Advanced Planning and Measurable Outcomes: Restoration Success in Southern Colorado

Colorado Springs Utilities Southern Delivery System Pipeline Work Packages S1, S2 and S3

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Western States Reclamation, Inc.


C A N A D A
PACIFIC OCEAN
Gulf of Mexico
MEXICO
ROCKY MOUNTAINS
CASCADE RANGE
SIERRA NEVADA
GREAT PLAINS
GREAT BASIN
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
WISCONSIN
ILLINOIS
INDIANA
TENNESSEE
MISSISSIPPI
ALABAMA
LOUISIANA
MAINE
Calgary
Regina
Winnipeg
Vancouver
Seattle
Portland
Spokane
Helena
Billings
Boise
Salt Lake City
Cheyenne
Denver
Colorado Springs
Sacramento
San Francisco
Reno
Las Vegas
Los Angeles
San Diego
Phoenix
Tucson
Santa Fe
Albuquerque
El Paso
Bismarck
Fargo
Pierre
Minneapolis
Omaha
Lincoln
Kansas City
Topeka
Wichita
St-Louis
Chicago
Milwaukee
Indianapolis
Memphis
Dallas
Austin
Houston
San Antonio
New Orleans
Ottawa
Montréal
Québec
Toronto
Monterrey
Guadalajara
CIUDAD DE MEXICO
Mérida
Cancún
Acapulco
BELIZE
GUATEMALA
HONDURAS
EL SALVADOR
Alaska at 25%
ALASKA
Anchorage
Fairbanks
Bering Sea
Gulf of Alaska
Aleutian Islands
Hawaii (at the same scale)
Hawaiian Islands
Honolulu
HAWAII
CITY OF COLORADO SPRINGS
N
LEGEND
SDS
River/Creek/Canal
Pump Stations
Finished Water Pipeline
Finished Water Pipeline
SDS WATER TREATMENT PLANT
SECURITY
Upper Williams Creek Reservoir
Bradley Pump Station
FOUNTAIN
Williams Creek Reservoir
Williams Creek Pump Station
Fountain Creek
Monument Creek
Teller County
Fremont County
Fort Carson Military Reservation
El Paso County
Pueblo County
PENROSE
PUEBLO WEST
Arkansas River
Juniper Pump Station
Pueblo Reservoir
PUEBLO

