September 19, 2014

Title: Assessment of revegetation methods, soil movement, wash morphology development, and cactus survival in southern Arizona.

General description:

The proposed work evaluates the impacts of the pipeline on vegetation, erosion, geomorphic characteristics of washes bisected by the construction, and Pima Pineapple Cactus (PPC) transplanting. The work specifically evaluates the practices used to reclaim the land in order to determine the best practices and their value in reclaiming semiarid desert areas. The practices include the use of seeding, livestock grazing, and wash reconstruction as well as techniques for transplanting PPC. Understanding the direct and indirect impacts of seeding, livestock and wash changes will have wide benefit beyond this specific project because the merits and cost/benefits of these practices are often debated based on anecdotal evidence. Additional PPC monitoring/research will inform their conservation. The addition of rigorously collected data will allow for better decisions.

The work will occur in three main parts: vegetation, wash channels, and Pima Pineapple Cactus.

Vegetation:

There are three main re-vegetation processes that will benefit from research: re-vegetation and associated soil movement, effect of seeding, and effect of animals (livestock, rabbits, etc.). The hypothesis for the herbaceous vegetation in the areas disturbed by construction is that they will be equal to the undisturbed parts of the site. This should occur in terms of plant density within the first year after sufficient rainfall and within three to five years in terms of biomass. The lag in biomass is due to perennial plants being small for the first few years until they reach a mature size. One can develop scenarios where there is more vegetation either on the reclaimed parts of the site or on the undisturbed parts of the site depending on the site history (e.g. the site was degraded due to historical factors and the reclamation mitigates those factors or the reclamation results in degraded conditions). This comparison will augment the larger monitoring effort that is not part of this project (contracted monitoring).

Seeding (adding seeds) should have a positive effect on vegetation diversity and abundance. The proposed research would compare seeded, unseeded sites and adjacent undisturbed sites. On the unseeded sites, the topsoil contains seeds and appropriate soil biota soil to allow some vegetation establishment even without seeding. Our hypothesis is that this volunteer vegetation community will be sparely distributed and with low diversity. Of more impact, we hypothesize that the unseeded vegetation will be less effective at holding the soil in place and that more soil movement will occur in comparison to seeded areas. We expect soil movement to be most in unseeded reclaimed, less in seeded reclaimed, and least on adjacent undisturbed areas.

Livestock grazing remains a common land use in Arizona and across the west. Livestock are not recommended on reclaimed sites for the first two years which can increase costs and decrease interest especially for smaller sites. The effect of livestock should be to reduce the density of plants (increase

mortality of newly established plants) and decrease the amount of biomass produced (due to having fewer plants to produce it). This issue is not likely to be as clear as it otherwise would be due to the limited control of grazing on the sites. The impacted areas will be small in comparison to the areas available to animals and far from attractants (water, salt, and shade). If somewhat more forage occurs on the reclaimed areas, then this could be an attractant. Livestock tend to be curious and can associate trucks with supplemental feeding which could draw them to the reclaimed areas. To test for livestock effects, small cages will be added to sites with livestock access and the vegetation inside the cage will be compared to adjacent vegetation outside the cage.

The cages will have an approximate 5 cm (2 inch) mesh which will also control for rabbits and larger wildlife. Wildlife can have a substantial impact on re-vegetated sites. The cages also block other kinds of disturbance, so to control for the differences in grazing and trampling related disturbances, an open cage will be added as an additional treatment included to prevent traffic on small areas but still allow grazing access.

Task 1.

Characterize vegetation reestablishment on the pipeline impacted areas in comparison to undisturbed areas.

1.1 Compare plant species density and biomass production on at least five impacted and five undisturbed sites with similar soils, landscape position, and close geographic proximity.

1.2 Estimate soil movement.

1.3 Assess seedbank

1.4 Comprehensively photograph sites every year.

1.5 Test soil.

1.6 Analysis and reporting.

Task 2.

Determine the effect of adding seeds versus not adding seeds to the resulting plant community on at least five areas (potentially whole washes) that have been seeded along with paired areas that have not been seeded (for a total of at least 10 areas).

2.1 Compare the vegetation (plant species density and biomass production) among the seeded/unseeded and inside/outside the construction area.

2.2 Estimate soil movement

2.3 Assess seedbank

2.3 Analysis and reporting.

Task 3.

Determine the impact of livestock grazing/access versus no livestock grazing/access on the plant community.

