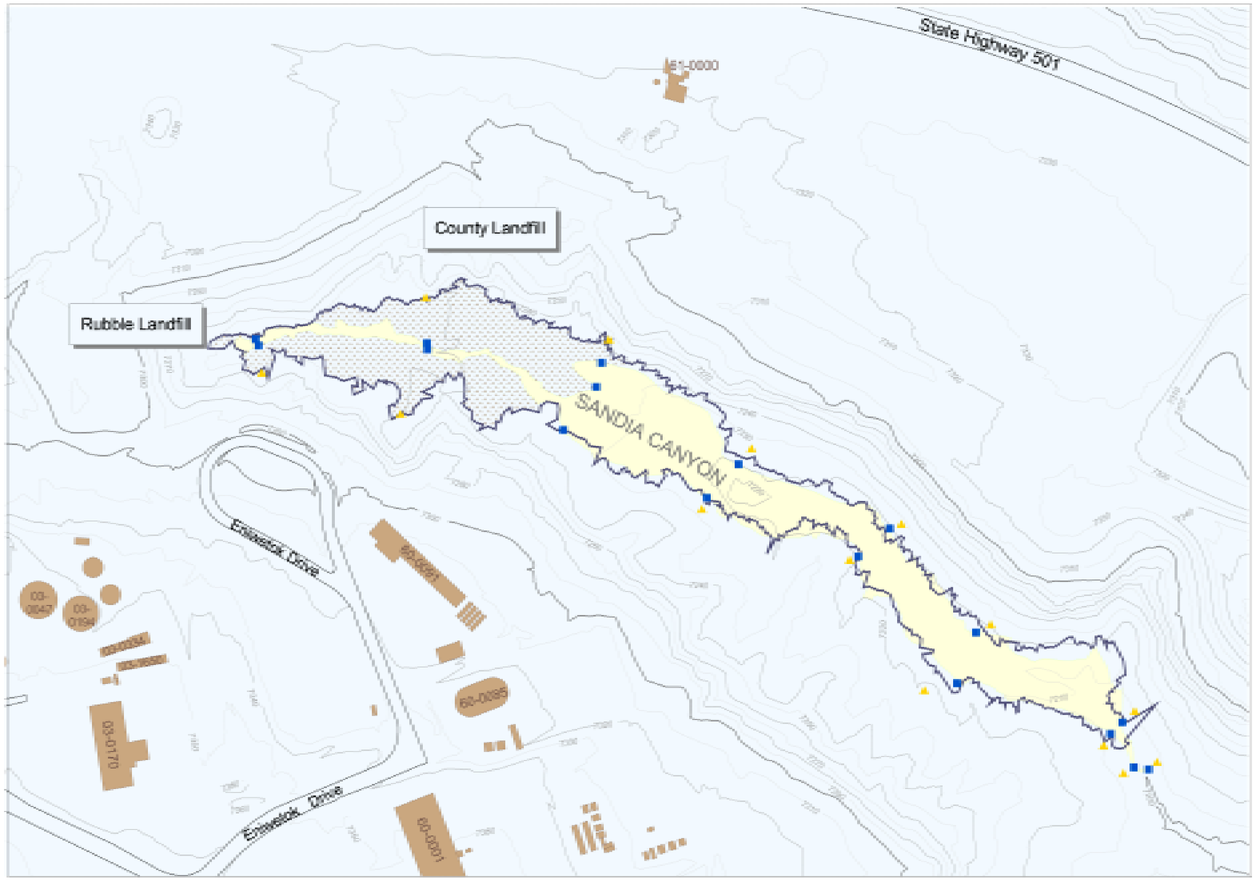
Hydrology was evaluated at each hydric soil pit. We examined hydrology by looking at soil moisture, freestanding water in the pit, and water droplets on the walls of the pit. In some cases, hydrology was assumed if the dominant wetland plant species were obligate and hydric soil conditions existed (COE 1987). Hydrology observations were recorded with the hydric soil data (Appendix 4).

Wetland Mapping

After we had characterized the wetland, we used GPS to delineate the boundary that was formed by the survey flagging. At each survey flag we took differential GPS locations for three minutes. For areas in between flagging we walked the area with differential GPS, staying within the same vegetation zone that was determined at the previous soil pit. Periodically, we would take a soil core to assure the soil and hydrology character had remained constant. A map of the area was made with the new wetland spatial extent. Map 1 shows the new Sandia wetland boundary, the 1996 boundary, upland/wetland determination areas (from hydric soil pits and vegetation plots) sites, and areas that have been de-watered. The de-watered areas are areas where the stream channel has incised and drained adjacent wetlands by lowering the water table away from these areas.

MAP 1

Current and Prior Boundaries of Sandia Wetland with Wetland Boundary Evaluation Results



Legend

- Roads
- Contours, 10 ft
- Contours, 20 ft
- Contours, 100 ft
- Buildings/structures

Sandia wetland boundaries
- Boundary of 1995-1996
- Boundary of summer 2000

Wetland boundary evaluations
- Upland conditions exist
- Wetland conditions exist
- Areas of current wetland de-watering

1:1682

100 0 100 200 Feet

30 0 30 60 Meters

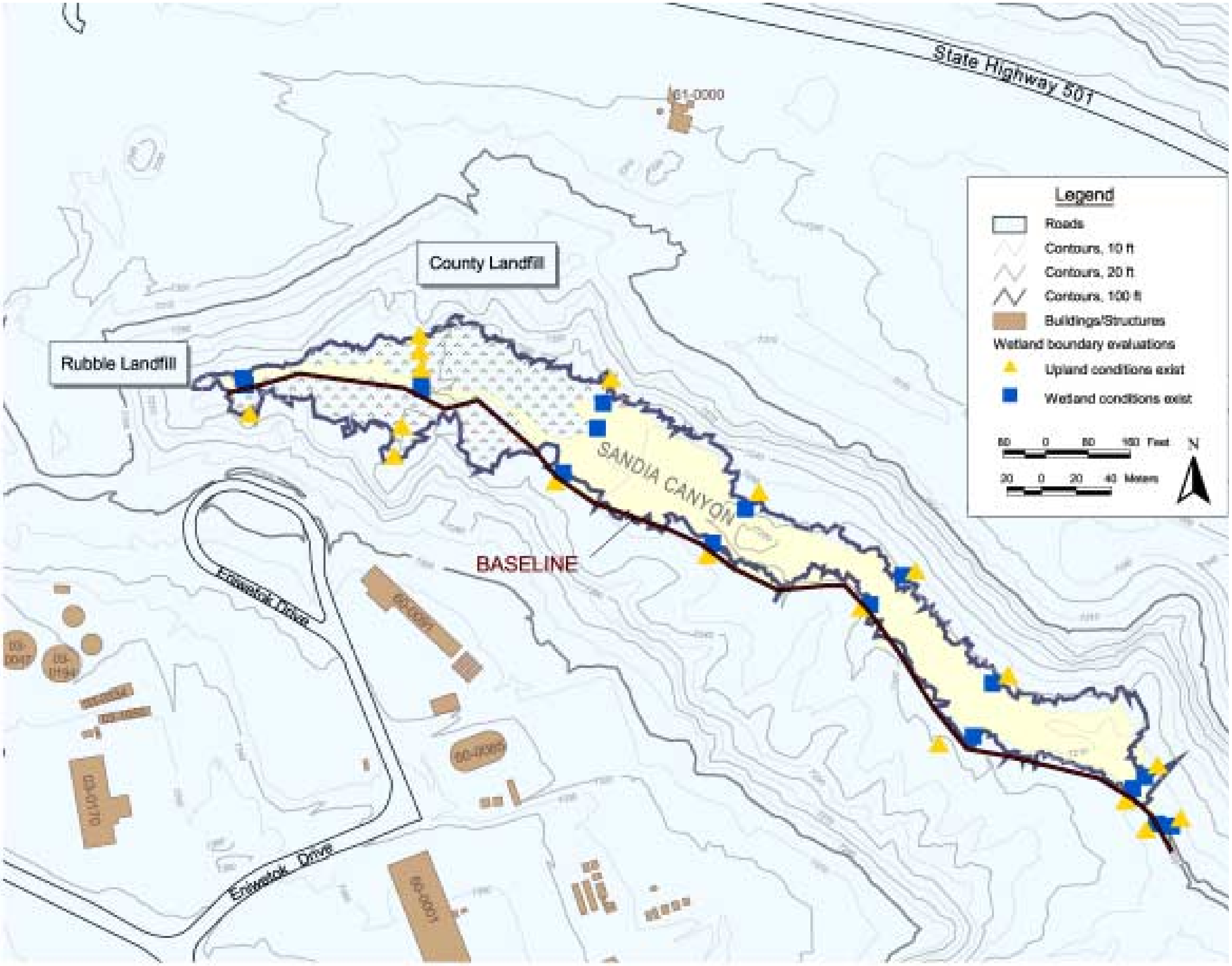
N

Digital Orthophotograph showing Sandia Wetland

New Mexico State Plane Coordinates, New Mexico Central Zone, North American Datum 1983.

Data are provisional and subject to change. Boundary information is for comparison purposes only and may not be suitable for other purposes.

Figure 6: Location of the vegetation baseline, hydric soil pits, and vegetation plots for boundary determination.



VIII. STREAM VELOCITY MEASUREMENTS, INDUSTRIAL EFFLUENT DISCHARGES, AND WETLAND OBSERVATIONS

Over the past 10 years, the upper Sandia Canyon area has received a variety of impacts and disturbances. These disturbances have included PCB contamination, accidental spills of sulfuric acid and chlorine, sedimentation from the rubble and county landfill, and re-routing discharge points. Some of these disturbances have had lasting effects within the wetland area. Observations over the past three years indicate that the upper portion of the wetland is losing hydrology and the extent of wetland vegetation is decreasing. The reduction in hydrology appears to be caused by

- increased sedimentation on the north, west, and south,
- changes of discharge location of a major outfall,
- expansion of gully system, lowering the water table,
- uncontrolled high-volume peak flows,
- asphalt within the wetland, and
- de-watering of sediments resulting in a potential for contaminant release and movement.

ESH-20 biologists measured flow from nine locations within the cattail marsh and two locations downstream from the marsh (Figure 7). At each location, water depth and width of the stream channel were also recorded. Table 1 lists the flow measurements and depth and width of the stream channel.

Sandia Canyon has received industrial effluents for greater than 30 years. In 1972, the combined industrial effluent releases into Sandia Canyon were estimated to be 168,200 gal. per day (gpd) (Purtymun 1975). From 1987 through 1996, effluent discharges were estimated to be approximately 192,000 gpd, and in 1996 the discharge volume was approximately 160,000 gpd (LANL 1999). In 1998 the combined estimated discharge flow of outfall 00101A (Power Plant) was approximately 181,200 gpd, and in 1999 the estimated discharge volume dramatically increased to 574,400 gpd, representing a 196% increase from the 1996 flow (LANL 2000). Table 2 gives the measured flow information from NPDES-permitted outfalls that discharge into upper Sandia Canyon for 1999 and 1998 (LANL 2000).

LANL's Water Quality and Hydrology Group has installed storm water gauging stations in Sandia Canyon. Flow information was available only for the lower station near State Road 4. No flow was noted in this downstream location and appears to only have flow after heavy storm events. Data will soon be available from the other stations and will be incorporated into this report at that time.

IX. WETLAND FUNCTIONAL ASSESSMENT MODEL

A functional assessment model was used to evaluate and compare different segments of the Sandia wetland. The purpose of this assessment was to assist us in developing mitigation priorities and tasks. The model we used and modified was developed for the Lake Dakota Sand Plains (Hopkins 1997). The assessment model is broken out into six indices of function, and five indices were valid for our geographic area. The five indices we used were

- maintenance of characteristics hydrology: the capacity of the wetland to regulate the outflow and/or inflow and the ability of the wetland to provide storage of water,
- retention, conversion, and release of elements and compounds: short- and long-term cycling and removal of elements/compounds on site through abiotic and biotic processes that convert elements from one form to another and nutrient cycling,
- retention of particles: deposition and retention of organic and inorganic particles from the water column, primarily through physical processes,
- maintenance of characteristic plant community: vegetative community is not dominated

Figure 7: Location of flow velocity stations within the Sandia wetland area.

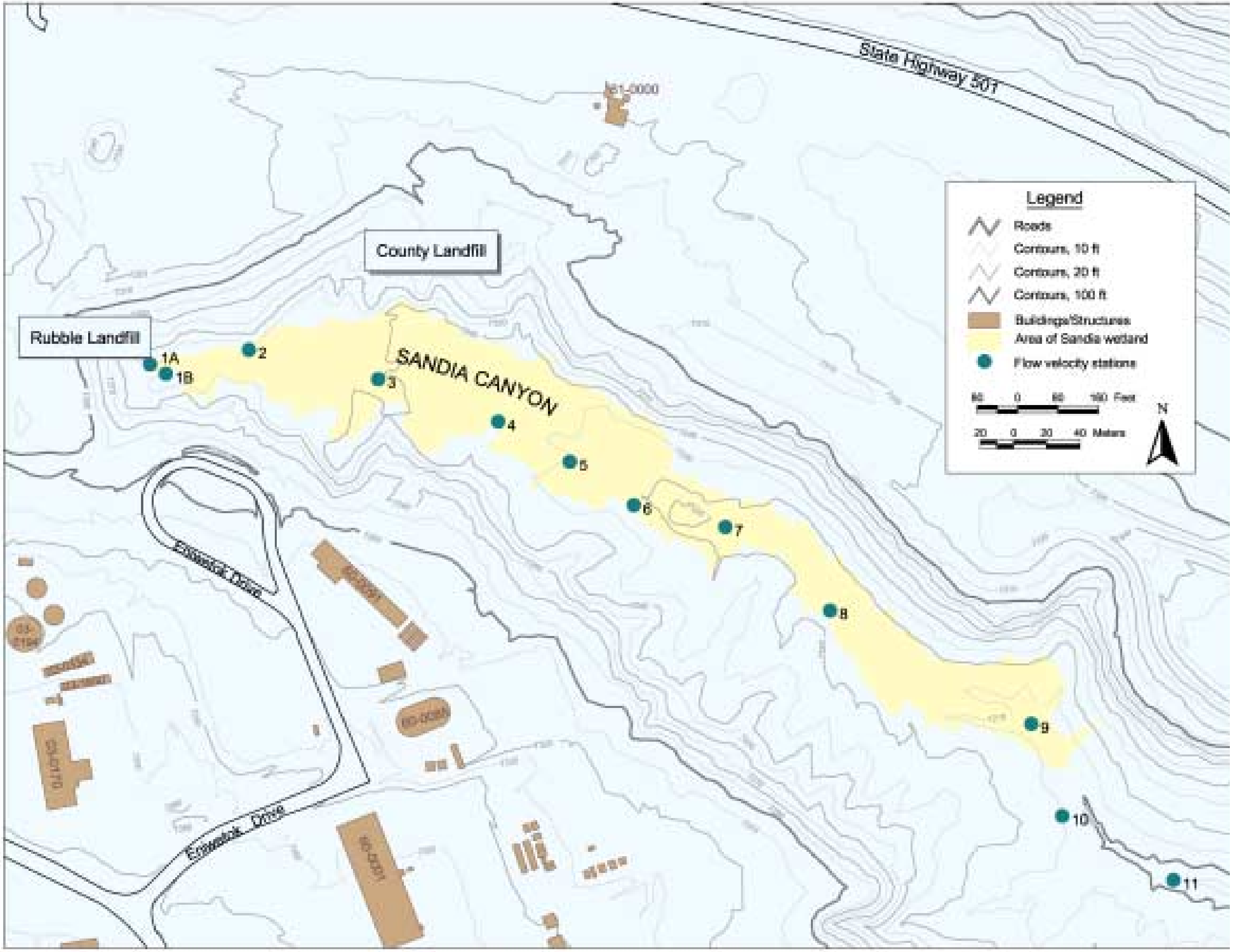


Table 1: Stream velocity measurements from Sandia Canyon. Points 1 through 9 are within the cattail marsh, and Points 10 and 11 are below the marsh.