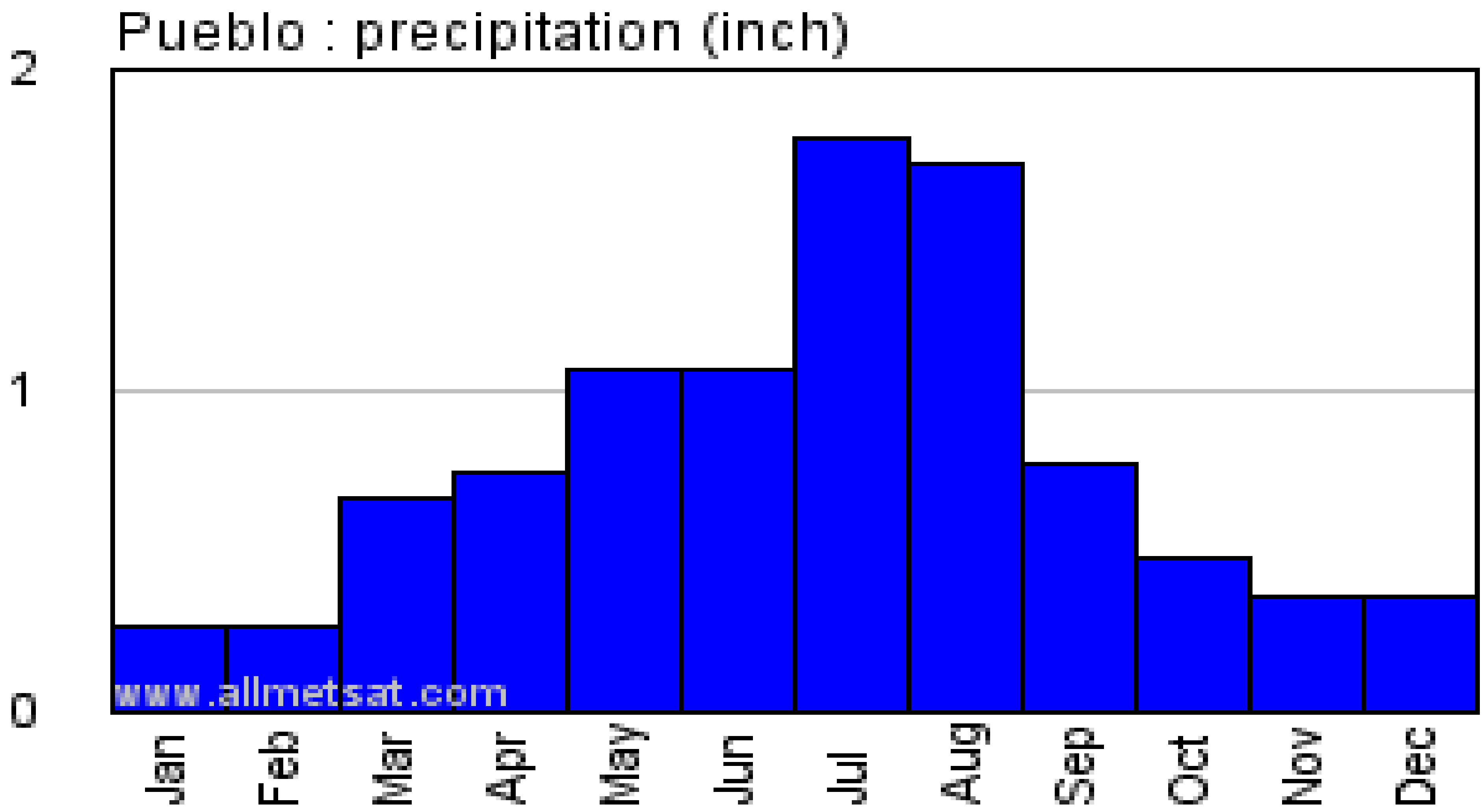
Existing Environmental Conditions

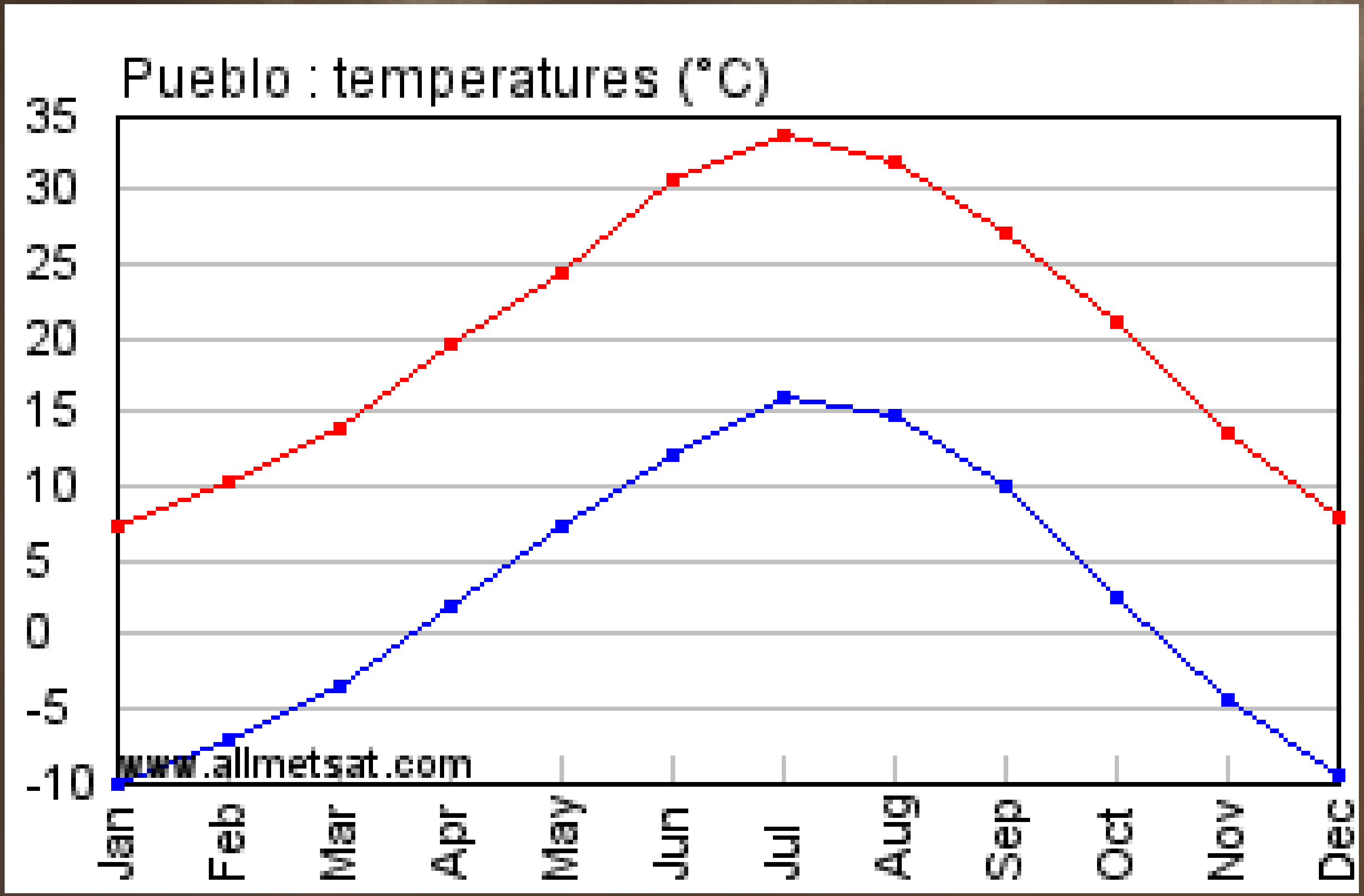
Elevation

4,960’ at Pueblo Reservoir

Climate

The climate of project area is described as semi-arid with an average annual precipitation of 11.9 inches per year. But in drought since 2007.


Pueblo : precipitation (inch)
2
1
0
www.allmetsat.com
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Pueblo : temperatures (°C)
35
30
25
20
15
10
5
0
-5
-10
www.allmetsat.com
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Soils

Soils that occur along the SDS Pipeline were for reclamation purposes divided into 5 groups:

1. Soils Shallow over Shale and Limestone (Penrose, Manvel and Minnequa series)
2. Soils on Clay-rich, Salt-affected Alluvial Material (Limon and Heldt series)
3. Soils Deep on Early Pleistocene Alluvium (Stoneham and Cascajo series)
4. Soils on Weathered Shales (with active erosional removal) (Midway – Shale complex; Shingle series)
5. Soils on Deeply Weathered Shales (without active erosion removal) (Razor series).
6. Soils on Recent Alluvium of Moderate Texture and Salt Content (Haverson series and Ustic Torrifluvents). The average A horizon depth is 4 inches.

