



**North Alkali Drain
Water Quality Improvement Pilot Project
Project Summary and Report of Preliminary Results**

**Prepared for:
Members of the Board of Directors
Lower Boise Watershed Council, Inc.**

**Prepared by:
Rob Tiedemann, Ph.D.
Hal Anderson
Integrated Watershed Solution, Inc.**

**With Contributions by:
Quadrant Consulting, Inc.
Rapid Creek Research**

January 6, 2015

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EXECUTIVE SUMMARY

Observations in the field and quantitative data produced in the laboratory demonstrate the practicality of constructing and operating a pilot project to remove phosphorous from the North Alkali Drain, and provide early evidence of its efficacy. The project may be scaled to larger sizes to accommodate greater water volumes in other waterways, and its design adjusted to complement the landscapes of natural rivers and their floodplains. Factors that limit its application include: (1) landform and elevation gradients allowing for passive operation rather than active pumping of water as is done for this project, (2) available area to construct and operate a sedimentation basin of a size sufficient to remove a range of forms and particle sizes of suspended sediments, and (3) available area to grow a community of hydrophytes and / or an agricultural crop that can later be harvested and removed from the path that cycles nutrients through the ecosystem.

This report completes the final phase of the project as described in the contract signed on March 7, 2013 between Lower Boise Watershed Council, Inc. and Integrated Watershed Solutions Inc. which is committed to five years of additional monitoring. This report describes: (1) the development of a conceptual plan and preliminary design alternatives; (2) survey and engineering; (3) status of the installed plant community designed to remove dissolved phosphorous from the raw water delivered to the project; (4) measurements of water quality and interpretations of the data; and (5) regulatory requirements met by the project.

The numeric data confirm what we know from experience. Water quality in the North Alkali Drain is variable during the growing season (Figure 4).

The data show consistent reductions of concentrations of suspended solids between the North Alkali Drain and samples taken at the outlet of “treatment” by the sedimentation basin and constructed wetlands (Figure 5).

The data are ambiguous for measured concentrations of total phosphorous (TP) and dissolved phosphorous (DP). We compared samples taken at the North Alkali Drain to those taken at the outlet of “treatment” and found no discernable pattern in which we had complete confidence. More data are needed (Figures 6 and 7).

Our documentation of reductions in load of suspended solids (Figure 8) by the “treatment”, in combination with the fact a portion of the load of phosphorous in water is known to be associated with particulates gives us optimism that we may find the same reduction in phosphorous when the plant community is fully established and with more data from our project.

A. INTRODUCTION

Idaho Watershed Solutions, Inc. is a 501(c)(3) non-profit corporation that develops engineered and biological solutions at the scale of landscapes to promote efficient use of water and precise application of nutrients for agricultural growers. We provide alternative solutions to the problems of water pollution and loss of wetlands, and are the founders of a nutrient exchange and wetland bank that will be available to public and private entities that must comply with the Clean Water Act §402 National Pollution Discharge Elimination System, and the Clean Water Act §404.

The Lower Boise Watershed Council, Inc. on March 7, 2013 awarded Idaho Watershed Solutions, Inc. a Clean Water Act §319 grant to design, construct, operate, and monitor a pilot project to remove phosphorous from the North Alkali Drain, a waterway known to convey pollutants from the lower Boise River drainage to the Snake River in Idaho.

Idaho Watershed Solutions, Inc. subcontracted portions of the project to Idaho Water Engineering, LLC; Ecological Design, Inc.; Quadrant Consulting, Inc., and Rapid Creek Research.

Idaho Water Engineering, LLC was responsible for: (1) administering the grant, (2) managing the logistics of the project, (3) obtaining the required Clean Water Act §404 permit, (4) acquiring a water right, (5) preparing a quality assurance / quality control plan for water sampling and analysis, (6) sampling water for analytical measurements by the Idaho Bureau of Laboratories, (8) measuring water quantity, and (9) monitoring the condition of Best Management Practices prescribed by the Stormwater Pollution Prevention Plan.

Ecological Design, Inc. was responsible for: (1) developing a conceptual plan for the project and preliminary design alternatives resulting from it, (2) preparing the Stormwater Pollution Prevention Plan, (3) filing a Notice of Intent and obtaining the required Clean Water Act §402 Construction General Permit, (4) preparing a revegetation prescription for the grow plots and surrounding areas, and (5) analyzing water quality and plant data by graphical and statistical methods.

