



EVALUATION OF VEGETATION ESTABLISHMENT ALONG THE S3 SECTION
OF THE SDS PIPELINE ROUTE IN PUEBLO COUNTY, COLORADO: SECOND REPORT

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INTRODUCTION

This report presents the results of the second field evaluation of the S3 section of the SDS Pipeline Route located in Pueblo County. Field observations were made on July 24 and 25, 2013. Field work consisted of walking the entire S3 section of the SDS Pipeline Route in Pueblo County. In addition to the general reconnaissance work, seedling density counts were also made.

METHOD FOR DETERMINATION OF SEEDLING DENSITY

Seedling densities were determined by counting the number of seedlings that were encountered in a circular 0.5 square meter quadrat. At 18 locations along the S3 route, six quadrats were sampled in an east-west line perpendicular to the direction of the SDS route for a total of 108 quadrats. To the extent possible, seedlings were identified by species. For summarization purposes, the species were grouped into three categories: species included in the seed mixes; native forb, shrub and cactus species; and non-native weedy species. After summarization, the mean number of seedlings per 0.5 square meters was converted to the mean number per square foot. The seeding specifications call for a target of four seedlings per square foot as a measure of seeding success. In order to clarify differences along the S3 route, the data were summarized based on soil types according to the distinctions made in the pre-construction vegetation survey. Also, the data were examined based on three general locations along the S3 route: Walker Ranch south of Steel Hollow, Walker Ranch North of Steel Hollow, and the portion of the S3 route located North of Antelope Road.

RESULTS

The primary purpose of the July field trip was to assess the status of seedling development along the S3 portion of the SDS water pipeline. While seedling density was not one of the performance standards for the demonstration success, it was listed as a performance standard for the seeding contractor. Also, evaluation of seedling density during the first growing season can provide insight into future success of the revegetation work. Observations made in late April (2013) revealed that only a few seedlings had become established, and mostly these were along parts of the S3 portion that had been irrigated, at least to some degree, in the fall of 2012. Drought conditions during the winter of 2012 and spring of 2013 had limited germination and seedling development. Once irrigation began in late spring and early summer, more seedlings became apparent. As of July 24th seedling establishment showed uneven patterns along the S3 portion, apparently in response to differences in irrigation. The part of the S3 portion located north of Antelope showed better vegetation development than other parts of the S3 portion.

The seedling density evaluations were conducted based on the different soil types along the S3 route. More samples were obtained from the more prevalent soil types. In the results of the seedling density counts which follow, the seedlings have been grouped based on three different species groups. In some cases it was possible to identify the species of the seedlings, but in other cases the seedlings were grouped by life forms as noted in the Methods section.

Seedling Density Evaluations Based on Soil Types

A -Penrose, Manuel, Minnequa Soils (Approximately 3.2 percent of the S3 route)

These soils occur to only a limited extent along the S3 section and are located north of Antelope Road. The density of seeded species and other acceptable perennial grasses was higher than on any of the other soil types. Also, the seedlings tended to be robust and some of the grasses had flowering stalks. Non-seeded native species (mostly fetid marigold – *Dyssodea aurea*) occurred at a density of approximately one seedling per square foot. Few weedy species were encountered and none of these were noxious weeds. For this soil type, the seedling density would seem to be more than adequate for establishing a good stand of seeded species within the next 1-2years.

Species Group	Mean Number of Seedlings per square foot
Seeded Species and other acceptable Perennial Grasses	7.84
Native forbs, shrubs, cacti not present in the seed mix	0.93
Undesirable non-native forbs and grasses	0.43

(One transect – 6 sample plots)

B- Limon and Heldt Soils (Approximately 32.8 percent of the S3 route)

These soils occur mostly along the southern section of the S3 route. Two other small sections occur, but all are on the Walker Ranch Property. This soil type had the fourth highest density of seeded species. While the computed mean density for this group is slightly less than 4.0 seedlings/square foot, the density appears to be adequate for establishment of good stand of seeded species in 1-2 years. Seedlings in this soil type tended to be small and apparently recently established. As long as the irrigation continues it is likely that they will survive. Also, it is possible that more seeds will germinate as the season progresses. While the seedlings were small, no seedling mortality was noted. Only a few non-seeded native species were noted. Also, few weed seedlings were encountered. The only weed species of concern in this soil type is halogeton (*Halogeton glomeratus*). Halogeton was encountered in approximately 27 percent of the 0.5 square meter sample plots in this soil type.