Map Code	Work Unit S3 *Soils Group**	*% of Work Unit*	*Base Veg. Cover ***	***Revegetation Cover Performance Std.** (0.9 x Base)*
A	**Soils Shallow over Shale and Limestone** (Penrose, Manvel and Minnequa series)	3.7	17.2%	15.5%
B	**Soils on Clay-rich, Salt-affected Alluvial Material** (Limon and Heldt series)	32.0	26.5%	23.9%
C	**Soils Deep on Early Pleistocene Alluvium** (Stoneham and Cascajo series)	19.0	35.0%	31.5%
D	**Soils on Weathered Shales (with active erosional removal)** (Midway – Shale complex; Shingle series)	10.8	17.0%	15.3%
E	**Soils on Deeply Weathered Shales (without active erosional removal)** (Razor series)	34.1	23.3%	21.0%
F	**Soils on Recent Alluvium of Moderate Texture and Salt Content** (Haverson series and Ustic Torrifluvents)	0.4	41.3%	37.2%
	* See Maps S3-1,-2, -3, and -4			
	** See report and tables for documentation			

Vegetation

The natural vegetation of the SDS Pipeline corridor is semi-desert grassland typical of this latitude in the southern Great Plains and southern Colorado Plateau with predominately warm season short and mid grasses. Some areas have moderate amounts of fourwing saltbush and there are localized heavy infestations of tree cholla cactus.