Quadrant Consulting, Inc. was responsible for: (1) surveying and mapping the project area, (2) engineering and developing a final design of the selected design alternative, and (3) providing construction support in the field.

Rapid Creek Research designed, installed, and maintained instrumentation and telemetry to measure and report water stage at the point of discharge and water volume leaving the project area.

This report describes their work; the means and methods of design, construction, and operation of the project; and reports - with the preliminary results we have produced - on its effectiveness.

B. BACKGROUND

Phosphorous is a plant nutrient that promotes the growth of floating and submerged aquatic vegetation. It is present in the lower Boise River and Snake River in concentrations that have the potential to create nuisance algal blooms. Documented blooms have occurred in the impoundment behind Brownlee Dam on the Snake River and have contributed to its eutrophication. While a Total Maximum Daily Load for phosphorous has not been finalized for the lower Boise River, the Idaho Department of Environmental Quality (DEQ) has accelerated the process of its development because of concern from the US Environmental Protection Agency, Idaho DEQ, and the public.

Phosphorous is known to reside on particulates, measured in the laboratory as suspended sediments, and to be susceptible to removal from the water column by the physical process of sedimentation. For this project we chose to settle particulates by constructing a sedimentation basin sized to provide a detention time sufficient to allow most particulates to travel to the bottom of the basin. In practical application, they would be periodically removed by excavation and applied to agricultural fields as a soil amendment.

A second chemical form of phosphorous is freely transported in water, measured in the laboratory as ortho- or dissolved phosphorous, and is not susceptible to sedimentation. Instead, uptake by actively growing plants sequesters dissolved phosphorous and temporarily removes it from the water column. In nature this most often occurs with the presence of floating algae and rooted aquatic plants. However, excessive amounts of phosphorous are associated with algal blooms and the subsequent depletion of dissolved oxygen as plants decompose after the growing season. For this project, we chose to install two grow plots where an actively growing community of hydrophytes, or wetland plants, would absorb dissolved phosphorous through their roots and incorporate it into their plant tissue. In practical application, they would be periodically harvested and composted to produce a soil amendment.

C. LOCATION AND OBJECTIVES OF THE PROJECT

The project is located in northwest Canyon County near Parma, Idaho (T5N, R6W, Section 11 as shown on the Owyhee USGS 7.5 minute quadrangle map) where the North Alkali Drain returns irrigation water diverted from the Boise River to the South Boise Drain and eventually the Snake River. The drain is less than three miles upriver from the confluence of the lower Boise River and the Snake River (Figures 1 and 2) and courses through an

active farming operation. Ground at the farm is presently cultivated to produce beans, onions, and other agricultural crops.