	Point											
	1A	**1B**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	4	1.5	1	1.9	1	2.2	1	0.8	0.4	1.8	1.6	1.2
	4.4	1.5	1.2	2.2	1.2	1.9	1.2	0.7	0.3	1.9	1.5	1.2
	4.6	1.5	0.9	2.1	1	2	1	0.8	0.3	1.9	1.3	1.2
	4.2	1.5	1.2	2.4	1.2	2.1	1	0.9	0.4	1.9	1.5	1.2
	3.9	1.6	1	2.1	1	2.2	1	0.8	0.6	2.1	1.3	1
	5.2	1.6	1	2.2	0.9	2.4	0.9	0.9	0.4	2.1	1.2	1.2
	4.6	1.6	1	2.4	0.9	2.2	1.2	1	0.4	1.8	1.3	1.2
	4.4	1.5	0.9	2.1	0.9	2.2	1.2	1	0.4	1.9	1.3	0.9
	4.3	1.6	0.9	2.1	1	2.2	1.2	0.6	0.6	1.8	1.4	1.2
	4.4	1.6	0.9	2.1	1	2.2	1.2	0.7	0.4	1.8	1.5	1
	4.8	1.4	1	1.9	1	2.4	1.2	0.8	0.4	1.8	1.4	0.9
	4.4	1.6	0.9	2.2	1	2.4	0.9	0.8	0.6	1.9	1.4	1
				2.1	1.2	2.2	0.8	0.8		1.9	1.3	1
				2.2			0.9	0.9		1.9	1.3	0.9
							0.9	0.8		1.9	1.4	1.3
							0.9	0.9		1.9	1.6	1
							0.9				1.3	1
							0.9				1.3	1
							1				1.5	1.2
											1.5	1
											1.8	
average (f/s)	**4.333333**	**1.5417**	**0.9917**	**2.1429**	**1.0231**	**2.2**	**1.0158**	**0.825**	**0.4333**	**1.8938**	**1.4143**	**1.08**
standard deviation	**0.3472838**	**0.0669**	**0.1084**	**0.1453**	**0.1092**	**0.1472**	**0.1385**	**0.1065**	**0.1073**	**0.0929**	**0.1424**	**0.1281**
stream width (ft)	**2.8**	**3.25**	**4.33**	**3.25**	**3.125**	**2.33**	**5.17**	**1**	*****	**4.5**	**4.5**	**4.42**
stream depth (in.)	**4.75**	**6.5**	**7.5**	**9**	**7**	**7.5**	**2.5**	**3.25**	**3.4**	**10**	**10**	**8.5**

* No defined stream channel. Water spreads out over the entire width of the wetlands.

Table 2: NPDES Flow Data for Outfalls Discharging into Sandia Canyon

1999 Flow Data				
Outfall #	**EPA #[1]**	**Description**	**Flow (MGD)[2]**	**Sample Date**
001	01A	Power Plant	0.3600	01/14/99
001	01A	Power Plant	0.3600	02/19/99
001	01A	Power Plant	0.8640	03/24/99
001	01A	Power Plant	0.0576	04/07/99
001	01A	Power Plant	0.5314	05/26/99
001	01A	Power Plant	0.9000	06/11/99
001	01A	Power Plant	0.9317	07/13/99
001	01A	Power Plant	0.5558	08/11/99
001	01A	Power Plant	0.7243	09/22/99
001	01A	Power Plant	0.0374	10/19/99
001	01A	Power Plant	0.0648	11/22/99
001	01A	Power Plant	0.0605	12/07/99
Mean Flow MGD (GPD)				*0.4540 (454,000)*
Minimum Flow MGD (GPD)				*0.0374 (37,4000)*
Maximum Flow MGD (GPD)				*0.9317 (931,700)*
027	03A	Treated Cooling Water	0.0011	04/07/99
027	03A	Treated Cooling Water	0.2880	07/21/99
027	03A	Treated Cooling Water	0.0720	09/28/99
Mean Flow MGD (GPD)				*0.1204(120,400)*
Minimum Flow MGD (GPD)				*0.0011 (1,100)*
Maximum Flow MGD (GPD)				*0.2880 (288,000)*
1998 Flow Data				
Outfall #	**EPA #**	**Description**	**Flow (MGD)**	**Sample Date**
001	01A	Power Plant	0.0360	01/16/98
001	01A	Power Plant	0.0432	02/11/98
001	01A	Power Plant	0.0288	03/12/98
001	01A	Power Plant	0.0576	04/13/98
001	01A	Power Plant	0.0576	05/15/98
001	01A	Power Plant	0.0504	06/09/98
001	01A	Power Plant	0.0864	07/13/00
001	01A	Power Plant	0.0576	08/20/98
001	01A	Power Plant	0.7200	09/17/98
001	01A	Power Plant	0.0317	10/23/98
001	01A	Power Plant	0.1440	11/10/98
001	01A	Power Plant	0.2880	12/17/98
Mean Flow MGD (GPD)				*0.1334 (133,400)*
Minimum Flow MGD (GPD)				*0.0288 (28,800)*
Maximum Flow MGD (GPD)				*0.7200 (720,000)*
027	03A	Treated Cooling Water	0.0144	04/28/98
027	03A	Treated Cooling Water	0.0086	05/18/98
027	03A	Treated Cooling Water	0.1296	06/26/98
027	03A	Treated Cooling Water	0.0864	09/29/98
027	03A	Treated Cooling Water	0.0001	11/10/98
Mean Flow MGD (GPD)				*0.0478 (47,800)*
Minimum Flow MGD (GPD)				*0.0001 (1,000)*
Maximum Flow MGD (GPD)				*0.1296 (129,600)*

1 EPA = Environmental Protection Agency 2 MGD = million gallons per day GPD = gallons per day

by exotic, or non-native, species. Vegetation is maintained by mechanisms such as seed banks, seed dispersal, and vegetation propagation. The emphasis is on structure of the plant community revealed by species composition and abundance, and

- maintenance of habitat structure: soil, vegetation, and other ecosystem aspects required by animals for feeding, cover, and reproduction.

Within each index there are a series of functional variables. Each variable is scaled from 0.0 to 1.0 with 1.0 being the most desired condition. The list of variables and the function index equations are given in Table 3.

Because the model was originally developed for a different geographic area and has not been tested for our area, we used the model to compare different segments of the wetland to each other to give us a comparative look at function. Sandia wetland was divided into three 700-ft-long segments; upper, middle, and lower (Figure 8). The assessment model was run for each segment and then the three segments were compared to each other. The segment with the lowest value would then have the highest priority for any type of mitigation. We used the index functions and variables to show where wetland mitigation measures would provide the most gain. Data for each variable were taken from the field data collection performed to determine wetland size, extent, and mapping (Appendices 2 and 4). Figures 9 through 20 show the variable output for each index of function for each wetland segment evaluated. The index of function values for the five indices of function are given in Table 4.

For the five indices of function examined, Segment 1 had the lowest functions calculated and Segment 3 consistently had the highest function. However, at the very eastern edge of Segment 3, gully erosion is occurring. Because this was at the easternmost boundary of the marsh, it did not influence the calculations of function. However, if unchecked, erosion could result in lower functions within this segment.

The first two indices of function (characteristics hydrology and retention, conversion, and release of elements and compounds) have the highest potential for improvement in Segment 1. Their function values are the lowest for the segment and some of their contributing variables would respond well to mitigation and active management. These variables are

- hydrology alteration,
- source area flow interception by the wetland,
- sedimentation delivered to the wetland, and
- vegetation density.

These variables and functions as applied to mitigation and management will be discussed further in the following section.

X. EVALUATION OF FLOW SCENARIOS

The Sandia wetland was enhanced and increased in size over the last many years because of industrial effluent discharges into the canyon. These discharges have occurred on a regular and consistent interval to support wetland vegetation and soils. Wetlands are an important habitat component, but equally as important is their potential to trap sediment, abate storm and flood waters, and enhance water quality. Over the last 10 years, numerous impacts have occurred in Sandia wetland affecting its ability to function at an optimal level. Over the next several years, Sandia wetland will most likely continue to experience impacts, mainly changes in discharge volume. We have evaluated the potential effect of five discharge flow scenarios (no flow change, 20% flow increase, 35% flow reduction, 75% flow reduction, and no discharge) on the wetland function, size, and extent. We used the 1998 discharge flow as our current flow and made all increase and decrease in flow based on this (Table 5).

Scenario: No change in flow

The Sandia wetland currently is experiencing unmitigated impacts. These impacts have greatly affected the Sandia wetland function in Segment 1 by reducing hydrology to the wetland area and reducing the wetland's capacity to retain, release,

Figure 8: The three analysis areas used in the wetland functional assessment.