Pre-Construction Vegetative Cover Measurements

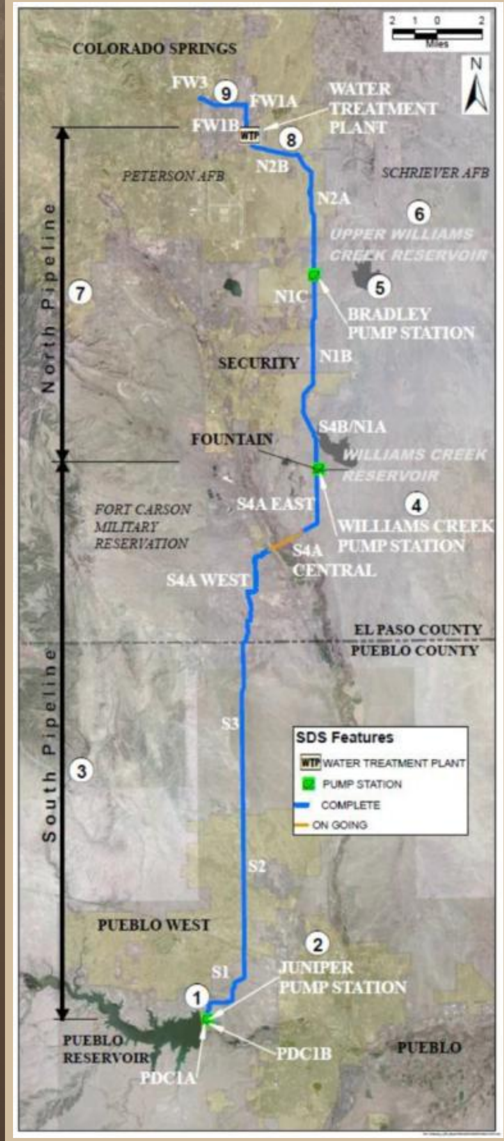
Colorado Springs Utilities retained ecological consultants to determine plant cover values of all vegetation communities that occur along the Pipeline Right-Of-Way during October of 2011, prior to initiation of any pipeline construction activities.

Waterline Description

The Southern Delivery System (SDS) is a regional delivery system that will transport water to Colorado Springs, Pueblo West, Security and Fountain.

SDS will allow the delivery of up to 96 MGD to the SDS partner communities by 2016.

- 80.47 kilometers (50 miles) of pipeline to transport raw water



Project Overview / Background

- **Previous land restoration efforts on an older waterline failed in Pueblo county** leaving a scar on the land that is still visible today.

- Colorado Springs Utilities was required to prepare and submit an **extensive land restoration plan**, in order to receive a Right-Of-Way from Pueblo county.

- To WSRI's knowledge the SDS waterline is the first known land restoration project of this size (40.23 kilometers (25 miles) in length) to **employ the use of an automated temporary irrigation system.**

- Colorado Springs Utilities required a **3 year monitoring and maintenance period.**

Project Overview / Background (continued)

- Ecological consultant prepared a **detailed land restoration plan** which included vegetation seed mixtures that matched the surrounding ecosystem.

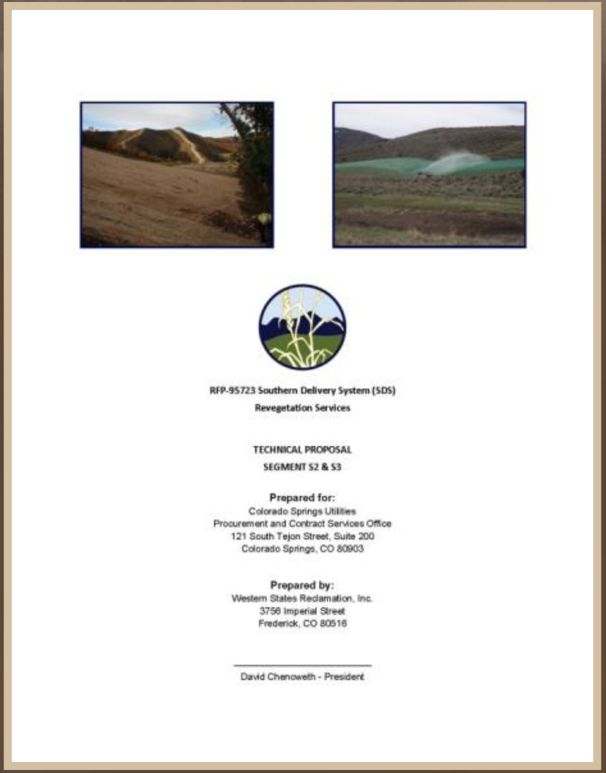
- Colorado Springs Utilities selected land restoration contractor(s) through a **stringent pre-qualification process** based upon past pipeline land restoration experience.s

Innovative and Science Based Reclamation Proposal Developed

- Required land restoration contractors to prepare a **detailed construction and maintenance plan** with price proposal.