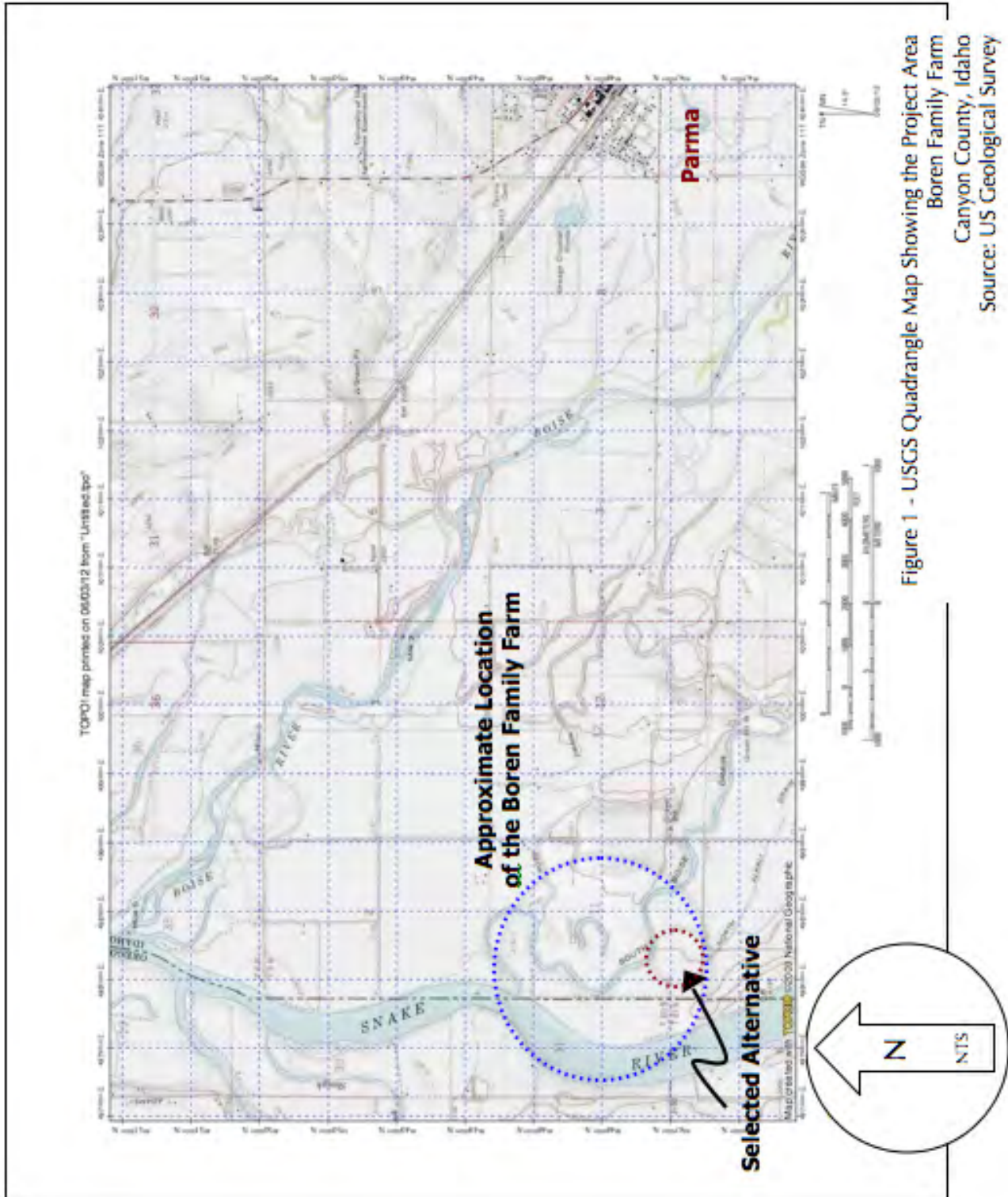


Figure 1 - USGS Quadrangle Map Showing the Project Area
Boren Family Farm
Canyon County, Idaho
Source: US Geological Survey



Figure 2 - Color Aerial Photograph Showing the Project Area
Boren Family Farm
Canyon County, Idaho
Source: Google Earth, May 9, 2013

The North Alkali Drain was constructed by the US Bureau of Reclamation to convey irrigation return flows and excess ground water from pastures and cultivated ground. The drain, located within the lowest portion of the Boise River basin, receives water from non-point sources along its length as well as accumulating loads of pollutants from upstream point and non-point sources.

This project tests the proof of concept and provides scientific documentation showing whether a sedimentation basin in combination with a constructed wetland(s) can remove significant quantities of sediment and phosphorous from receiving waters in southwest Idaho. If successful, it is the objective of Integrated Watershed Solutions, Inc. to transport the means and methods used by this project to other drainages and to give regulators, National Pollution Discharge Elimination System permit holders, and river managers the information they need to better evaluate alternatives for nutrient removal from the lower Boise River.

D. CONCEPTUAL AND PRELIMINARY DESIGN

1. Detention Time

The efficiency of the physical process of sedimentation, or downward movement of particles in a water column, is directly dependent on the length of time a parcel of water resides within a basin. That time is commonly referred to as *detention time* and is expressed, in hours, as the following:

$$DT \text{ Hours} = (BV / Q) / 3,600$$

Where:

DT = detention time (hours)

BV = basin volume (cubic feet)

Q = flow into the basin (cubic feet / second)