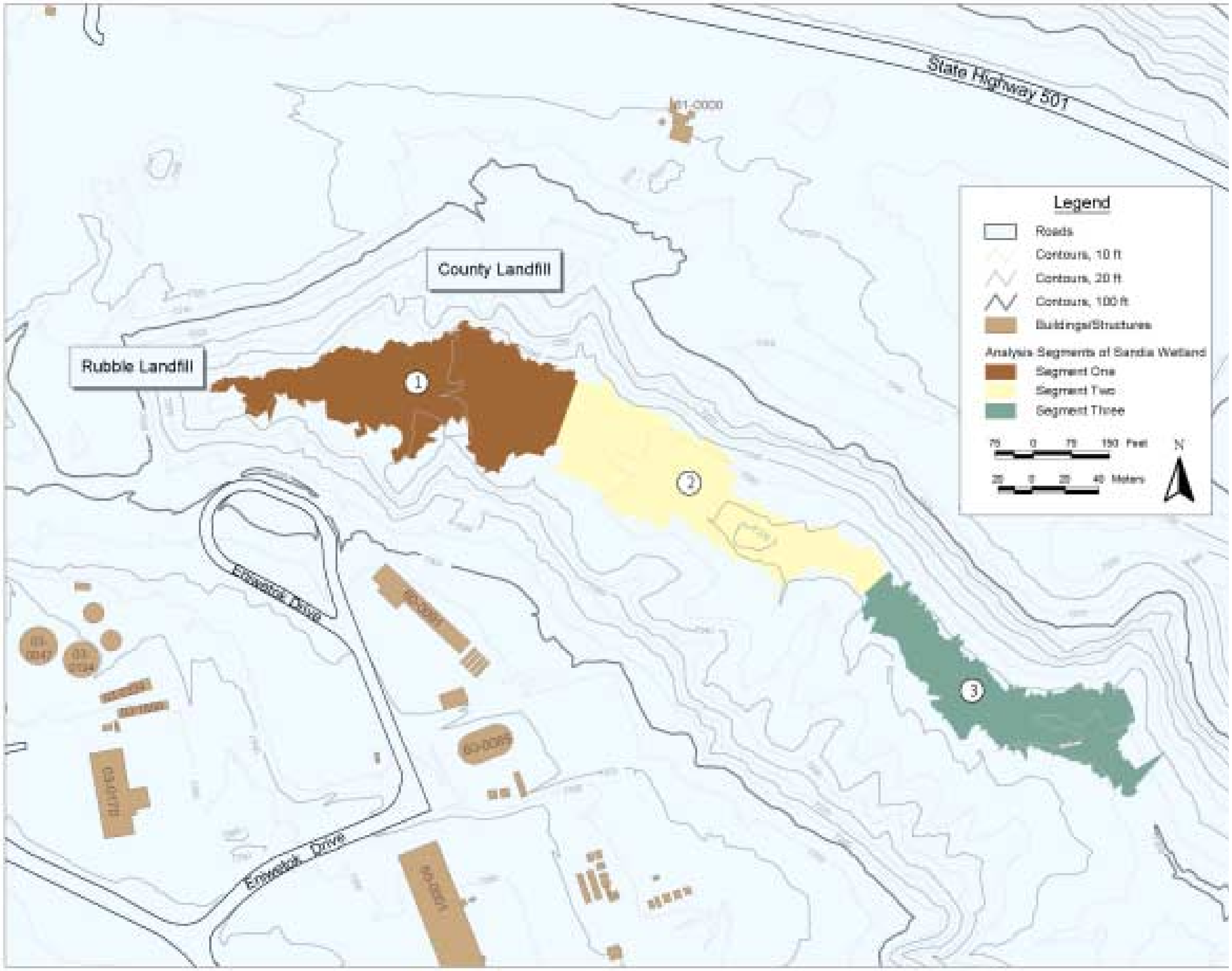
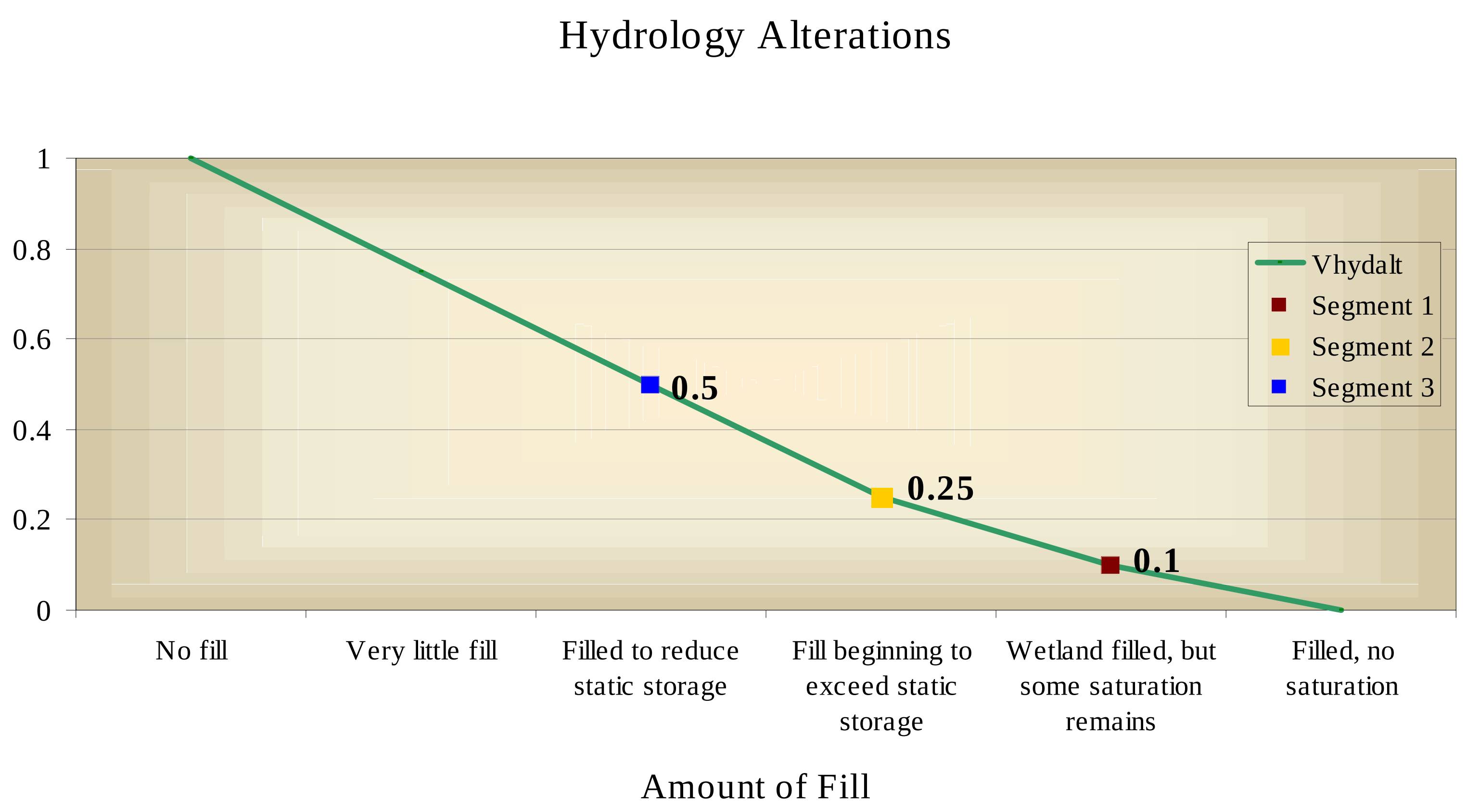
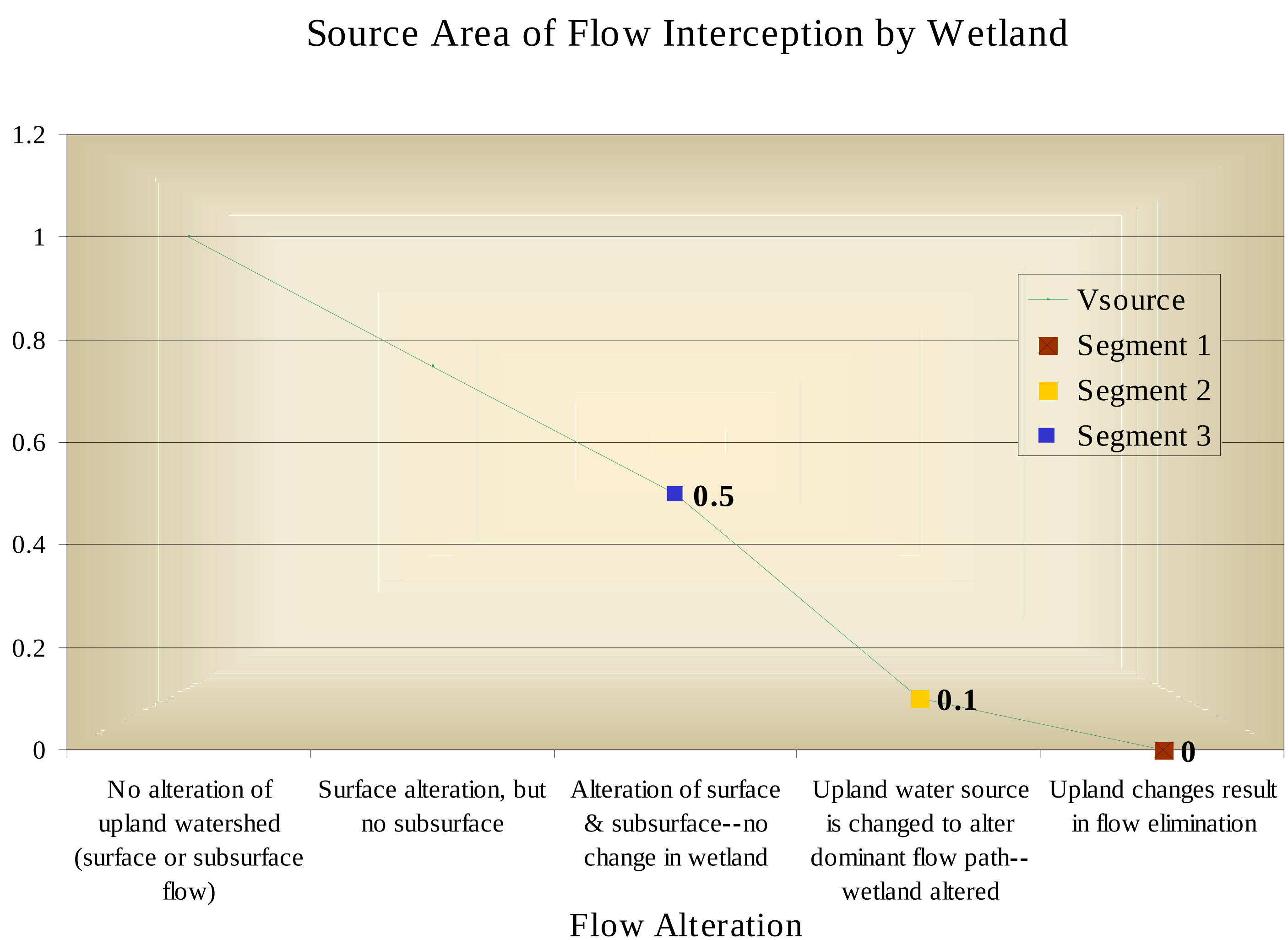


Figure 9: Hydrology alteration calculated for each segment of the Sandia wetland.



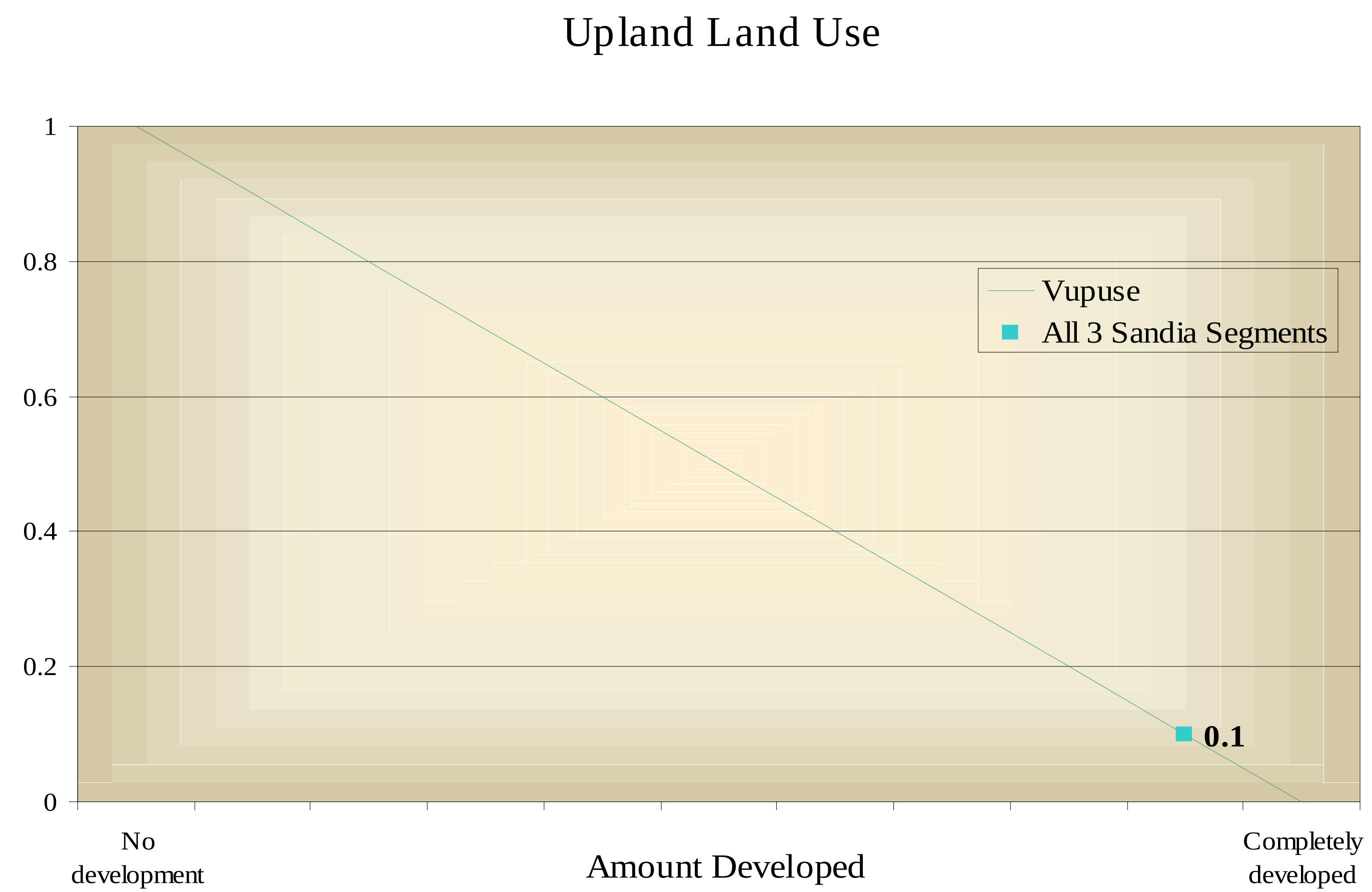
Based on field observations and measurements of fill noted in hydric soil pits.

Figure 10: The source area flow interception by the wetland calculated for each segment of the Sandia wetland.



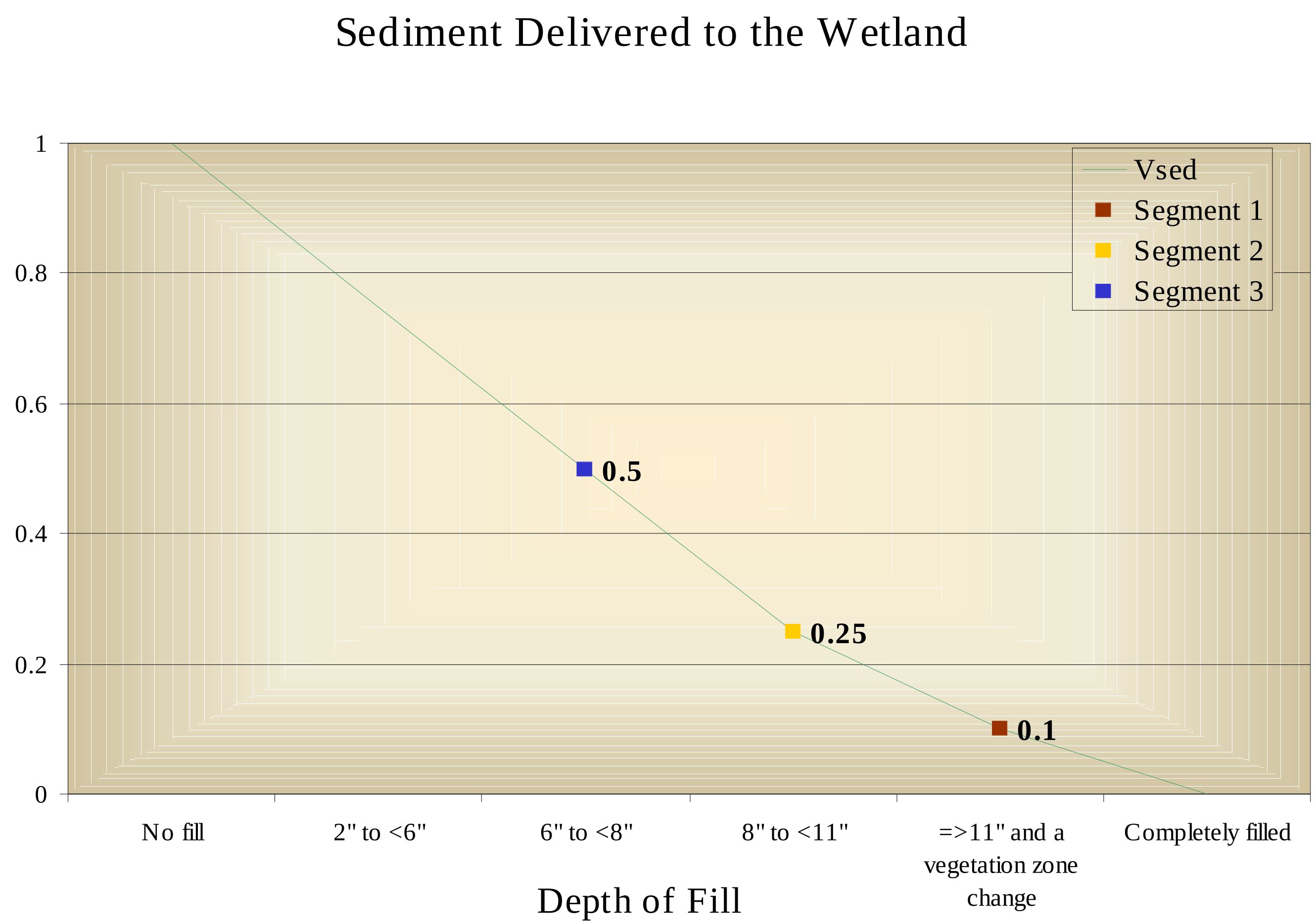
Determined by historical knowledge (e.g., moving NPDES discharge points and TA-3 development) and field observation.

Figure 11: The upland land use calculated for each segment of the Sandia wetland.