- Required the land restoration contractor to submit **engineered drawings and details of the temporary irrigation system**. A detailed construction and maintenance plan for the irrigation system was also required.

- Colorado Springs Utilities required a **three year monitoring and maintenance program** to successfully grow in vegetation, control noxious weeds, and repair any erosion damage.



RFP-95723 Southern Delivery System (SDS)
Revegetation Services

TECHNICAL PROPOSAL
SEGMENT S2 & S3

Prepared for:
Colorado Springs Utilities
Procurement and Contract Services Office
121 South Tejon Street, Suite 200
Colorado Springs, CO 80903

Prepared by:
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3756 Imperial Street
Frederick, CO 80516

David Chenoweth - President

Project Bidding Challenges

While WSRI had previously completed numerous pipeline projects throughout the Western U.S., we had never been faced with such **stringent vegetation cover requirements**. Failure to provide the required vegetative cover in three years could result in forfeiting a bond for $2,000 per acre in damage fees.

–Project Bidding Challenges (continued)

- How difficult would it be to establish vegetation on **poor quality soil types in a semi-arid environment** that only receives 31.24 centimeters (12.3 inches) of annual precipitation?

- What type and amount (if any) of **soil amendments** should be used on areas of the pipeline that contained poor soil chemistry?

- What type of **temporary irrigation system** would be the most cost effective and still ensure proper watering of the 45.75 meter (100-150 foot) wide ROW?

- **How much water** would be needed to grow in the native vegetation?

Project Bidding Challenges (continued)

- **How much time** would be needed each season for crews to operate the irrigation system?

- What was the risk of **vandalism** and what ordinary irrigation repairs should be allowed for?

- What amount of **reseeding** could be required after the initial seeding?

- What amount of **mowing and herbicide treatment** should be allocated to control all noxious weed species during the 3 year maintenance period?

Revegetation Construction

WSRI was eventually awarded all three Pueblo County Revegetation Packages, SDS segments S1, S2, and S3.

- WSRI would take over the project ROW's from the pipeline general contractors after topsoil had been replaced and final grades established. WSRI was provided the opportunity to inspect the ROW condition prior to take over.

- Permits required on the project consisted of CDPHE Stormwater Permit and CDPHE Air Pollution Emission Notice Permit

- Irrigation construction began in the late winter/early spring of 2012

- Revegetation processes began in the late spring/early summer of 2012


08/21/2011

TABLE 1

Seed Mix for Upland Areas Scientific Name	Common Name - Variety	Mix %*	Lbs Pure Live Seed (PLS)/ Acre**
Bouteloua gracilis	Blue grama – Bad River	15	0.5
Bouteloua gracilis	Blue grama – Alma	15	0.5
Bouteloua gracilis	Blue grama – Hachita	15	0.5
Bouteloua curtipendula	Sideoats grama – Vaughn	10	1.4
Elymus trachycaulus	Slender wheatgrass – San Luis	5	0.8
Hilaria (Pleuraphis) jamesii	Galleta – Viva	10	1.6
Pascopyrum smithii	Western wheatgrass – Arriba	22	5.6
Sporobolus airoides	Alkali sacaton-Salado	13	0.2
Sporobolus cryptandrus	Sand dropseed – VNS	5	0.02
TOTAL		**100**	**11.22**

*Mix percent based on seed number.

**Seeding rate is for drill seeding. If the seed is broadcast, double the rates shown.

TABLE 2

Seed Mix for Lowland Areas Scientific Name	Common Name - Variety	Mix %*	Lbs Pure Live Seed (PLS)/ Acre**
Bouteloua gracilis	Blue grama – Alma	20	0.6
Bouteloua gracilis	Blue grama – Lovington	20	0.6
Elymus trachycaulus	Slender wheatgrass -San Luis	10	1.6
Pascopyrum smithii	Western wheatgrass – Arriba	25	6.0
Sporobolus airoides	Alkali sacaton – Salado	25	0.4
TOTAL		**100**	**9.2**

*Mix percent based on seed number.

**Seeding rate is for drill seeding. If the seed is broadcast, double the rates shown.


Watering Schedule and Approach

- Deep early wetting in first year to wet dry soil and leave deep moisture for roots to seek. Of course seedbed kept wet early to support germination and early establishment.

- End of First year saw very heavy moisture in Sept. – wetting subsoil well and setting up very good second year growth. Always planned to slowly back off 2nd Season watering to harden off seedlings during second season.