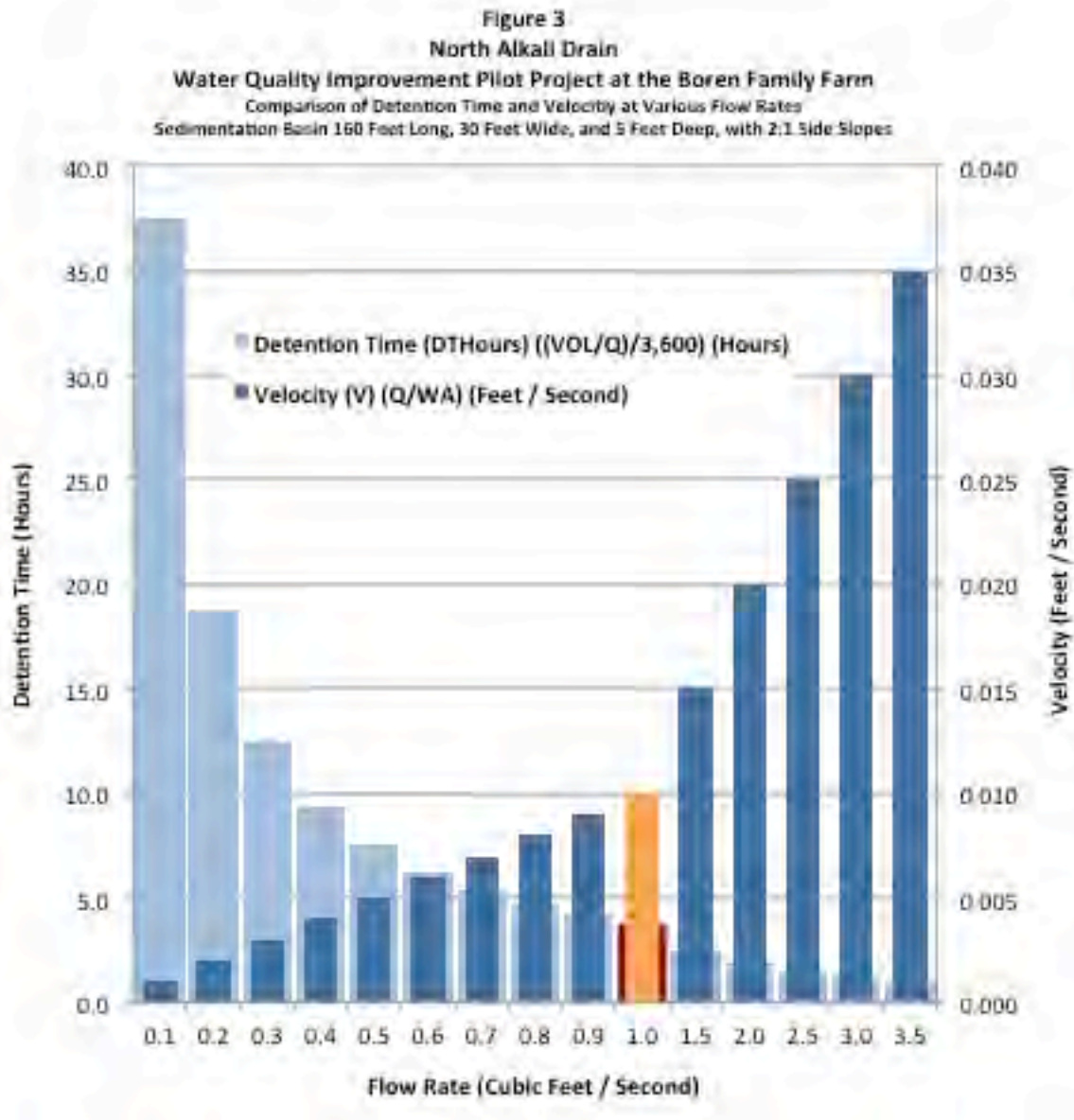
Flow into the basin is assumed to be equal to flow out of the basin.

Particles in a water column are “pulled” toward the bottom of a basin by the force of gravity. Particles of different mass settle at the same rate, much like the result shown in Galileo’s experiment when he dropped cannon balls of different mass in air from the tower of Pisa. However, particles in water in the form of floccules (a.k.a. floc) that may appear to some as “fluffy” are buoyant and settle at a slower rate than those that are not buoyant. Extremely small particles may also settle at a slower rate because of random collisions with atoms and molecules known as Brownian motion. These soil particles, their texture often described as clay, are of particular interest to us because they have a greater affinity to bind with phosphorous than larger particles.

A four-hour detention time was described to us by practitioners as effective in removing soil sediments in southwest Idaho (pers. comm. Dr. David Bjorneberg, USDA-ARS, Kimberly Experiment Station). We prepared preliminary designs for the project - based on a basin volume constrained by the footprint of ground available to us - that could, at a minimum, achieve this goal and used the model we constructed and shown in Figure 3 to guide us in determining an appropriate flow rate (see red bar) for the project.