3.1 Add cages (1.5 X 2 m; 4.5 X 6 feet on a side) to the treatments in task 2 to exclude cattle and wildlife that cannot fit through a 5 cm (2 inch) mesh. The caged areas are paired with plots that will have open access. A third treatment limits traffic but allows grazing (e.g. a teepee of T posts). There would be two clusters of plots per area (for a total of 40 observations) with one on the disturbed part of the ROW and one cluster on the undisturbed part of the ROW. The plots would be randomly established in areas accessible to grazing and not in the wash bottom.

3.2 Estimate soil movement

3.3 Assess seedbank

3.4 Analysis and reporting.

Wash Channels:

The main factors that influence washes include: construction practices, flow, and vegetation. We hypothesize that little evolution of the plan form of wash channels will occur in response to reclamation. However, because differences in construction practices change the ability of the wash bottom/sides to erode, we expect to see change in channel profiles above and below any hardening of the bed (e.g. installation of soil cement). In addition, there may be scour or deposition on the downstream side of the pipeline right of way. These changes can be detected through annual topographic surveys down the center of the channel bed extending above and below the disturbed area. These profiles will show deposition and scour if it occurs. In order to separate the effects of various construction practices, both washes with different pracitces need to be evaluated. Extending the profiles above and below the areas impacted by the pipeline will also allow assessment of undisturbed conditions.

While changes to channels (construction) are likely to have a detectable effect, the other significant driver of change is the flow down the channel. The geomorphic changes in channels will be interpreted in the context of measured rainfall and the number and depth of runoff events. We propose to establish a rain gauge centrally located among the washes being researched. We also will put maximum flow (crest) gauges in the washes to determine the highest flows. The source areas for the specific washes will also be determined.

The wash channels will be evaluated in terms of their condition and function on vegetation establishment and growth. This will test the hypotheses that these channel modifications change water infiltration and promote or retard vegetation growth. We will evaluate the soil moisture, general soil properties, and vegetation establishment/condition in three different situations: above the construction, in the areas impacted by construction, and below the construction.

Task 4.

Evaluate the impact of soil cement, and pipeline construction on the general site topography and channel morphology. At least ten washes will be selected for evaluation.

4.1 Install a centrally located rain gauge to serve all research locations.

4.2 Install crest gauges which will provide information on the number of flows and the peak runoff depth.

4.3 During the period of study channel profiles will be re-measured annually after each monsoon season. Channel profile plots will be evaluated to identify areas of aggradations (fill), degradation (scour), and/or no change. At the time of the channel surveys, each area with construction will be evaluated to determine whether it is intact, degraded, or failed. The main analysis will occur in years 3-5 to allow time for changes to occur.

4.4 Monitor plant species density and biomass production above/below construction.

4.5 Compare the vegetation immediately downstream of the pipeline impacts to vegetation in similar un-impacted areas.

4.6 Compare the seedbanks of all plots.

4.5 Monitor soil moisture above and below the construction to assess the contribution to favorable growth conditions.

4.7 Determine the runoff contributing area for the washes being evaluated (from digital elevation models that are currently available).

4.6 Test soils.

4.7 Analysis and reporting.

Pima Pineapple Cactus:

The rationale for this part of the project is a separate document to better separate the SOW for the contractor supplied effort from the efforts specified here. MS student would augment the described work with additional observational studies. An initial report will be prepared in May 2016 (MS thesis) and a final report in December 2019.

Task 5.

5.1 Analyze soil samples collected by others.

Approximately 200 to 240 samples for texture and chemistry

Approximately 120 samples for root fragments

Approximately 20 samples for soil biotic community

5.2 Plants will be revisited once a month August 2014 through December 2015 and twice a year after that through August 2019.

Variables to be measured:

Survival (mortality).

Size (diameter and height of main stem),

Number of stems,

Number of pups (ramets),

Presence of flowers,

Presence of fruit (seeds),

Presence of plant damage (small mammal, livestock trampling).

Soil moisture using a TDR 10 cm probe.

Light at the soil surface.

Soil temperature at the surface using an infrared soil thermometer.

5.3 Photograph the plants during each visit from the side and directly overhead.

Timeline

September 2014	Site selection and initial documentation of site conditions
August-September 2015	Characterization of first monsoon results
June 2016	Report on initial evaluation of tasks 1, 2, 3, and 5.
August-September 2016	Characterization of second monsoon results
August-September 2017	Characterization of third monsoon results
August-September 2018	Characterization of forth monsoon results
June 2019	Final report for all tasks