- Second season of watering targeted weak areas or areas that had been re-seeded.

-Watering Schedule and Approach (continued)

The majority of supplemental irrigation occurred over a year and half period 2013-2014

25.4 centimeters (10 inches) of irrigation water was used on average, which consisted of over 325,545,413.42 liters (86 million gallons) of water over 135.17 hectares (334 acres).

- Water use limited by water demands on the Fountain Valley Water Authority (FVA) raw water line.
  - 350 GPM Per Segment
  - 1,200 GPM Project Wide

- Cost of water was $356.58 per acre foot or $10,000 per inch applied across the project ROW

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Maintenance and Monitoring

Vegetation Monitoring

Midway through the first growing season, a quantitative assessment of seedling density was made to provide early knowledge of the direction of plant establishment. **A criterion of average 4 seedlings (of desirable species) per .093 square meters (square foot) was used. WSRI achieved 4-6 seedlings across the various soil types.**

In late summer of the first and second growing seasons, quantitative measurement of cover and species diversity/richness were made at more than 165 randomly selected locations. At each random sample point, sampling of cover was accomplished along randomly oriented 50 m transects using point-intercept methods (see details at http://www.esco-associates.com/ESCOdatacollection.htm). Frequency plots (ten 1m x 1m evenly spaced along the 50 m transects) were used in determining the presence and distribution of desirable plant species.

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General Project Results

-The revegetation program established by the assembled team of environmental consultants, contractors and inspectors was successful in achieving 90% of pre-disturbance coverage.

- Vegetation along all three major work segments reached required levels of cover by the end of growing season 2015

-These results could have never been achieved in a 2 year period without supplemental irrigation.

- Soil amendments were not required on the majority of the ROW.

Final Quantitative Results

- Pre-existing vegetation cover was 21.93% average for all soil types.

- WSRI achieved 32.45% cover, which is 10.52% greater than the minimum requirement.

- Species richness:
  - 5.4 (Baseline) to 6.3 (Final) warm season grasses per square meter
  - 1.3 (Baseline) to 2.2 (Final) cool season grasses per square meter
  - 2.7 (Baseline) to 5.9 (Final) native perennial forbs per square meter
  - Natural precipitation was 24.97 cm (9.83 in) in 2013 and 27.51 cm (10.38 in) in 2014.

These numbers are below the historic average of 31.24 cm (12.3 in) per year.

- Achievement of over 30% cover by primarily native perennial warm season grasses in the second growing season while maintaining high species richness substantially exceeded results in previous similar projects. This result was attributable to appropriate soil salvage and replacement, proper seedbed preparation, and of course the ability to control moisture conditions during the warm season germination period.

Questions?

Lessons Learned

- In the heat of the summer, establishing vegetation reduces Foliar development and focuses on root development as a natural plant physiology process thus, watering frequency and volume was limited to what was needed for plant survival.

- It was better to concentrate the use of supplemental irrigation in the spring and fall periods.

- WSRI made a good estimation on how much supplemental water would be needed to establish the vegetation across the ROW.

- WSRI included several contingencies in the maintenance plan that weren't needed due to the irrigation of the ROW.

- Grasses & Forbs benefited from focused deep watering rather than a continually moist seed bed.

- The design and installation of the irrigation on Segments 1, 2 and 3 has led to the innovation of more economical above ground irrigation systems that has been used on other sections of the pipeline.

- If you are successfully going to install a 13 mile long 150' wide irrigation system in the desert you need a general superintendent from the desert with a lengthy golf course construction resume.