2. Conceptual Design Goals

Members of the Lower Boise Watershed Council, Inc. described to us that process is as important as product in their assessment of the results of our project. Meaning, in part, the knowledge we share with them should demonstrate to the farm community both the practicality (e.g. scalable to available land area, use of readily available equipment, and compliance with regulatory requirements) and feasibility (e.g. constructability, efficacy in removing phosphorous, and cost) of the project.



Their direction led us to develop a working concept for the project, and later preliminary design alternatives, based on the following design goals:

1. Minimize the cost of construction.
2. Minimize the cost of operation and maintenance.
3. Use common methods and materials.
4. Use readily available equipment.
5. Produce marketable product(s) when possible.
6. Comply with exemptions or other waivers from the need for Federal, State of Idaho, and local permits and approvals.
7. Garner acceptance of the project by the owner(s) of the property and the neighboring farm community.

The conceptual design is described in a memo dated March 18, 2013 and shown in Appendix 1.

3. Preliminary Design Alternatives

Four preliminary design alternatives were initially developed for consideration by the project team and the farm owner (Appendix 1). The family is the owner of the property that is both the footprint and access to the project. Each alternative differs in size, location, and aesthetic. Three are “industrial” in appearance and one a visual complement to the adjacent landscape with a sinusoidal channel and gentle side-slopes, much like a natural stream and its riparian fringe. The cost of each was evaluated after consultation with local contractors interested in building the project, and all were found to exceed estimates prepared during the preliminary design process.

A fifth alternative was then developed that met our design goals and - with donations of labor and equipment by Parma Company, Boise River Enhancement Network, Rapid Creek Research, and others - was within budget. That selected alternative is shown in Appendix 2. It achieved savings by moving all operations to the east side of the North Alkali Drain, rather than locating the sedimentation pond west of, and the grow plots east of the drain. This minimized the transport of earth by truck and the lengths of pipe required to convey water. However, in doing so the footprint of the project was greatly reduced in size because of limited space between the drain and the easterly property line of the farm property. As a result, the grow plots could no longer be sized to accept the 1 cubic foot / second (CFS) of water that could be delivered to them from the sedimentation basin. A novel engineering solution that shunted a portion of that water to a bypass around the grow plots compensated for this loss of area. The flow of raw water from the drain delivered to the sedimentation basin remains at the design rate of 1 CFS. However, only a portion of it is delivered to the grow plots, and instead a portion returned to the drain after passing through the sedimentation basin only. This obviously results in a lesser load of dissolved phosphorous removed from the raw water.

Recommendation No. 1 - As early in the design process as possible, complete a detailed ground survey and calculate quantities of earthwork in the detail required to estimate costs with some accuracy. Prepare a “value engineering” estimate of cost of each alternative to best determine those

that should be eliminated from further consideration because of expense or other factors. An example is shown in Appendix 2.

E. METHODS

1. Surveys and Engineering

Surveys were done with the use of commercially available green LIDAR and on-the-ground measurements of x and y coordinates, and elevations (z coordinate).

Engineering calculations and layout that produced the final design of the project, specifications, and plan sheets for use by the contractor were approved and stamped by a registered professional engineer and are generally described in the following narrative:

1. Elevate by placed fill the water surface of the North Alkali Drain to allow sufficient depth for a pump to feed 1 CFS of water into the sedimentation basin.
2. Deliver by plastic pipe the raw water from the drain to the near end of the sedimentation basin that is sized to allow a detention time of 4 hours.
3. Locate a fabricated overflow weir at the water surface of the sedimentation basin to receive the decant of the treated water, and at its far end to prevent "short circuiting" which would shorten detention time.
4. Deliver by plastic pipe water from the weir to another pipe that is gated to control flow to the plowed furrows within the two grow plots.
5. Locate a fabricated concrete structure with check boards at the end of the gated pipe to portion the volumes of water delivered between a bypass ditch and the grow plots.
6. Locate a catch ditch at the end of each grow plot to receive water from them. Join the ditches to deliver water to a calibrated weir allowing measurement of stage and calculation of flow.
7. Armor a constructed channel, from the top of bank to the channel of the North Alkali Drain, to prevent scour and head-cutting by water returned to the drain.

Final design plans are shown in Appendix 3.