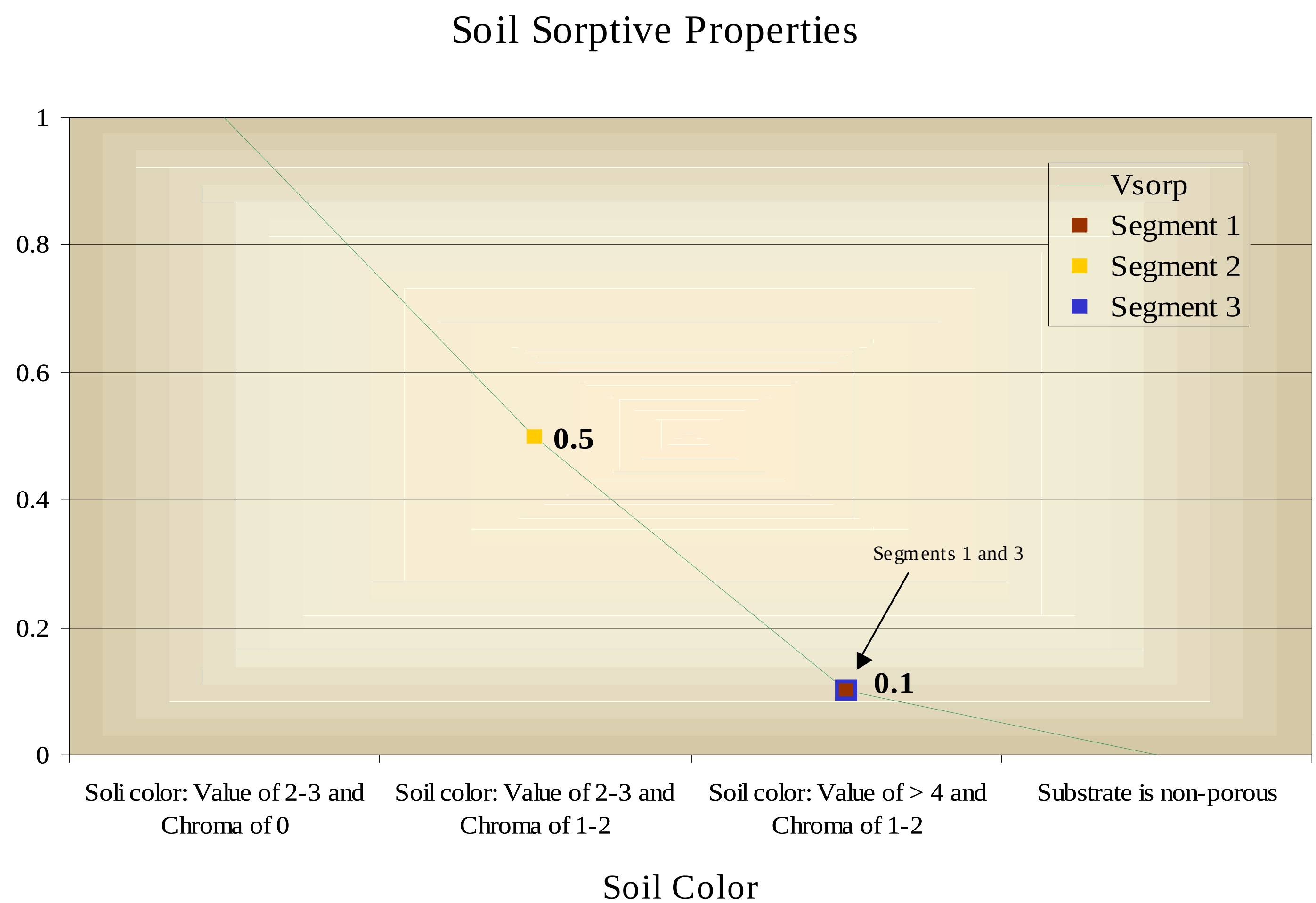
Determined by the amount of developed area in the upper watershed compared to the total area of the upper watershed (GPS analysis).

Figure 12: Sediment delivered to a wetland calculated for each segment of the Sandia wetland.



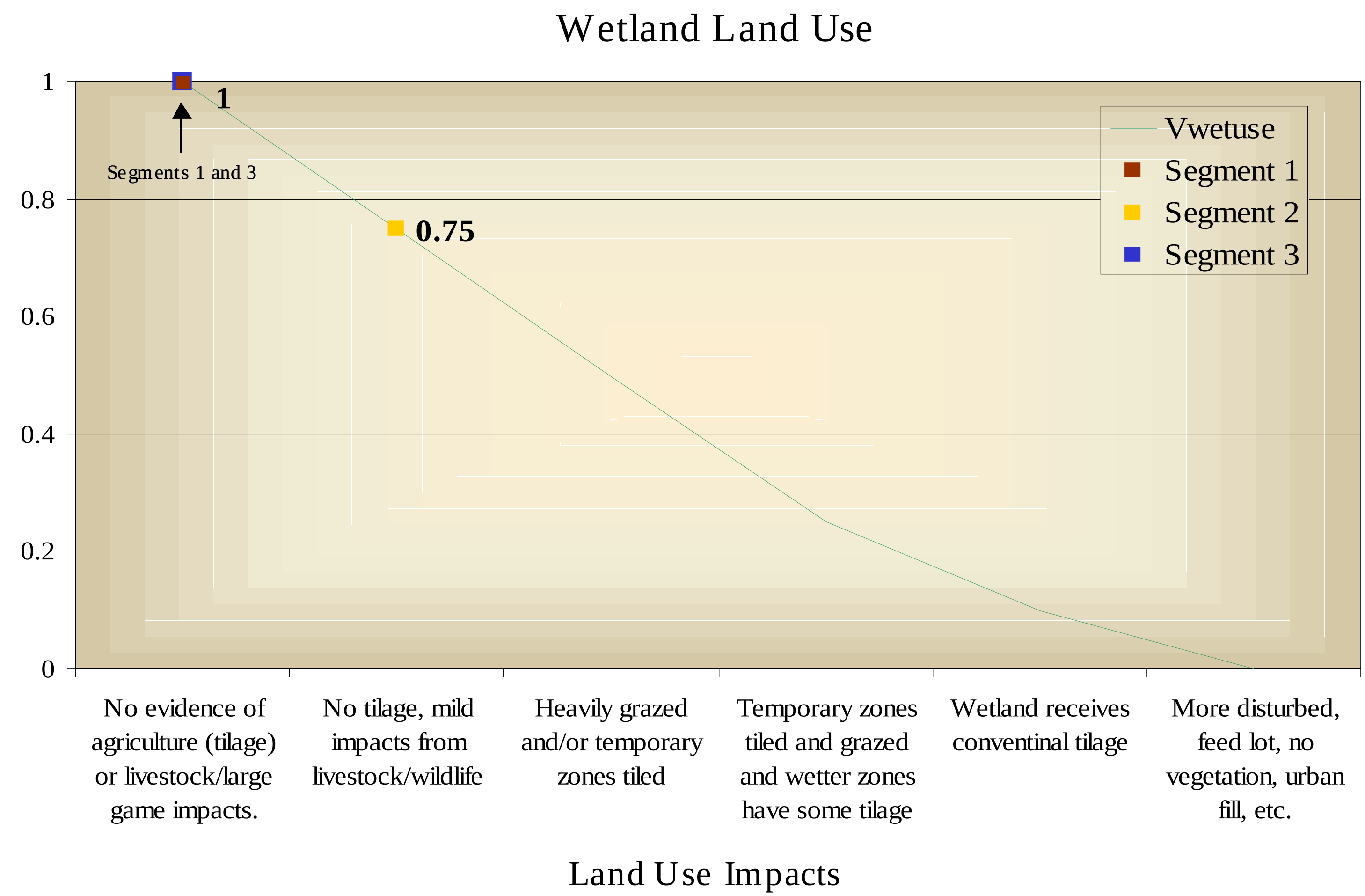
Determined by measuring sediment in the three different segments.

Figure 13: Soil sorptive properties calculated for each segment of the Sandia wetland.



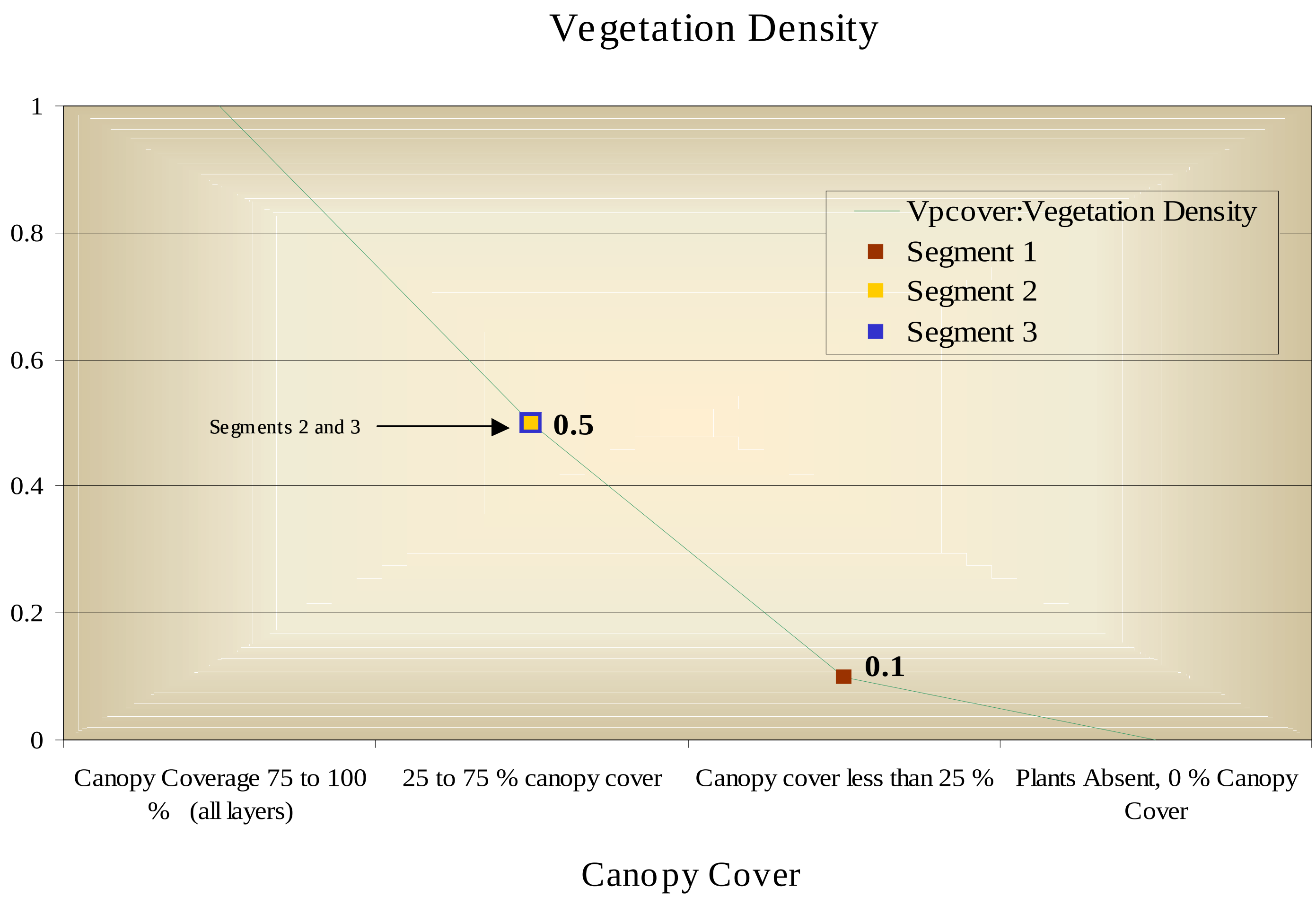
Determined by measuring sediment in the three different segments.

Figure 14: Wetland use calculated for each segment of the Sandia wetland.



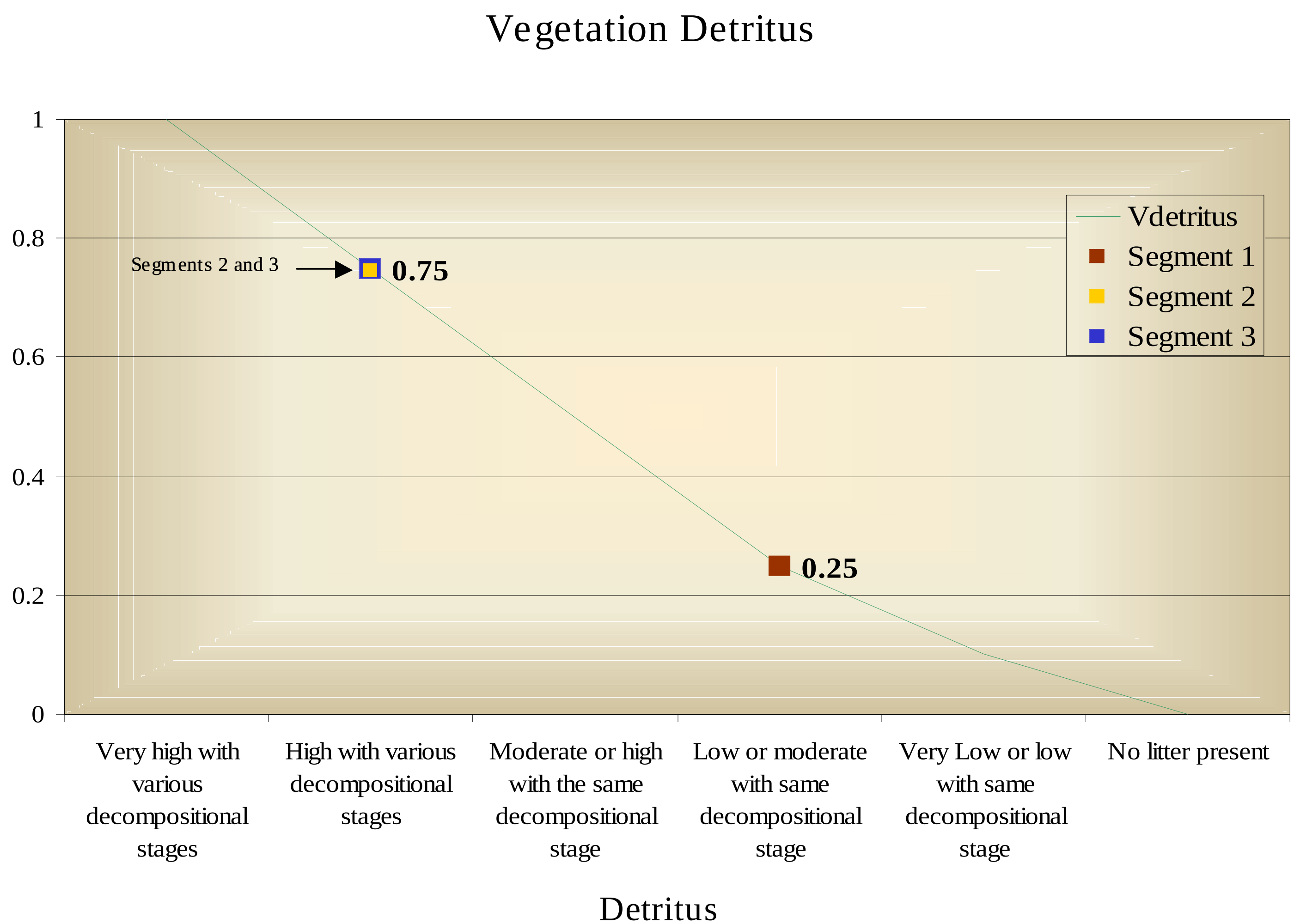
Determined by field observations, elk use (bedding, trampling, etc) was considered.

Figure 15: Vegetation density calculated for each segment of the Sandia wetland.