Species Group	Mean Number of Seedlings per square foot
Seeded Species and other acceptable Perennial Grasses	3.97
Native forbs, shrubs, cacti not present in the seed mix	0.29
Undesirable non-native forbs and grasses	0.49

(Five transects – 30 sample plots)

C- Cascajo and Stoneham Soils (Approximately 18.6 percent of the S3 route)

These soils occur to a limited extent along the S3 section and are located north of Antelope Road. The sections with these soils are somewhat longer than for Penrose, Manual, Minnequa and the Haverson, Ustic Torriorthent soils. These soils had the second highest seedling density for seeded and acceptable grass species. The density exceeds the seeding standard and should be high enough for an acceptable stand of seeded species to develop in the next 1-2 years. Most of the undesirable non-native forbs were Russian thistle (*Salsola* spp.) which will not likely cause any long-term problems.

Species Group	Mean Number of Seedlings per square foot
Seeded Species and other acceptable Perennial Grasses	5.34
Native forbs, shrubs, cacti not present in the seed mix	2.09
Undesirable non-native forbs and grasses	3.28

(Four transects – 24 sample plots)

D- Midway Shale Complex/ShingleSoils (Approximately 10.7 percent of the S3 route)

These soils occur on the more northern portion of the S3 Section on the Walker Ranch Property. The sections cover less than one mile of the route. These soils had the lowest seedling density of the six soil types. Density of seeded species and other acceptable perennial grasses was less than the 4.0 seedlings/square foot performance standard. Most of the grass seedlings that were counted were quite small (less than 2 inches in height). Few other seedlings were encountered. As of the date of sampling, the data show that the density performance standard is currently not being met. It possible that more seedlings will develop as the growing season and irrigation continue.

Species Group	Mean Number of Seedlings per square foot
Seeded Species and other acceptable Perennial Grasses	1.73
Native forbs, shrubs, cacti not present in the seed mix	0.57
Undesirable non-native forbs and grasses	0.02

(Two transects – 12 sample plots)

E- Razor Soils (Approximately 33.7 percent of the S3 route)

These soils occur as mostly non-continuous sections in the northern part of the Walker Ranch Property and also in the far north section adjacent to the El Paso County Line. These soils had the second lowest seedling density for seeded species and other acceptable perennial grasses. The data show that as of late July the seedling density standard has not been met in this soil type. It is possible that more seeds will germinate as the growing season continues. Few seedlings of weedy species were encountered.

Species Group	Mean Number of Seedlings per square foot
Seeded Species and other acceptable Perennial Grasses	2.61
Native forbs, shrubs, cacti not present in the seed mix	1.44
Undesirable non-native forbs and grasses	0.13

(Five transects – 30 sample plots)

F- Haverson, Ustic Torriorthent Soils (Approximately 1.0 percent of the S3 route)

These soils occur to only a limited extent along the S3 section and are located north of Antelope Road. This soil type occurs mostly in the bottoms of draws and ephemeral drainages. Seedlings of seeded species were common and this soil type had the third highest seedling density for seeded and acceptable perennial grasses. Western wheatgrass (*Pascopyrum smithii*) was the most prevalent of the seeded species. The most common weedy species were Russian thistle (*Salsola* spp.), kochia (*Kochia scoparia*) and pigweed (*Amaranthus* spp.). These species are not noxious weeds and should not pose any long-term problems. The density of acceptable species exceeds the performance standard and should be adequate for an acceptable stand of seeded species to develop in the next 1-2 years.

Species Group	Mean Number of Seedlings per square foot
Seeded Species and other acceptable Perennial Grasses	5.30
Native forbs, shrubs, cacti not present in the seed mix	0.50
Undesirable non-native forbs and grasses	1.98

(One transects – 6 sample plots)

General Comments Regarding Seedling Density and Soil Types

- Irrigation has not been uniform along the entire S3 route. In the section north of Antelope Road where irrigation began in fall 2012, the seedlings tend to be much more robust than in other portions of the route where irrigation began in the 2013 growing season.
- All of the species that were included in the seed mixes were observed in the sample plots.
- Fifteen species of native forbs, shrubs and cacti were encountered in the sample plots in addition to the seeded species.
- Thirteen weedy species were encountered in the sample plots.
- Four species of introduced annual grasses were encountered in the plots.
- In addition to the known species, several unknown species were also encountered.
- Four of the six soil types had seedling density values that approximated or exceeded the 4.0 seedlings/square foot standard. These four types account for approximately 56 percent of the S3 route.
- Two soil types did not have at least 4.0 seedlings/per square foot as of late July when the field observations were made. It is possible that more germination will occur as the growing season continues. These two types account for approximately 44 percent of the S3 route.