2. Selection and Installation of Plant Materials

Plant materials were selected based on their ability to: (1) tolerate alkali soils, know to practitioners as halophytes; (2) compete with both weedy and noxious species common to the project area and its surroundings; (3) tolerate periodic drought that might occur during operation of the project; and (4) be marketed as the feed stock of a soil amendment or sale as a cutting for use by other river or wetland restoration projects.

Selected species, rates of application of seed, and methods of gathering cuttings are described in documents shown in Appendix 4.

3. Construction

A contract was signed on April 4, 2014 for \$16,500 with Timberlake Construction to provide the materials and labor required to construct the project shown as a final design by Quadrant Consulting, Inc. and further described in their specifications and plan sheets

(Appendix 3). Factors contributing to a higher than expected bid include additional earthwork due to variable topography and escalating fuel prices. Their work began on April 9, 2014 and was completed May 2, 2014. All work was done with conventional equipment including track hoe, dump truck, water truck, tractor and plow, and hand tools.

When earthwork was complete, on May 5, 2014 Veasy Seeding, Inc. installed the prescribed seed mixes, mulch with tackifier, and soil amendments to one of the two grow plots and all other disturbed ground. A total of 2.25 acres were revegetated by this method for a total cost of \$5,000 for materials and labor. Work was done by a conventional hydro-seeder mounted on a tanker truck.

Volunteers from the Boise River Enhancement Network, with Hal Anderson and Rob Tiedemann on May 7, 2014 installed willow cuttings on the second grow plot that they gathered and processed from a site along the Weiser River in Washington County. There was nominal cost associated with rental of equipment and no cost for either materials or labor. Planting holes were excavated by use of a hydraulic “stinger” or water jet, and cuttings installed and backfilled by hand.

Electric power was delivered to the project by Idaho Power and connections to the pump made by a local contractor in late May 2014. Instrumentation to measure water flow and telemetry equipment were also installed in late May 2014 by Jim Brock, Rapid Creek Research.

4. Operation and Maintenance

An operations test of the completed project was begun the last week of May 2014. The pump was switched on and water soon after entered the sediment pond and grow plots. It was later switched off to resolve the following problems:

1. Compaction of the embankments of the sedimentation basin was difficult because of their steepness. Sloughing was expected and remedied by further compaction with a mechanical, hand operated compactor.
2. Initial settings for the gated pipe delivered too much water to the grow plots causing scour. Gates were adjusted to lessen the rate of flow of water.
3. Electric power is intermittent and known to go off an average of once every other week, sometime twice a week in the area. Instrumentation and telemetry to measure and report water stage at the point of discharge allowed us to remotely detect interruptions of power and to allow our local contractor to manually turn on the pump.

Routine and ongoing maintenance includes the following:

1. Periodically fill the tank that delivers lubricant to the pump.
2. Periodic inspect the pipe that delivers water to the sedimentation basin and all conveyance channels, and remove debris.

Recommendation No. 2 - Reduce operation and maintenance costs by: (1) installing an automatic pump restart switch to activate the pump when power is restored after a disruption and (2) at times when raw water is not greatly impaired, reduce the time the pump is operating to 12 hours on and 12 hours off. Although this will result in lesser removal of loads of sediment and total phosphorous from the raw water, it will not harm hydrophytic, or wetland, plants in the grow plots. Because flows in the North Alkali Drain are variable - we measured rates between <1 to 9 CFS - install a float or other switch linked to the pressure transducer that measures flow in the North Alkali Drain to turn the pump off at low flows that can cause damage.

5. Sampling of the Plant Community

The plant communities in grow plot A, grow plot B, and a nearby control were sampled by a stratified design which subdivided each plot into three, equally sized sub-plots along their lengths. We made ocular estimates of percent cover of each observed species, five times, within a 0.25 by 0.25 meter frame (i.e. quadrat) randomly placed along one transect within each of the six sub-plots. Each of the six transects were also located in a random fashion using a random number generator.

All observed species were identified by genus and species according to convention described in the US Department of Agriculture, Natural Resources Conservation Service, Plants Database.

6. Production of Data and Analysis

Water quantity (i.e. stage and flow) data for the North Alkali Drain were produced using a pressure transducer and a continuous stage recorder.

A Cipolletti weir was fabricated and installed at the outlet of the sediment basin, and a V-notch weir in the outlet channels conveying water from each of the two grow plots. Staff gages were installed at each of these three weirs.