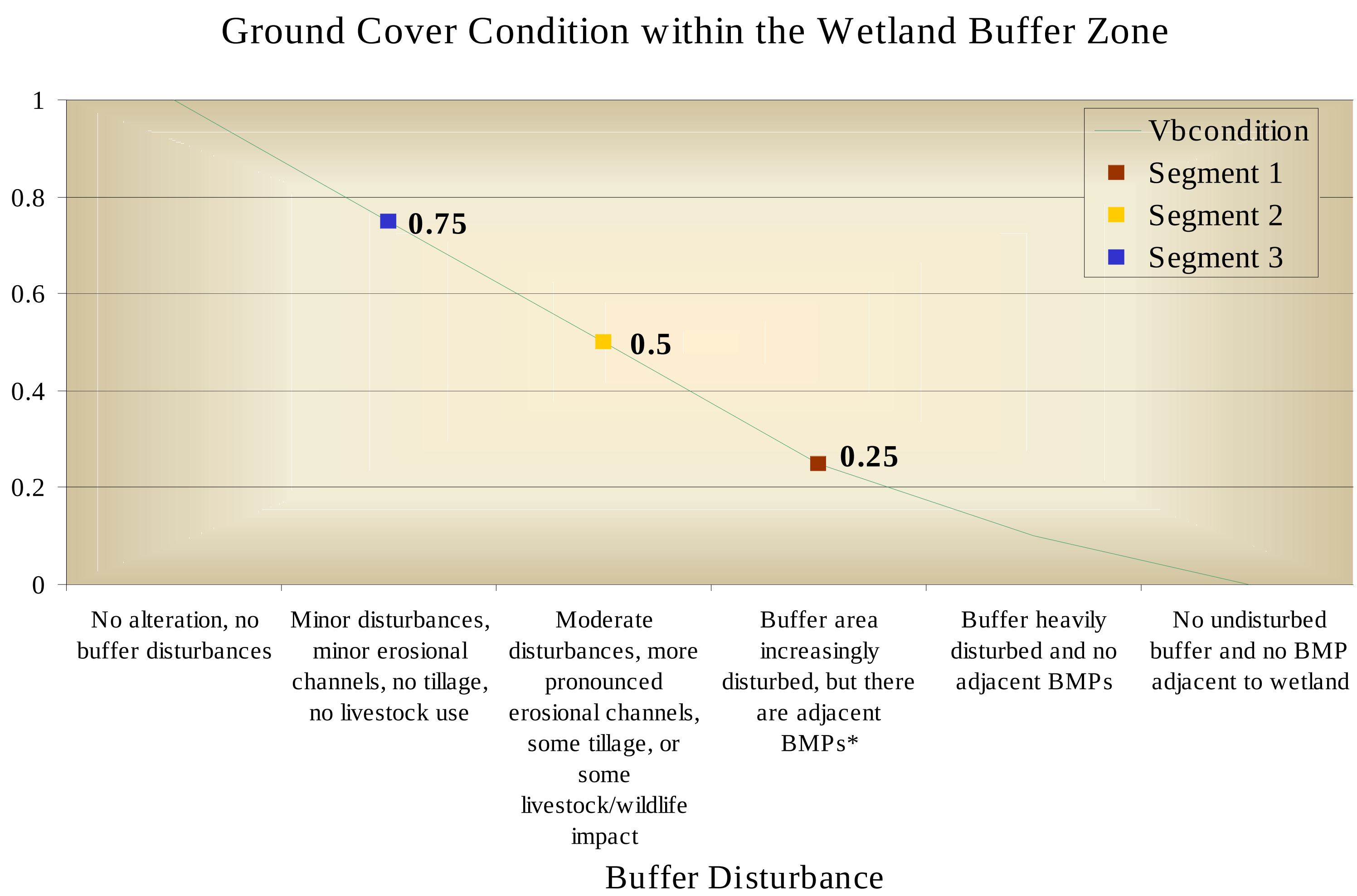
Determined with vegetation transects.

Figure 16: Vegetation detritus calculated for each segment of the Sandia wetland.



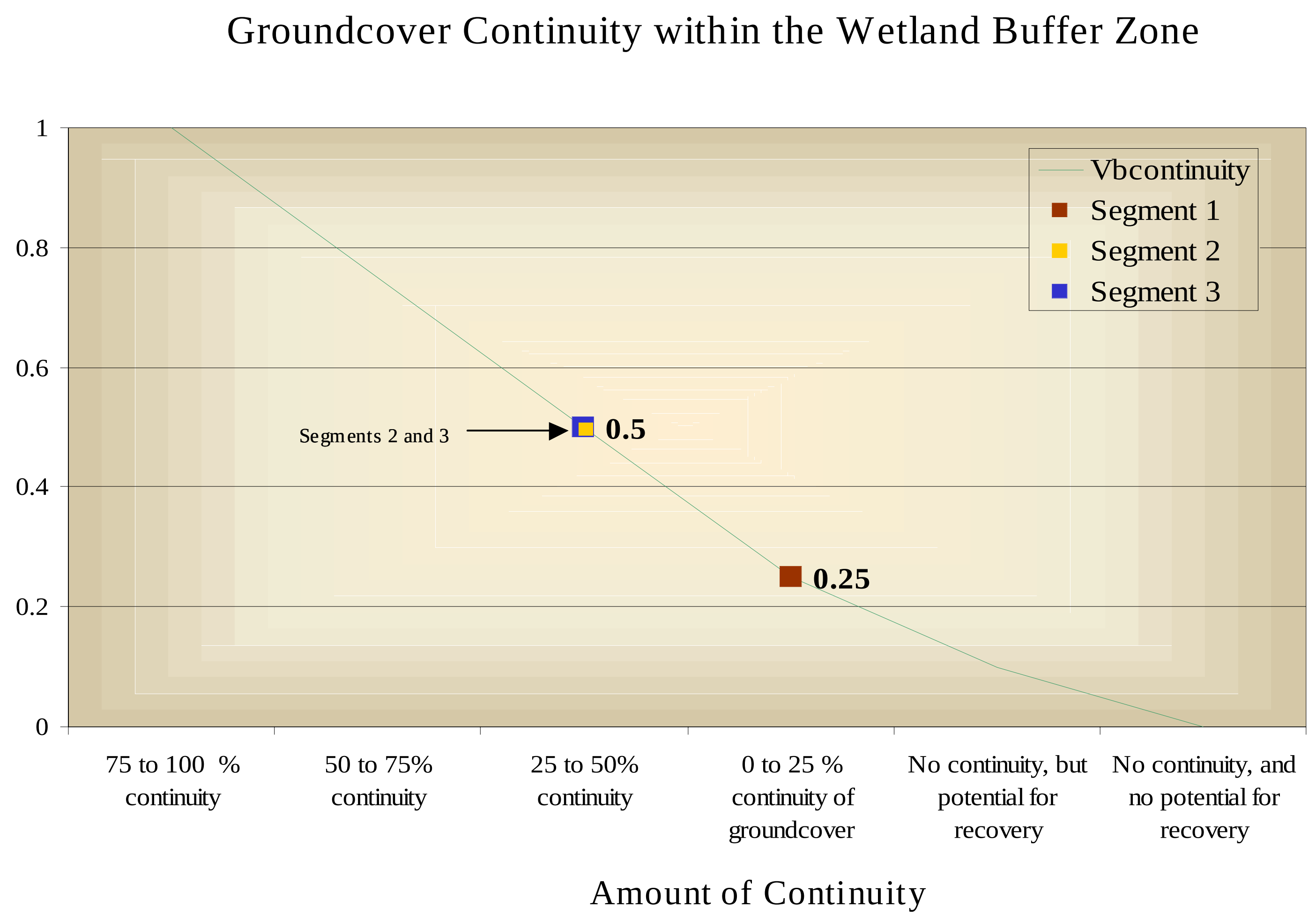
Determined with vegetation transects.

Figure 17: The ground cover condition within the wetland buffer zone calculated for each segment of the Sandia wetland.



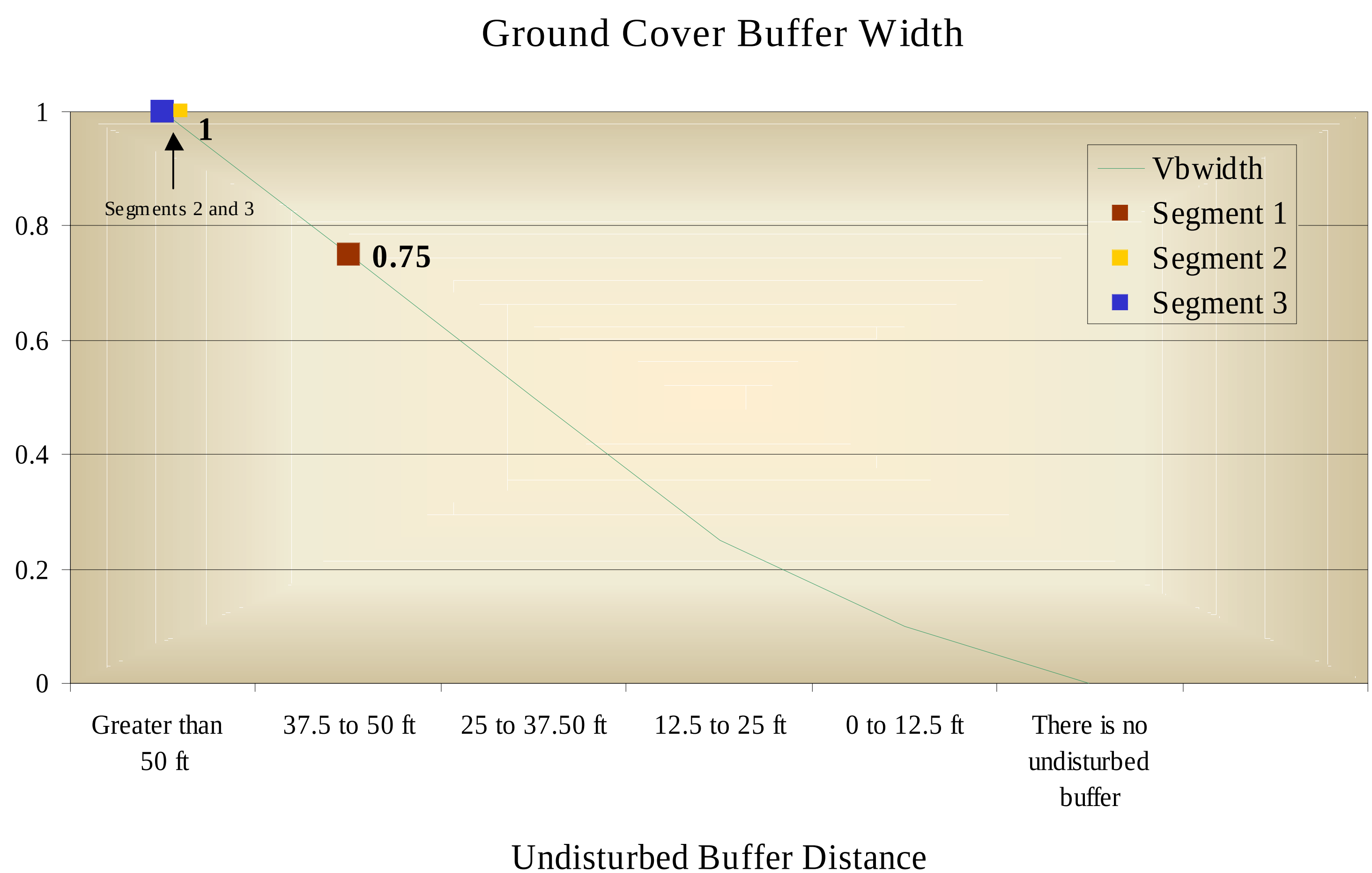
Determined from vegetation transects and field observations.
* BMPs = best management practices

Figure 18: The ground cover continuity within the wetland buffer zone calculated for each segment of the Sandia wetland.



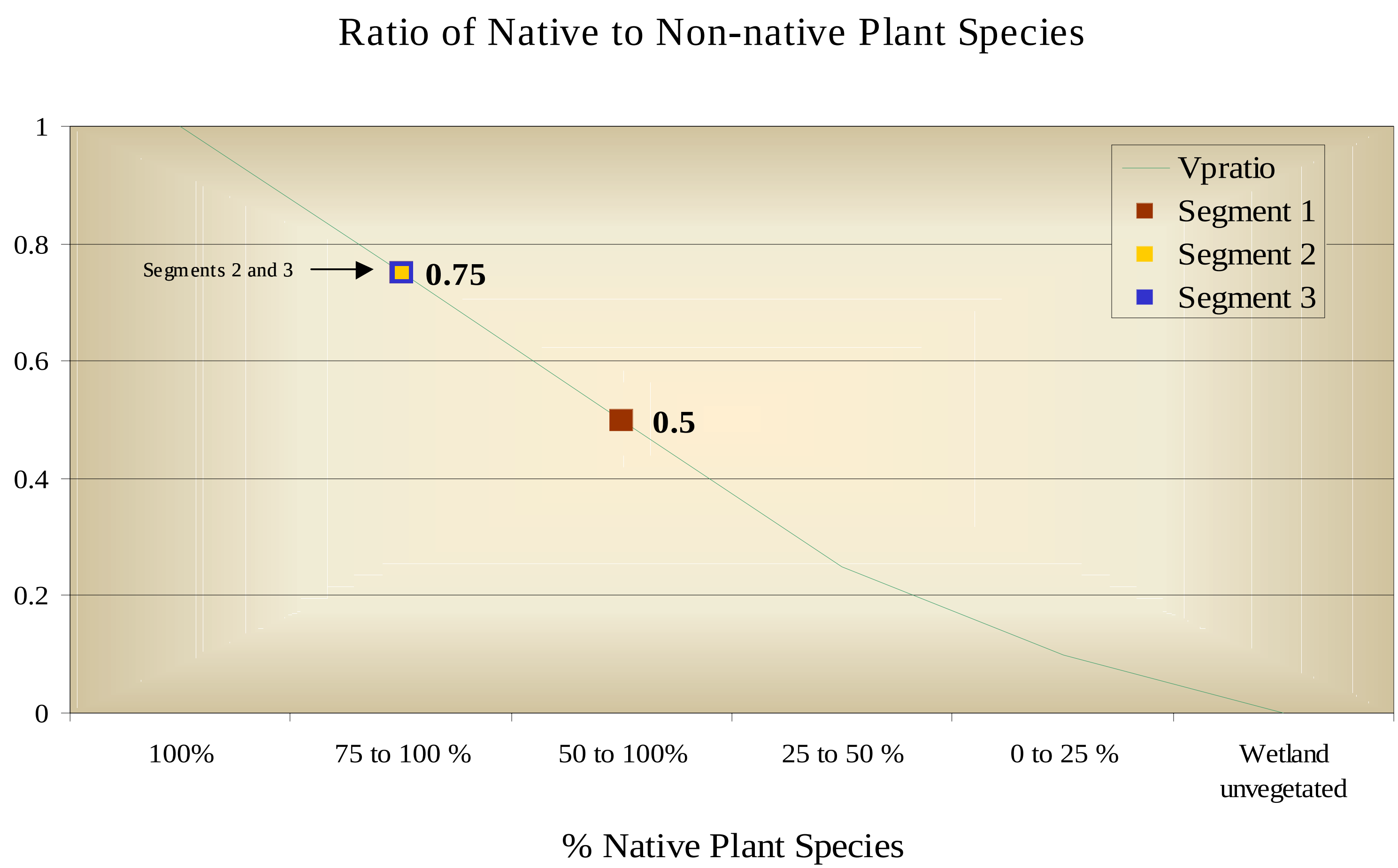
Determined from vegetation transects and field observations.