Seedling Density Evaluations Based on General Location

General field observations suggested that the portions of the S3 route located north of Antelope Road showed better vegetation development than other parts of the S3 route. This is probably related to differences in the amount and duration of irrigation. The vegetation differences are reflected in the seedling density values. Based on the 36 density quadrats sampled north of Antelope Road, the density of seeded and acceptable perennial grasses was approximately six seedlings/square foot. All areas south of Antelope Road had lower densities. Between Antelope Road and Steel Hollow the density of seeded and acceptable species was approximately three seedlings/square foot and between Steel Hollow and the southern end of the S3 portion the seedling density was 2.8 seedlings/square foot. As noted in the soil type evaluations some of this difference is related to soil type, but also differences in the amount and frequency of irrigation are likely influencing these results. As with the soil type evaluations, it is important to note that seedling density may increase as the growing season continues.

Other Observations

Species Diversity. As part of the seedling density sampling, other general observations about the S3 route were also made. In all, 72 species were observed along the S3 route (Table 1). Many of these species were observed in the area prior to installation of the water line. Under irrigation, the plants tend to be more robust and occur at higher densities than in the adjacent non-irrigated native vegetation.

Erosion. In general, soil erosion does not seem to be a problem along the S3 route. Some small rills and flow patterns were noted. Also, some small amounts of erosion have occurred in association with some of the sprinkler heads of the irrigation system.

Vegetation Development. As the vegetation continues to develop, it is likely that some areas with limited vegetation development will become apparent. The degree to which this is a problem will depend on the size of the sparse areas. While the average seedling density suggest that the number of seedlings should be adequate, it is important to note that some of the sites that were sampled had few or no seedlings. If no additional germination occurs in these areas, then it may become necessary to develop repair or re-seeding plans in order to meet the cover performance standards within the next 1-2 years.

Table 1. List of Species Observed along the S3 Section of the SDS Pipeline in Pueblo County. “(?)” indicates uncertain identification.

Scientific Name	Common Name	Observation Date			
		04/30/13	7/24/2013 7/25/2013		
COOL SEASON PERENNIAL GRASSES					
<i>Elymus trachycaulus</i>	Slender Wheatgrass		x		
<i>Pascopyrum smithii</i>	Western Wheatgrass	x	x		
<i>Sitanion longifolium</i>	Squirreltail Grass		x		
WARM SEASON PERENNIAL GRASSES					
<i>Bouteloua curtipendula</i>	Side-oats Grama	x	x		
<i>Chondrosum gracile</i>	Blue Grama	x	x		
<i>Hilaria (Pleuraphis) jamesii</i>	Galleta Grass		x		
<i>Sporobolus airoides</i>	Alkali Sacaton		x		
<i>Sporobolus cryptandrus</i>	Sand Dropseed		x		
ANNUAL GRASSES					
<i>Bromus japonicus</i>	Japanese Brome		x		
<i>Bromus tectorum</i>	Cheatgrass		x		
<i>Digitaria sanguinalis</i>	Crab Grass		x		
<i>Echinochloa crus-galli</i>	Barnyard Grass		x		
<i>Munroa squarrosa</i>	False Buffalo Grass		x		
<i>Panicum capillare</i>	Witchgrass		x		
NATIVE PERENNIAL FORBS					
<i>Argemone polyanthemos</i>	Prickly Poppy		x		
<i>Asclepias subverticillata</i>	Milkweed		x		
<i>Astragalus bisulcatus</i>	Two-grooved Milkvetch	x	x		
<i>Astragalus sp.</i>	Milkvetch	x	x		
<i>Cirsium undulatum</i>	Thistle	x	x		
<i>Erigeron strigosus (?)</i>	Daisy Fleabane		x		
<i>Eriogonum sp.</i>	Buckwheat		x		
<i>Euphorbia marginata (?)</i>	Snow-on-the-Mountain		x		
<i>Evolvulus nuttallianus</i>	Evolvulus		x		
<i>Gaillardia aristata</i>	Blanket Flower		x		
<i>Glandularia bipinnatifida</i>	Showy Vervain	x	x		
<i>Grindelia squarrosa</i>	Curlycup Gumweed		x		

Table 1. (Continued) List of Species Observed along the S3 Section of the SDS Pipeline in Pueblo County. “(?)” indicates uncertain identification.