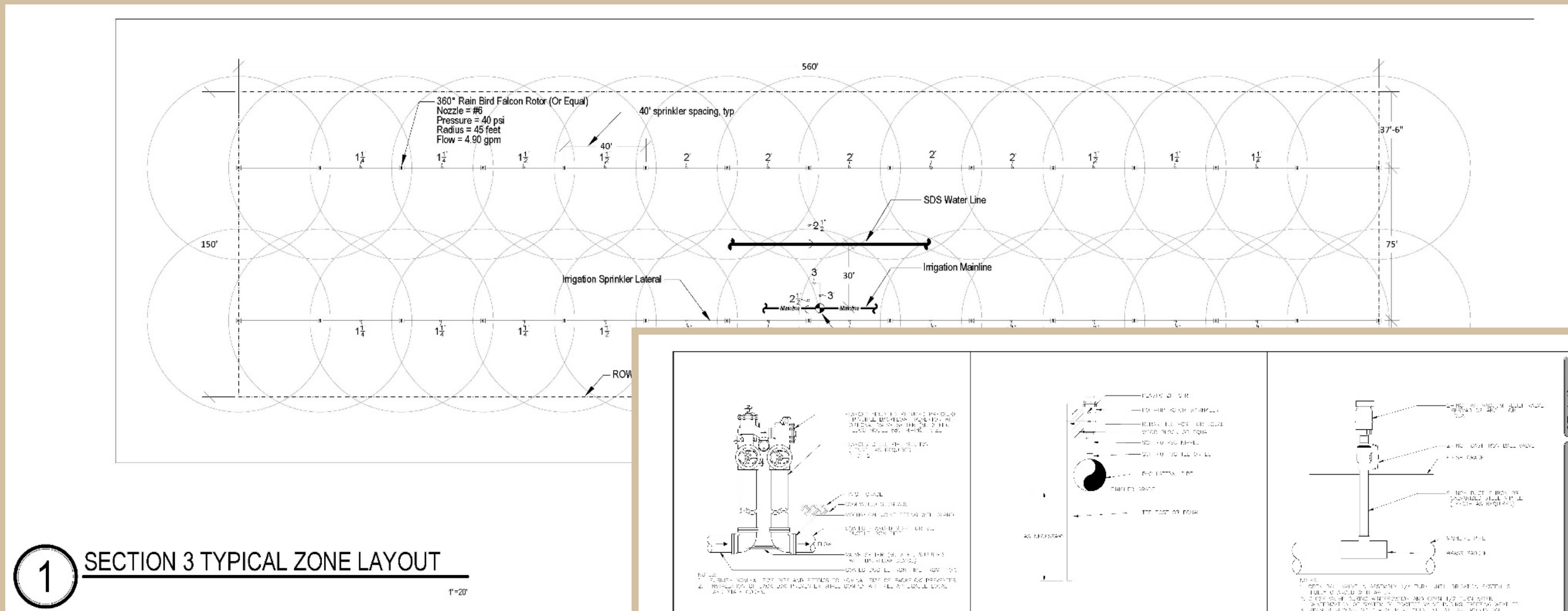
Contract Quantities

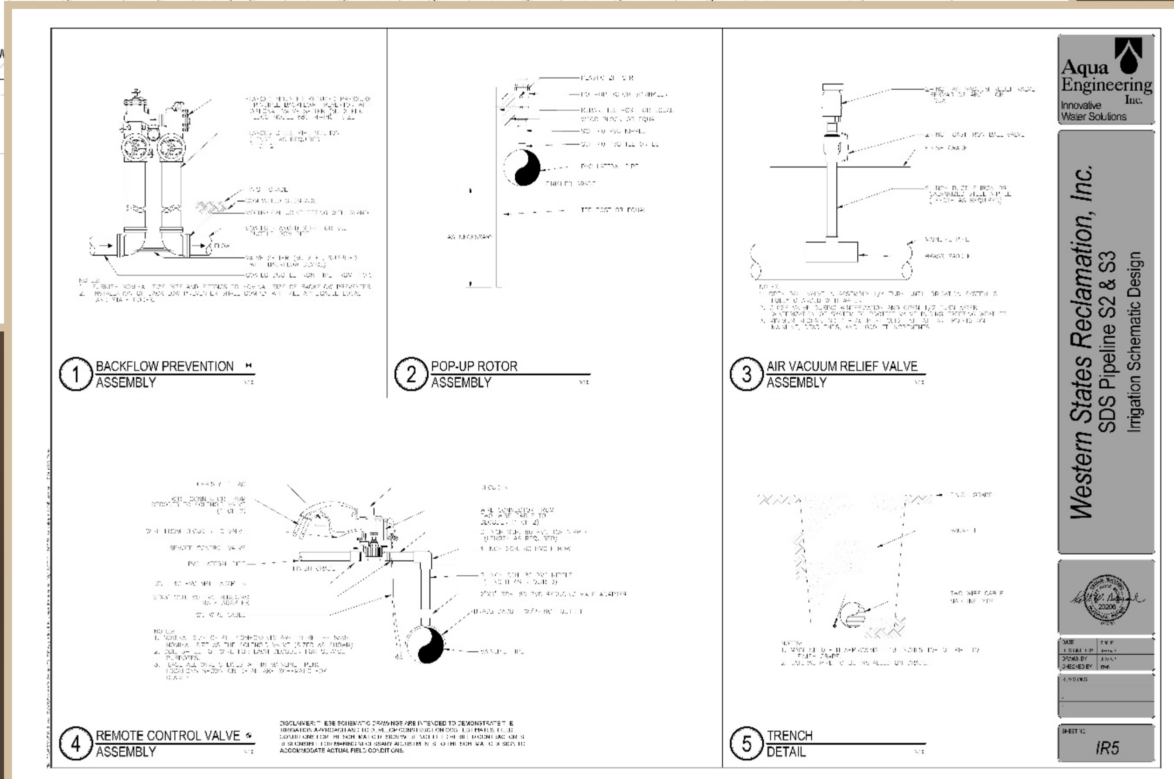
- 135.27 Hectares (**334 Acres**) of revegetation
- 24,575.38 meters (**80,575 lineal feet**) of 10.16-15.24 centimeter (4-6 inch) HDPE pipe
- 60,201.7 meters (**203,940 lineal feet**) of 2.54-7.62 centimeter (1-3 inch) PVC lateral pipe
- **4,370** Pop up rotor sprinkler heads
- **208** control valves
- **7** Points-of- Connection, backflow preventers, and meters
- **2** pump stations