Figure 19: The ground cover buffer width within the wetland buffer zone calculated for each segment of the Sandia wetland.



Determined from vegetation transects and field observations.

Figure 20: Ratio of native to non-native plant species calculated for each segment of the Sandia wetland.



Determined from vegetation transects and field observations.

Table 3: List of index function variables and equations for the calculation of each index function.

Variable Name	Abbreviation	Description
• Maintenance of characteristics hydrology		
Variable Name	***Abbreviation***	***Description***
hydrology alteration	V_{hydalt}	Examines the depth of fill within a wetland that would impact the hydrology
source area of flow interception by wetland	V_{source}	Alteration of the upper watershed
upland land use	V_{upuse}	Dominant upland land use and condition
sediment delivered to wetland	V_{sed}	Amount of sedimentation delivered to the wetland
soil sorptive properties	V_{sorpt}	The physical ability of soils to hold and transmit elements/compounds in the upper 18 inches of the soil
wetland land use	V_{wetuse}	Dominant land use and condition of the wetland
$= SQRT(V_{hydalt} * (((V_{source} + V_{upuse} + V_{sed})/3) + ((V_{sorpt} + V_{wetuse})/2)/2))$		
• Retention, conversion, and release of elements and compounds		
Variable Name	***Abbreviation***	***Description***
source area flow interception by wetland	V_{source}	Alteration of the upper watershed
hydrology alteration	V_{hydalt}	Examines the depth of fill within a wetland that would impact the hydrology
upland land use	V_{upuse}	Dominant upland land use and condition
wetland land use	V_{wetuse}	Dominant land use and condition of the wetland
sedimentation delivered to wetland	V_{sed}	Amount of sedimentation delivered to the wetland
vegetation density	V_{pcover}	The abundance of live woody and herbaceous plants within all zones within the wetland
detritus	$V_{detritus}$	The presence of litter in several stages of decomposition
soil sorptive properties	V_{sorpt}	The physical ability of soils to hold and transmit elements/compounds in the upper 18 inches of the soil
ground cover condition	$V_{bcondition}$	Dominant land use/ground cover condition within the buffer area around the wetland
ground cover buffer continuity	$V_{bcontinuity}$	Continuity of the ground cover within the buffer area around the wetland
ground cover buffer width	V_{bwidth}	Width of the grassland/ground cover buffer surrounding the outermost wetland edge.
$= ((V_{source} + V_{hydalt})/2 + (V_{upuse} + V_{wetuse} + V_{sed})/3 + (V_{pcover} + V_{detritus})/2 + V_{sorpt} + (V_{bcondition} + V_{bcontinuity} + V_{bwidth})/3)/5)$		
• Retention of particles		
Variable Name	***Abbreviation***	***Description***
upland land use	V_{upuse}	Dominant upland land use and condition

Table 3: continued

sedimentation delivered to wetland	V_{sed}	Amount of sedimentation delivered to the wetland
source area flow interception by wetland	V_{source}	Alteration of the upper watershed
hydrology alteration	V_{hydalt}	Examines the depth of fill within a wetland that would impact the hydrology
wetland land use	V_{wetuse}	Dominant land use and condition of the wetland
ground cover condition	$V_{bcondition}$	Dominant land use/ground cover condition within the buffer area around the wetland.
ground cover buffer continuity	$V_{bcontinuity}$	Continuity of the ground cover within the buffer area around the wetland.
ground cover buffer width	V_{bwidth}	Width of the grassland/ground cover buffer surrounding the outermost wetland edge
$= (V_{hydalt} + V_{wetuse} + V_{upuse} + V_{sed} + ((V_{bcondition} + V_{bcontinuity} + V_{bwidth})/3)/5)$		
• **Maintenance of characteristic plant community**		
Variable Name	***Abbreviation***	***Description***
wetland land use	V_{wetuse}	Dominant land use and condition of the wetland
sedimentation delivered to wetland	V_{sed}	Amount of sedimentation delivered to the wetland
hydrology alteration	V_{hydalt}	Examines the depth of fill within a wetland that would impact the hydrology
ratio of native to non-native plant species	V_{pratio}	The ratio of native to non-native plant species present in the wetland
vegetation density	V_{pcover}	The abundance of live woody and herbaceous plants within all zones within the wetland
detritus	$V_{detritus}$	The presence of litter in several stages of decomposition.
ground cover condition	$V_{bcondition}$	Dominant land use/ground cover condition within the buffer area around the wetland
ground cover buffer continuity	$V_{bcontinuity}$	Continuity of the ground cover within the buffer area around the wetland
ground cover buffer width	V_{bwidth}	Width of the grassland/ground cover buffer surrounding the outermost wetland edge
$= (V_{wetuse} + V_{sed} + V_{hydalt} + V_{pratio} + V_{pcover} + V_{upuse} + V_{detritus} + ((V_{bcondition} + V_{bcontinuity} + V_{bwidth})/3)/7)$		
• **Maintenance of habitat structure**		
Variable Name	***Abbreviation***	***Description***
upland land use	V_{upuse}	Dominant upland land use and condition
wetland land use	V_{wetuse}	Dominant land use and condition of the wetland
sedimentation delivered to wetland	V_{sed}	Amount of sedimentation delivered to the wetland
ratio of native to non-native plant species	V_{pratio}	The ratio of native to non-native plant species present in the wetland

Table 3: continued

detritus	$V_{detritus}$	The presence of litter in several stages of decomposition
hydrology alteration	V_{hydalt}	Examines the depth of fill within a wetland that would impact the hydrology
ground cover condition	$V_{bcondition}$	Dominant land use/ground cover condition within the buffer area around the wetland
ground cover buffer continuity	$V_{bcontinuity}$	Continuity of the ground cover within the buffer area around the wetland
ground cover buffer width	V_{bwidth}	Width of the grassland/ground cover buffer surrounding the outermost wetland edge
$= ((V_{upuse} + V_{wetuse} + V_{sed} + (V_{pratio} + V_{pcover})/2 + V_{detritus} + V_{hydalt} + ((V_{bcondition} + V_{bcontinuity} + V_{bwidth})/3)/7)$		

Table 4: Five index of function values for the three Sandia wetland segments.

Index of Function	Segment 1	Segment 2	Segment 3
characteristics hydrology	0.175	0.197	0.478
retention, conversion, and release of elements and compounds	0.228	0.339	0.501
retention of particles	0.343	0.373	0.57
maintain characteristics plant community	0.352	0.538	0.678
maintain habitat structure	0.324	0.463	0.6036

and convert elements/compounds. The impacts are seen in the current wetland storage. The wetland has experienced hydrology alterations that have caused the wetland to become de-watered (through an incised stream channel and gully erosion) or adjacent areas filled. The vegetative plant community in a large area of Segment 1 has shifted from a wetland plant community to an upland community and the cover associated with the current vegetation has decreased. All of these impacts have resulted in a 48% reduction in wetland size and extent.

Table 5: Flow rates used for each scenario.

Scenario	Assumed Flow
No change	181,200 gpd
20% increase	226,500 gpd
35% reduction	117,780 gpd
75% reduction	45,300 gpd

Mitigation measures, active management, and monitoring would be required to increase wetland function (characteristic hydrology and retention, conversion, and release of elements/compounds). These mitigation measures are designed to return/increase function by increasing variable values that contribute to this function. Mitigation measures, at a minimum, need to include

- control releases of discharge volumes,
- control sediment input (current best management practices [BMPs] need to be evaluated, revised/increased, and monitored),
- install a series of small check dams within the stream channel of the wetland (low-disturbance methods are recommended using material found on site),
- mitigate any areas of head cutting with head cut control structures (Zeedyk 1999) (use low-disturbance methods such as logs found

on site),
- perform stream channel manipulations to reduce channelization (increase channel meandering and raise channel floor through the use of sand bagging or other low-intrusive methods), and
- plant wetland/riparian tree and shrub species on streambanks requiring stabilization.

Scenario: 20% Flow Increase

Without mitigation a 20% increase in flow would potentially accelerate the reduction of the characteristics hydrology function and the retention functions of the wetland. The increased flow volume would contribute to the incised stream channel and the retention function and time would decrease. The decrease in hydrology function (through de-watering and gully erosion) and retention would not be contained in Segment 1, but would contribute to lower functions throughout the wetland. Any substantial increase in flow in Sandia Canyon would require the following mitigation measures:
- control releases of discharge volumes,
- control sediment input (BMPs need to be evaluated, revised/increased, and monitored),
- install a series of small check dams within the stream channel of the wetland (low-disturbance methods are recommended using material found on site),
- mitigate any areas of head cutting with head cut control structures (Zeedyk 1999) (use low-disturbance methods such as logs found on site),
- perform stream channel manipulations to reduce channelization (increase channel meandering and raise channel floor through the use of sand bagging or other low-intrusive methods), plant wetland/riparian tree and shrub species on streambanks requiring stabilization,
- create a series of small open water areas for storage of increased volume and increase the retention time within the wetland, and
- monitor to evaluate the effectiveness of mitigation and provide feedback for future mitigation.

Scenario: 35% reduction in flow

A 35% reduction in discharge flow to Sandia wetland would have impacts to the size, extent, and function of the wetland if no mitigation measures were implemented. This reduction in flow would probably have the greatest impact to Segments 2 and 3 of the wetland. In these segments the stream has many small branches and fans out over the cattail marsh. With a 35% reduction in flow, the fringes of these areas would begin to lose hydrology, and wetland vegetation would begin to change to upland species. We expect, without mitigation, this would result in a 20% to 35% reduction in wetland size. The retention and hydrology character function could possibly increase or decrease in this scenario, depending on how the water is released. A blow down of large plugs of water would cause the upper stream channel to become more incised and continue with gully erosion, decreasing hydrology character and the retention function. However, if the discharge is controlled, hydrology character and retention function would most likely increase in Segment 1. The following mitigation measures would be required to prevent a reduction in wetland size and increase/maintain wetland function:
- control releases of discharge volumes,
- control sediment input (current BMPs need to be evaluated, revised/increased, and monitored),
- install a series of small check dams within the stream channel of the wetland (low-disturbance methods are recommended using material found on site),
- mitigate any areas of head cutting with head cut control structures (Zeedyk 1999) (use low-disturbance methods such as logs found on site),
- perform stream channel manipulations to reduce channelization (increase channel meandering and raise channel floor through

the use of sand bagging or other low-intrusive methods),
- plant wetland/riparian tree and shrub species on streambanks requiring stabilization, and
- monitor and evaluate the effectiveness of mitigation and provide feedback for future mitigation.

For this scenario, if all mitigation measures have been implemented and size and function reduction is still occurring, then an open water area (shallow depression) should be created to provide for longer retention time and further saturation.

Scenario: 75% reduction in flow

A 75% reduction in discharge flow to Sandia wetland would have impacts to the size, extent, and function of the wetland if no mitigation was implemented. This reduction in flow would probably have the greatest impact to Segments 2 and 3 of the wetland. In these segments the stream has many small branches and fans out over the cattail marsh. With a 75% reduction in flow, the fringes of these areas would begin to lose hydrology rapidly and would be lost further into the wetland. The size of the wetland would change fairly dramatically with a 50% to 75% loss. The majority of the wetland would be comprised of a series of small belts of cattails surrounding the stream channel. Old wetland areas would be dominated by upland plant species. With good mitigation the wetland loss could be decreased. Mitigation could probably prevent the loss from exceeding 40% to 50%. The retention and hydrology character function could possibly increase or decrease in this scenario, depending on how the water is released. A blow down of large plugs of water would cause the upper stream channel to become more incised and continue with the gully erosion, decreasing hydrology character and the retention function. However, if the discharge is controlled, hydrology character and retention function would most likely increase in Segment 1. The following mitigation measures are required to minimize the reduction of wetland and maintain wetland function:

- control releases of discharge volumes,
- control sediment input (current BMPs need to be evaluated, revised/increased, and monitored),
- install a series of small check dams within the stream channel of the wetland (low-disturbance methods are recommended using material found on site),
- mitigate any areas of head cutting with head cut control structures (Zeedyk 1999) (use low-disturbance methods such as logs found on site)
- perform stream channel manipulations to reduce channelization (increase channel meandering and raise channel floor through the use of sand bagging or other low-intrusive methods),
- plant wetland/riparian tree and shrub species on streambanks requiring stabilization,
- monitor and evaluate the effectiveness of the mitigation and provide feedback for future mitigation, and
- create open water to maximize water retention time and provide longer-term storage.

For this scenario, creating open water areas would be essential for controlling wetland loss. Open water areas would provide longer-term storage and dramatically increase retention time. Open water areas would also increase the habitat diversity in the canyon and provide wildlife watering in an area where water availability has decreased.

Scenario: Zero Discharge

The Sandia wetland relies heavily on industrial effluent discharges. These discharges have increased and maintained the wetland over the past 30 years and the wetland has become part of the normal conditions within this canyon system. Without effluent discharge the Sandia wetland would decrease in size dramatically. The once six-acre wetland would most likely be reduced to less than one acre. Fauna and flora that are dependent on the wetland habitat would also decrease. Wildlife that use Sandia Canyon for watering would also be affected. Watering may not even be available in the small wetland (only soils saturated, no surface water). Mitigation for the zero discharge scenario would need to be in the form of a mitigation-in-kind or in combination with Sandia wetland mitigation. Mitigation-in-kind allows you to mitigate and enhance another location when on-site mitigation is not possible or does not fully mitigate the impact.

Possible Sandia Canyon mitigation measures include

- control sediment input (current BMPs need to be evaluated, revised/increased, and monitored),
- mitigate any areas of head cutting with head cut control structures (Zeedyk 1999) (use low-disturbance methods such as logs found on site),
- where possible, perform stream channel manipulations to reduce channelization (increase channel meandering and raise channel floor through the use of sand bagging or other low-intrusive methods),
- install wildlife watering tanks similar to those used on Forest Service lands, and
- plant wetland/riparian tree and shrub species on streambanks requiring stabilization.

Mitigation-in-kind would need to be conducted at another wetland site to increase that wetland's size and function. Possible mitigation-in-kind could occur in the Pajarito wetland. Pajarito wetland is a mostly self-sustaining wetland that exists adjacent to Pajarito Road near White Rock. This wetland habitat would respond well to the creation of open water and general habitat improvements by vegetation planting. Other areas of the Laboratory may also be suitable for mitigation-in-kind. If a zero discharge is seriously considered, we would need to evaluate suitable locations for mitigation-in-kind activities.