Scientific Name	Common Name	Observation Date			
		04/30/13	7/24/2013 7/25/2013		
<i>Heterotheca villosa</i>	Golden Aster		x		
<i>Lesquerella sp.</i>	Bladderpod	x			
<i>Linum lewisii</i>	Blue Flax		x		
<i>Lomatium orientale (?)</i>	Biscuitroot	x			
<i>Picradeniopsis oppositifolia</i>	Bahia		x		
<i>Polanisia dodocandra</i>	Clammy Weed		x		
<i>Psoralea tenuiflora</i>	Scurfpea		x		
<i>Sphaeralcea coccinea</i>	Scarlet Globemallow	x	x		
<i>Stephanomeria pauciflora</i>	Wire Lettuce		x		
<i>Zinnia grandiflora</i>	Zinnia		x		
INTRODUCED PERENNIAL FORBS					
<i>Convolvulus arvensis</i>	Field Bindweed		x		
<i>Cirsium (Brea) arvense</i>	Canada Thistle		x		
<i>Malva neglecta</i>	Cheeseweed		x		
<i>Trifolium pratense</i>	Red Clover		x		
NATIVE ANNUAL/BIENNIAL FORBS					
<i>Artemisia dracunculus</i>	False Tarragon		x		
<i>Chamaesyce glyptosperma</i>	Spurge		x		
<i>Chamaesyce stictospora</i>	Spurge		x		
<i>Chenopodium leptophyllum</i>	Narrowleaved Goosefoot	x	x		
<i>Cryptantha sp.</i>	Cryptantha		x		
<i>Descurainia pinnata</i>	Tansy Mustard		x		
<i>Dyssodia aurea</i>	Fetid Marigold	x	x		
<i>Lappula redowskii</i>	Stickseed		x		
<i>Lepidium densiflorum</i>	Peppergrass		x		
<i>Nuttallia decapetala</i>	White Evening Star		x		
<i>Plantago patagonica</i>	Woolly Plantain		x		
<i>Tripterocalyx micranthus</i>	Sand Verbena		x		

Table 1. (Continued) List of Species Observed along the S3 Section of the SDS Pipeline in Pueblo County. “(?)” indicates uncertain identification.

Scientific Name	Common Name	Observation Date			
		04/30/13	7/24/2013 7/25/2013		
INTRODUCED ANNUAL/BIENNIAL FORBS					
<i>Amaranthus albus</i>	White Pigweed		x		
<i>Amaranthus graecizans</i>	Pigweed		x		
<i>Amaranthus retroflexus</i>	Pigweed		x		
<i>Artemisia biennis</i>	Biennial Wormwood		x		
<i>Chenopodium sp.</i>	Goosefoot	x	x		
<i>Descurainia sp.</i>	Tansy Mustard	x			
<i>Erysimum repandum</i>	Wallflower		x		
<i>Halogeton glomeratus</i>	Halogeton		x		
<i>Kochia scoparia (Bassia sieversiana)</i>	Kochia		x		
<i>Melilotus alba</i>	White Sweetclover		x		
<i>Melilotus officinalis</i>	Yellow Sweetclover		x		
<i>Portulaca oleracea</i>	Purslane		x		
<i>Quincula lobata</i>	Chinese Lantern		x		
<i>Salsola australis</i>	Russian Thistle		x		
<i>Salsola collina</i>	Russian Thistle		x		
<i>Solanum rostratum</i>	Buffalo Bur		x		
<i>Solanum triflorum</i>	Nightshad		x		
<i>Verbena bracteata</i>	Creeping Charlie		x		
<i>Ximenesia encelioides</i>	Cowpen Daisy		x		
SHRUBS					
<i>Atriplex canescens</i>	Four-wing Saltbush	x	x		
CACTI AND SUCCULENTS					
<i>Cylindropuntia imbricata</i>	Cholla		x		
<i>Opuntia polyacantha</i>	Plains Prickly-pear Cactus	x	x		
<i>Yucca glauca</i>	Spanish Bayonet	x	x		