Revegetation Proposal and Cost Estimate

WSRI submitted a detailed proposal that included all methods and materials that would be used for the temporary irrigation system and revegetation process. We retained an irrigation engineer to design the irrigation system based upon our proposed use of 10.16 cm and 15.24 cm (4” and 6”) High Density Polyethylene Mainline Pipe, 2.54 cm and 7.62 cm (1” and 3”) PVC lateral lines, and pop-up rotor sprinkler heads. The engineers had to take into account available water volume available, water pressure available, and sprinkler head coverage requirements. **Our contingencies for establishing the required percentage of vegetative canopy cover included the following:**

- Initial seeding plus 25% reseeding
- Initial mulching plus 10%
- 25.4 centimeters (10 Acre-inches) of water to be applied during one growing season
- 2 Mowings with a bush hog mower to control weeds and annuals during the initial establishment of native grasses
- 6 Spot application herbicide applications over the course of 3 years
- Monthly monitoring by ecologist and superintendent
- Full time irrigation staff to monitor and adjust watering regime





Proposed Irrigation System

Proposed Approach

WSRI determine that the growing season for native vegetation was from late April through the end of September. The hottest average temperatures were from mid June to late August. Thus, the best time to start watering would be around the first of May. Our planning and proposal took into account the following internal objectives:

- Install irrigation mainline whenever possible outside of the actual growing season when weather conditions allowed for trenching and proper pipe fusing.

- Seed and mulch areas immediately behind mainline installation and make every attempt to avoid seeding in the summer months.

- Install irrigation laterals and heads after seeding was completed.

- Use soil thermometers to determine when soil temperatures were consistently at or above 12.22 degrees Celsius (54 degrees Fahrenheit), which is the optimum temperature for native grass germination. Commence watering when these soil temperatures were reached. Target these watering times to conserve water and money.

- Work with project owner to avoid watering any newly seeded areas during the heat of the summer. Forcing germination during hot periods could result in desiccation and die back of seedlings.

- Water those areas which had germinated in the spring on a limited basis during the hot summer months.

- Push irrigation watering to its highest level from the end of August up until ground freeze in order to increase vegetation growth before the onset of winter.

Maintenance and Monitoring

Restoration Maintenance

WSRI had a full time staff on the project performing the following maintenance and monitoring activities

- Stormwater inspections and repairs
- Irrigation operation, repairs and adjustments
- Focused Irrigation during spring and fall
- Weed control as needed
- Touch up seeding - Full time superintendent and irrigation technician to run the irrigation schedule and maintain system.

- Fully automated 2-wire irrigation system.

- WSRI benefited from a quantitative evaluation of the ROW by ESCO Associates Inc. mid way through

Project Challenges and Solutions

- Majority of the precipitation during the project life-span occurred during major storm events. These intense focused storms resulted in flooding and damage to the Project ROW.

- Final grading was established without consideration for existing drainage patterns.

- Coordination and continual communication with SDS public relations team and property owners.

-Limited access along the right of way during maintenance and monitoring period.

- Irrigation application on different soil types

-Vandalism to irrigation system.

- Algae in raw water going through system.

- Dismantling the system without destroying vegetative cover