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APPENDIX 1: SANDIA CANYON

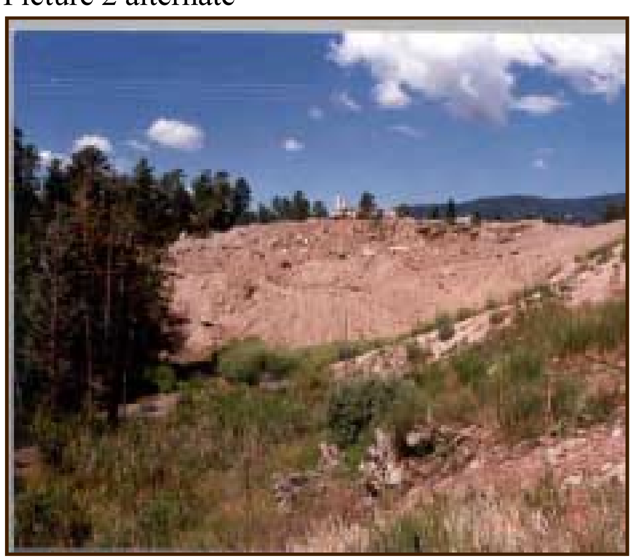
Photograph Comparisons from 1990 and 2000

Note: 1990 photographs are on the left side.

Picture 1

Picture 2

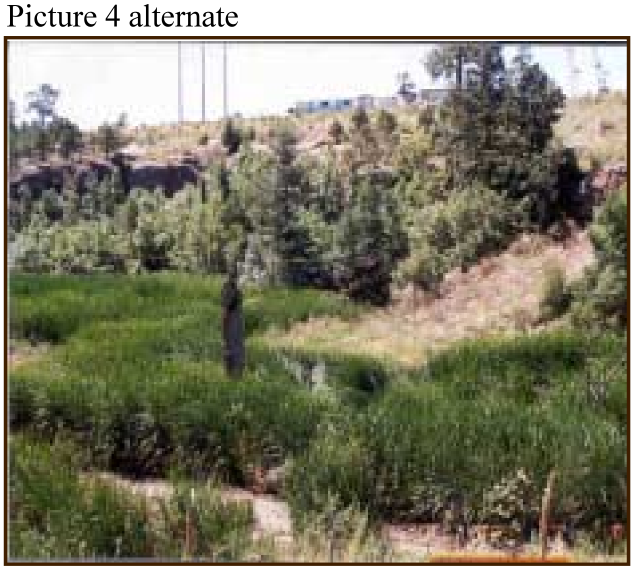
Picture 2 alternate



Picture 3

Picture 4

Picture 4 alternate



Picture 5


Picture 6


Picture 6 alternate


Picture 7

Picture 8

Picture 9

Picture 10

Picture 11

Picture 12

Picture 13

Picture 14

Picture 14 alternate

Picture 15

Picture 15 alternate

Picture 16

Picture 16 alternate

Picture 17

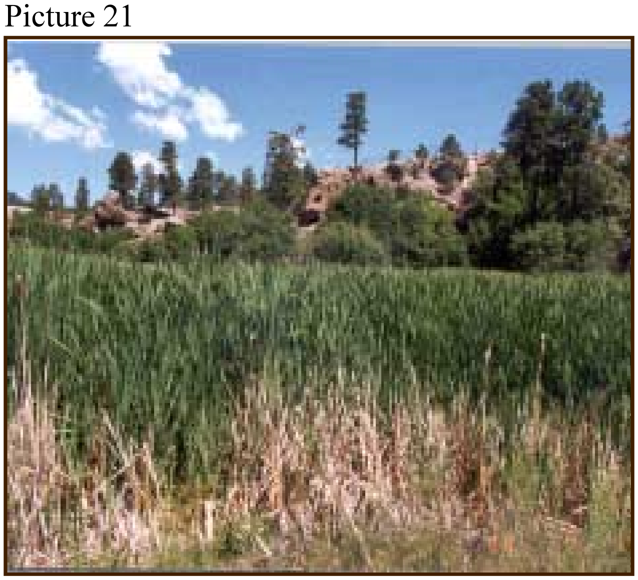
Picture 18

Not Found

Picture 19

Picture 20

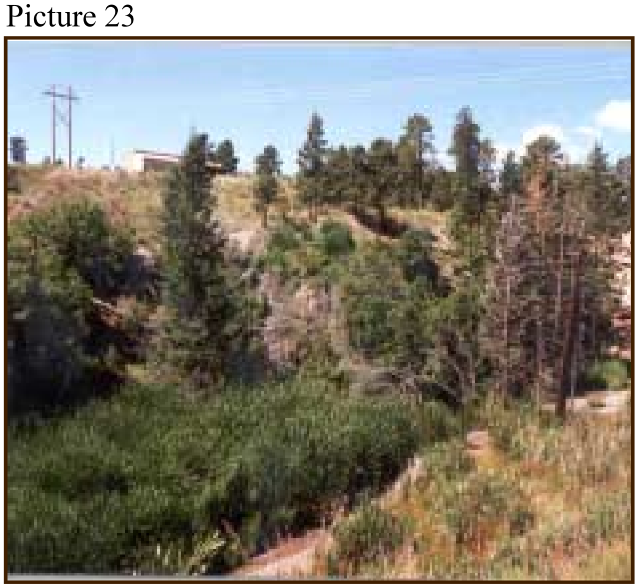
Picture 21



Picture 22

Picture 22 alternate

Picture 23



Picture 24

Picture 24 alternate

Picture 25

Picture 25 alternate

Picture 26

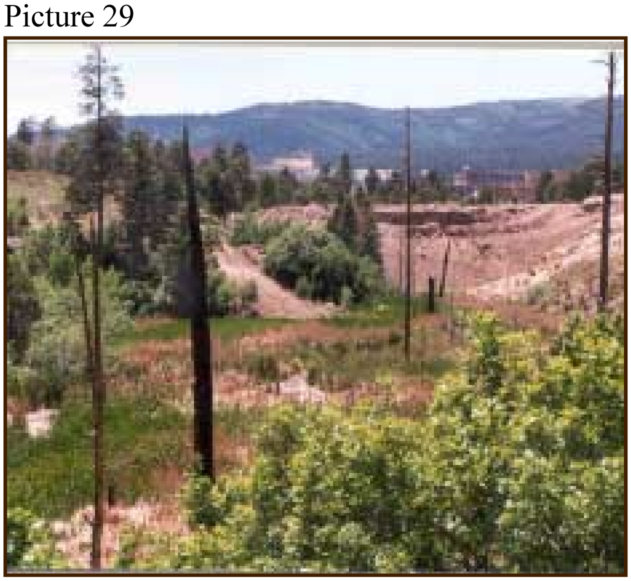
Not Found

Picture 27

Picture 28

Picture 28 alternate

Picture 29



Picture 29 alternate

Picture 29 alternate

Picture 30

Picture 31

Picture 32

Picture 33

Picture 34

Picture 34 alternate

Notes about year 2000 pictures:

- Pictures taken on November 1, 2000
- Pictures taken between 0830 and 1130 hours
- Weather was partly cloudy to sunny
- Temperature was ~32 degrees F
- Pictures taken by Chuck Hathcock with am Olympus Camedia Digital Camera C-2500L

APPENDIX 2

Sandia Wetland

Vegetation Transects

Transect Location: Upper Sandia Canyon
Date: June 20, 2000
Transect Number: 1 east end of wetland

Project Name: Sandia Characterization
Performed by: David K., Rhonda R., Kathy B.

Species	Scientific Name	10	20	30	40	50	60	70	80	90	100	Total	Average	Wetland Status
Understory														
Wheat Grass	*Agropyron trachycaulum*	20	1	100	15	1						137	13.7	Fac
Downey Chess	*Bromus tectorum*	15										15	1.5	Fac+
Penstemon	*Penstemon unk*	1			10							11	1.1	Fauc
Desert Trumpet	*Ipomopsis aggregata*				1							1	0.1	Upl
Inland Rush	*Juncus interior*					10						10	1	Facw
Unknown 1						1						1	0.1	
Cattail	*Typha latifolia*						10	10	25	5		50	5	Obl
Thistle	*Cirsium undulatum*									10		10	1	Fac
Virginia Creeper	*Parthenocissus inserta*									5	30	35	3.5	Fac
Litter		20	30		10	68	90	90	75	80	40	503	50.3	
Rock		30	10									40	4	
Bare Soil		15	60		65	20					30	190	19	
Total		101	101	100	101	100	100	100	100	100	100	1003	100.3	
Overstory														
Rose	*Rosa woodsii*				30							30	3	Fac
Gambel Oak	*Quercus gambelii*					35						35	3.5	Facu
Total					30	35						65	6.4	

Transect Location: Upper Sandia Canyon Project Name: Sandia Characterization
Date: June 20, 2000 Performed by: David K., Rhonda R., Kathy B.
Transect Number: 2

Species	**Scientific Name**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**
Downey Chess	*Bromus tectorum*		50						10		5	10	10	10			
Wheat Grass	*Agropyron trachycaulum*																
Mullein	*Verbascum thapsus*			20													
Wavyleaf Thistle	*Cirsium undelatum*			15	5	5	5										
Cattail	*Typha latifolia*			15	15	40	10								10	15	15
Penstemon	unknown			5							15						
Yarrow	*Achillea lanulosa*										15	10					
Rabbit Brush	*Chrysothamnus nauseosus*											5					
False Tarragon	*Artemisia dracunculus*												20				
Lambs Quarter	*Chenopodium album*													10			
Rose	*Rosa woodsii*																
Gambel Oak	*Quercus gambelii*																
Water										100							
Litter		100	50	30	80	55	75	20			20	30	20	30	90	85	85
Rock								80	60		10			5			
Bare Soil				15			10		30		35	45	50	45			
Total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Transect Number: 2 continued

Species	**Scientific Name**	**170**	**180**	**190**	**200**	**210**	**220**	**230**	**240**	**250**	**260**	**270**	**Total**	**Average**	**Wetland Status**
Downey Chess	*Bromus tectorum*								30	30	10	10	175	6.48148	Facu
Wheat Grass	*Agropyron trachyucaulum*												0	0	Fac
Mullein	*Verbascum thapsus*												20	0.74074	Facw
Wavyleaf Thistle	*Cirsium undelatum*								1				31	1.14815	Fac
Cattail	*Typha latifolia*	5	20			5	10	10					170	6.2963	Obl
Penstemon	unknown								5				25	0.92593	Facu
Yarrow	*Achillea lanulosa*												25	0.92593	Facu
Rabbit Brush	*Chrysothamnus nauseosus*												5	0.18519	Opl
False Tarragon	*Artemisia dracunculus*												20	0.74074	Upl
Lambs Quarter	*Chenopodium album*												25	0.92593	Facu
Rose	*Rosa woodsii*								5	20	10	15	50	1.85185	Fac
Gambel Oak	*Quercus gambelii*								5				5	0.18519	Facu
Water													100	3.7037	
Litter		95	80	100	100	95	90	90	49	50	80	40	1639	60.7037	
Rock													155	5.74074	
Bare Soil									5			35	270	10	
Total		100	100	100	100	100	100	100	100	100	100	100	2700	100	

Transect Location: Upper Sandia Canyon Project Name: Sandia Characterization
Date: June 20, 2000 Performed by: David K., Rhonda R., Kathy B.
Transect Number: 3

Species	**Scientific Name**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**
Inland Rush	*Juncus interior*	5												
Wheat Grass	*Agropyron trachycaulum*		5		10				5					
Thistle	*Cirsium undelatum*			20										10
Cattail	*Typha latifolia*					20	5	15			40	40	15	20
Spectacle Pod	*Dithyrea wislizenii*						5							
Rabbit Brush	*Chrysothamnus nauseosus*													
Penstemon	unknown													
Gambel Oak	*Quercus gambelii*													
Downey Chess	*Bromus tectorum*													
Water									30		50			
Litter		90	80	60	10	80	80	85	5			60	85	60
Rock				5						30	10			10
Bare Soil		5	15	15	80		10		60	70				
Total		100	100	100	100	100	100	100	100	100	100	100	100	100

Transect Number: 3 continued

Species	Scientific Name	140	150	160	170	180	190	200	Total	Average	Wetland Status
Inland Rush	*Juncus interior*								5	0.02463	Facw
Wheat Grass	*Agropyron trachycaulum*		5						25	1.25	Fac
Thistle	*Cirsium undelatum*				10				40	2	Fac
Cattail	*Typha latifolia*	40			5	15	10		225	11.25	Obl
Spectacle Pod	*Dithyrea wislizenii*								5	0.25	Facu
Rabbit Brush	*Chrysothamnus nauseosus*		15						15	1.15385	Upl
Penstemon	unknown		5					40	5	0.25	Facu
Gambel Oak	*Quercus gambelii*							10	40	2	Facu
Downey Chess	*Bromus tectorum*			10					20	1.53846	Facu
Water									80	4	
Litter		60		85	85	75	90	40	1130	56.5	
Rock			70						125	6.25	
Bare Soil			5	5		10		10	285	21.9231	
Total		100	100	100	100	100	100	100	2000	100	

Transect Location: Upper Sandia Canyon
Date: June 20, 2000
Transect Number: 4

Project Name: Sandia Characterization
Performed by: David K., Rhonda R., Kathy B.

Species	Scientific Name	10	20	30	40	50	60	70	80	90	100	110	120	130	Total	Average	Wetland Status
Wheat Grass	*Agropyron trachycaulum*					1								1	2	0.15385	Fac
Downey Chess	*Bromus tectorum*	20													20	1.53846	Fac+
Horse Mint	*Monarda menthaefolia*							10	30						41	3.15385	Upl-Fac+
Gooseberry	*Ribes inerme*							10							10	0.76923	Facu
Penstemon	unknown										10				10	0.76923	Facu
Cattail	*Typha latifolia*			25			40	40	25	40	50	30	40		290	22.3077	Obl
Nodding Brome	*Bromus anomalus*													30	3030	2.30769	Fac+
Gambel Oak	*Quercus gambelii*														0	0	Facu
Fendler Barberry	*Berberis fendleri*	40													40	3.07692	Facu
Litter		40	60	40	10	100	50	5	35	60	40	49	50	20	559	43	
Rock			40												40	3.07692	
Bare Soil				35	90			35	10			20	10	49	249	19.1538	
Total		100	100	100	100	101	100	100	100	100	100	100	100	100	1301	100.077	

Transect Location: Upper Sandia Canyon
Date: June 20, 2000
Transect Number: 5

Project Name: Sandia Characterization
Performed by: David K., Rhonda R., Kathy B.

Species	**Scientific Name**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**Total**	**Average**	**Wetland Status**
Little Blue Stem	*Schizachyrium scoparius*										40	40	4	Facw
Cattail	*Typha latifolia*		20	20	15	40	40	80	40	20		275	27.5	Obl
Rose	*Rosa woodsii*									10		10	1	Fac
Nodding Brome	*Bromus anomalus*									40		40	4	Fac+
Coyote Willow	*Salix exigua*									10		10	1	Facw
Mutton Grass	*Poa fendleriana*	10										10	1	Fac
Litter		60	80	80	85	60	60	20	60	20	60	585	58.5	
Rock												0	4	
Bare Soil		30										30	19	
Total		100	100	100	100	100	100	100	100	100	100	1000	100.3	

Transect Location: Upper Sandia Canyon
Date: June 20, 2000
Transect Number: 6

Project Name: Sandia Characterization
Performed by: Davis K., Rhonda R., Kathy B.

Species	Scientific Name	10	20	30	40	50	60	70	80	90	100	110	Total	Average	Wetland Status
Wheat Grass	*Agropyron thrachycaulum*	5	20										25	2.27273	Fac
Mullein	*Verbascum thapsus*	10											10	0.90909	Facw
Cattail	*Typha latifolia*			15	10	10	20	70	30	60	25	25	240	21.8182	Obl
Inland Rush	*Juncus interior*											40	40	3.63636	Facw
Thistle	*Cirsium undulatum*											10	10	0.90909	Fac
Coyote Willow	*Salix exigua*		40										40	3.63636	Facw
Litter		85	40	85	90	90	80	30	70	40	75	25	710	64.5455	
Rock													0	0	
Bare Soil													0	0	
Total		100	100	100	100	100	100	100	100	100	100	100	1000	100	

Transect Location: Upper Sandia Canyon
Date: June 20, 2000
Transect Number: 7

Project Name: Sandia Characterization
Performed by: David K., Rhonda R., Kathy B.

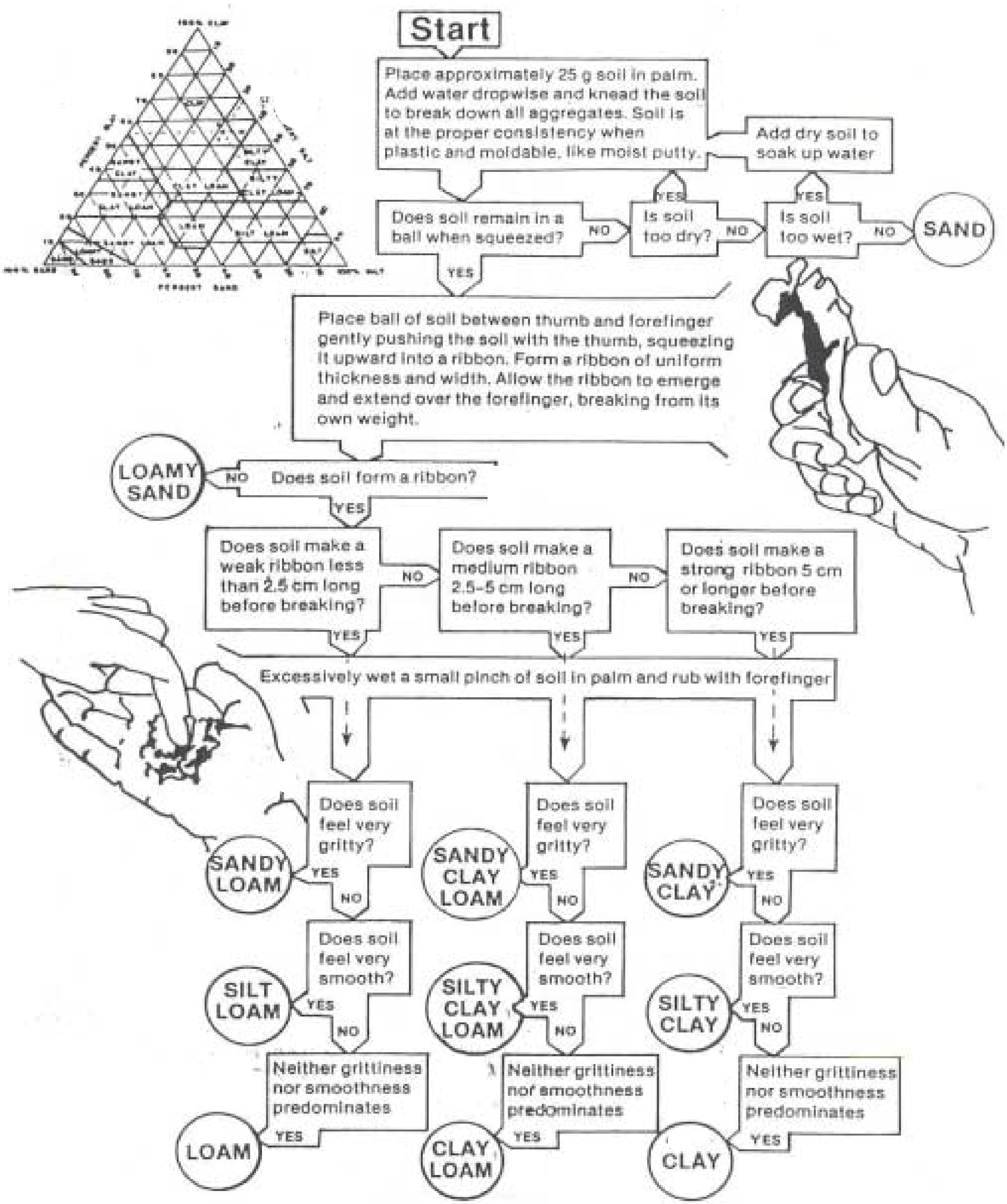
Species	**Scientific Name**	**10**	**20**	**30**	**40**	**50**	**60**	**Total**	**Average**	**Wetland Status**
Pony Mint	*Monarda pectinata*				15		1	16	2.66667	Fac+
Thistle	*Cirsium undulatum*				5			5	0.83333	Fac
Wheat Grass	*Agropyron thrachycaulum*		30					30	5	Fac
Little Blue Stem	*Schizachyrium scoparius*		1					1	0.16667	Facw
Litter		100	40	100	80	75	45	340	56.6667	
Rock								100	16.6667	
Bare Soil			30			25	55	110	18.3333	
Total		100	101	100	100	100	100	601	600	

Transect Location: Upper Sandia Canyon
Date: June 20, 2000
Transect Number: 8

Project Name: Sandia Characterization
Performed by: David K., Rhonda R., Kathy B.

Species	Scientific Name	10	20	30	40	50	60	Total	Average	Wetland Status
Understory										
Milkweed	*Asclepias speciosus*						20	20	3.33333	Facw
Mint	*Mentha arvensis*					1		1	0.16667	Fac
Nodding Brome	*Bromus anomalus*					1		1	0.1667	Fac+
Wheat Grass	*Agropyron thrachycaulum*				1			1	0.1667	Fac
Mullein	*Verbascum thapsus*			5				5	0.83333	Facw
Little Blue Stem	*Schizachyrium scoparius*	5						5	0.8333	Facw
Litter		95	60		39	20	30	244	40.6667	
Rock				95	60			155	25.8333	
Bare Soil						80	50	130	21.6667	
Overstory										
Salix			20					20	3.333	
Rowo			20					20	3.333	
Total		100	100	100	100	102	100	65	6.4	

APPENDIX 3: SOIL TEXTURE DETERMINATION



APPENDIX 4

Hydric Soil Pits

Pit Number:8-1 (south side of channel)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present:no
Mottle color: N/A
Soil Texture: Sandy Loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 8-2
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles not present at 10 " but a few present at 18"
Mottle color:5YR5/6
Soil Texture: Loamy sand
Soil Moisture: no free water, but soils are a little moist
Conclusion: Not Hydric-mottles do not appear until 18"

Pit Number: 8-3
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 10YR2.5/2
Mottles: yes
Mottle color: 5YR5/6
Soil Texture: clay
Soil Moisture: soils very moist
Conclusion: Hydric

Pit Number: 8-4 (north side of channel)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present: no
Mottle color: N/A
Soil Texture: Sandy Loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 7-1 (south side of stream channel)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present:no
Mottle color: N/A
Soil Texture: Loamy clay
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 7-2 and 7-3 (right at stream channel on ea side)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 10YR2.5/2
Mottles present: yes
Mottle color: 5YR5/6
Soil Texture: clayey loam-clay
Soil Moisture: very mosit
Conclusion: Hydric

Pit Number: 7-4 (south side of stream channel)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present:no
Mottle color: N/A
Soil Texture: Loamy clay
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 6-1 (south side of stream channel, in marsh)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 10YR2.0/1
Mottles present:yes
Mottle color: 10YR 4/8 and 7.5 YR 2.5/1
Soil Texture: Loamy clay
Soil Moisture: mosit
Conclusion: Hydric

Pit Number: 6-2 (south side of stream channe in the upland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present: no
Mottle color: N/A

Soil Texture: sandy loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 6-3 (north side of stream channel, in marsh)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 10YR2.0/1
Mottles present:yes
Mottle color: 10YR 4/8 and 7.5 YR 2.5/1
Soil Texture: Loamy clay
Soil Moisture: mosit
Conclusion: Hydric

Pit Number: 6-2 north side of stream channel in the upland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present:no
Mottle color: N/A
Soil Texture: sandy to sandy loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 5-1 (south side of stream channel in the wetland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: Gley 1 3/10 Y
Mottles present: yes
Mottle color: 10YR 4/6 and 10 YR 2.5/1
Soil Texture: clay
Soil Moisture: free standing water at 8"
Conclusion: Hydric

Pit Number: 5-2 (south side of stream channel in the upland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present:no
Mottle color: N/A
Soil Texture: sandy loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number: 5-3 (north side of stream channel in the wetland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: Gley 1 3/10 Y
Mottles present: yes
Mottle color: 10YR 4/6 and 10 YR 2.5/1
Soil Texture: clay
Soil Moisture: free standing water at 8"
Conclusion: Hydric

Pit Number: 5-4 (north side of stream channel in the upland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present: no
Mottle color: N/A
Soil Texture: sandy loam
Soil Moisture: not moist
Conclusion: Not Hydric

Hydric Soil Pits

Pit Number: 4-1 (south side of stream channel in the upland)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present: no
Mottle color: N/A
Soil Texture: sandy loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number:4-2 (north side of stream channel in the marsh-just north of fill area)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 10YR2.0/1
Mottles present: yes
Mottle color: 10YR 4/8 and 7.5 YR 2.5/1
Soil Texture: Loamy clay
Soil Moisture: mosit
Conclusion: Hydric
Comments: at 18" gley soils exist above 18" mottles present

Pit Number: 4-3 (north edge of wetland)

Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 10YR2.5/2
Mottles: yes
Mottle color: 5YR5/6
Soil Texture: clay
Soil Moisture: soils very moist
Conclusion: Hydric

Pit Number: 4-4 (south side of channel)
Date: 6/22/00
Performed by: David K, Kathryn B. and Chuck Hathcock
Soil Color: 5YR4/3
Mottles present: no
Mottle color: N/A
Soil Texture: Sandy Loam
Soil Moisture: not moist
Conclusion: Not Hydric

Hydric Soil Pits

Pit Number:3-1 (south side of channel)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 5YR4/3
Mottles present: no
Mottle color: N/A
Soil Texture: Sandy Loam
Soil Moisture: not moist
Conclusion: Not Hydric

Pit Number:3-2 (stream channel)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR6/1
Mottles present: yes
Mottle color: 10YR 5/6
Soil Texture: Sandy
Soil Moisture: saturated soils at 8"
Conclusion: Hydric

Pit Number: 3-3 (outside edge in area de-watered south side of channel)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR4/3
Mottles present: yes
Mottle color: dark black
Soil Texture: Sandy
Soil Moisture: not moist
Conclusion: not hydric : no hydrology, area is de-watered

Pit Number:3-5 (north side of stream in area of live cattials)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR6/1
Mottles present: yes
Mottle color: dark black
Soil Texture: Sandy loam
Soil Moisture: saturated soils at 8"
Conclusion: Hydric

Pit Number:3-6 (south side of stream in area of live cattials)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR6/1
Mottles present: yes
Mottle color: dark black
Soil Texture: Sandy loam
Soil Moisture: saturated soils at 8"
Conclusion: Hydric

Hydric Soil Pits

Pit Number:2-1 (north side of stream channel in fill area)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR5/4
Mottle color: none
Soil Texture: Sandy
Soil Moisture: soils very dry
Conclusion: not hydric

Pit Number: 2-2 (north side in area of struggling cattails)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson

Soil Color: 10YR5/3
Mottles some faint mottles
Mottle color: 5YR4/3
Soil Texture: Sandy Loam
Soil Moisture: soil dry
Conclusion: Hydric, but no hydrology. Hydric soils are prior to de-watering

Pit Number: 2-3 (north side in area of struggling cattails closer to canyon slope)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR5/2
Mottles some faint mottles
Mottle color: 5YR4/3
Soil Texture: Sandy Loam
Soil Moisture: soil dry
Conclusion: Hydric, but no hydrology. Hydric soils are prior to de-watering

Pit Number: 2-4 (north side in area of struggling cattails at canyon slope)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR5/2
Mottles: some faint mottles
Mottle color: 5YR4/3
Soil Texture: Sandy Loam
Soil Moisture: soil dry
Conclusion: Hydric, but no hydrology. Hydric soils are prior to de-watering.

Pit Number:2-5 (south side of stream channel in fill area)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR6/3
Mottles: no
Mottle color: none
Soil Texture: Sandy/gravel
Soil Moisture: soils very dry
Conclusion: not hydric, no hydrology , fill is > 12" in depth

Pit Number:2-6 (south side of stream channel)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 5YR6/1
Mottles: a few
Mottle color: 5YR4/3
Soil Texture: Loamy sand
Soil Moisture: soils very dry
Conclusion: hydric, but no hydrology. Area has >10" of fill

Pit Number:2-7 (next to stream channel)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 7.5YR3/2
Mottles: yes
Mottle color: Rust color, FE oxidation
Soil Texture: loamy sandy
Soil Moisture: very moist, free water when squeezed
Conclusion: Hydric with hydrology

Hydric Soil Pits

Pit Number: 1-1 (south side of stream channel, immediately adjacent to stream)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 7.5 YR 3/2
Mottles present: yes
Mottle color: dark black
Soil Texture: Loamy clay
Soil Moisture: very moist
Conclusion: Hydric

Pit Number: 1-2 (north side of stream channel, immediately adjacent to stream)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 7.5 YR 3/2
Mottles present: yes
Mottle color: dark black
Soil Texture: Loamy clay
Soil Moisture: saturated
Conclusion: Hydric

Pit Number:1-3 (north side in area of struggling cattails)
Date: 9/26/00
Performed by: David K, Kathryn B. and Rhonda Robinson
Soil Color: 10YR5/3
Mottles some faint mottles
Mottle color: 5YR4/3
Soil Texture: Sandy Loam
Soil Moisture: soil dry
Conclusion: Hydric, but no hydrology. Hydric soils are prior to de-watering