Water quantity (i.e. stage and flow) data were produced using a calibrated V-notch weir in the channel below where the two outlet channels from the grow plots join. Water level flowing over the weir is measured by a custom device fabricated specifically for the project. Because of its uniqueness it is described here in some detail.

The device places a float and shaft encoder instrument in a stilling well constructed from 12-inch diameter corrugated steel pipe that is located in the bank of the channel. The stilling well is connected to the channel with a 1.5-inch steel pipe. Water level is sensed using a shaft encoder (Model 1, Microcom Design) with a 1-foot diameter pulley, a 6-inch diameter polyethylene float (No. 12221, Campbell Scientific Inc.) with stainless steel tape, and a 4-ounce counter weight. Water level is sensed by the shaft encoder with an accuracy >0.002 feet, and is recorded at 15 minute intervals using a CR200x data logger (Campbell Scientific Inc.). Power is provided by a 12-VDC, 26-ampere battery charged with a 10-watt solar panel. Data are retrieved using a cellular data modem (Option Cloudgate). Current conditions and plots of historic data are available for visual display using Vista Data Vision software.

Water samples were gathered in accord with the North Alkali Drain Quality Assurance Project Plan (Idaho Water Engineering, LLC 2013) and analytical measures of suspended solids, total phosphorous, and dissolved phosphorous made by the Idaho Bureau of Laboratories.

To further explain, water quality samples were collected using a DH-81 sampler and combined in a churn sample splitter. Individual bottles for each analytical measurement were filled while the churn was mixing to ensure each bottle received a representative sample from the composite. The samples for year 2013 were collected in the North Alkali Drain about forty meters downstream from Brumbach Lane. The samples for year 2014 were collected at the impoundment for the pump, about 10 meters upstream from where the 2013 samples were collected. Samples of water leaving the project were taken on the upstream side of the V-notch weir in the outlet channel.

We compiled both water quantity and quality data and produced the graphics shown in this report using Microsoft Excel v. 14.2.2.

Plant community data were compiled and evaluated using the statistical software JMP 11 (SAS Institute). We analyzed the data using Principal Components Analysis (PCA), a multivariate statistical method of expressing numerous variables as one, and later compared their means by the statistical methods known as “All Pairs, Tukey HSD” and “With Control, Dunnett’s”. This allowed us to determine if significant differences exist between the species observed and percent cover measured in grow plot A as compared to grow plot B.

F. PRELIMINARY RESULTS AND DISCUSSION

1. Water Quality

Water quality data for the years 2013 and 2014 are shown in Appendix 5. The graph of the 2013 data (Figure 4) is a comparison of the three measured water quality parameters (i.e. suspended solids, total phosphorous, and dissolved phosphorous) with time in the North Alkali Drain. The graphs of the 2014 data (Figures 5 through 7) are comparisons of the three water quality parameters for the North Alkali Drain, and the outlet of the project after water has flowed through both the sedimentation basin and grow plots.

The data are confounded in that no samples were gathered and no measurements made for the three water quality parameters at the outlet of the sedimentation basin and for each of the grow plots. As such, the data reported for the outlet of the project are for a composite sample from sedimentation basin + grow plot A, and sedimentation basin + grow plot B. Grow plot A was planted with the seed of six grass and one rush species that are halophytes, and Grow Plot B was planted with willow cuttings. A more comprehensive sampling protocol, allowing for assessments of the efficacy of the sedimentation basin and each of the grow plots alone, was not possible because of our constrained budget.

Recommendation No. 3 - Design and implement a robust sampling protocol that includes, at a minimum, the following locations where samples are taken: (1) the waterway from which raw water is delivered to the project, (2) the inlet and outlet of the sedimentation basin, and (3) the inlet and the outlet of each grow plot. Samples should be taken on a

weekly schedule to provide a large enough data set for statistical analysis and to capture variability over the growing season. If budget allows: (1) multiple samples may be taken at a single time, at a single location to allow for an assessment of sampling error, (2) samples may be taken both day and night to assess diurnal changes in the rate of removal of dissolved phosphorous due to changes in metabolic activity of plants, and (3) sub-surface samples may be taken to assess the effect of infiltration of phosphorous laden water into the shallow groundwater table.

Figure 4
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
 Measured Water Quality Parameters in the North Alkali Drain
 Prepared by: Rob Tiedemann, Ph.D.

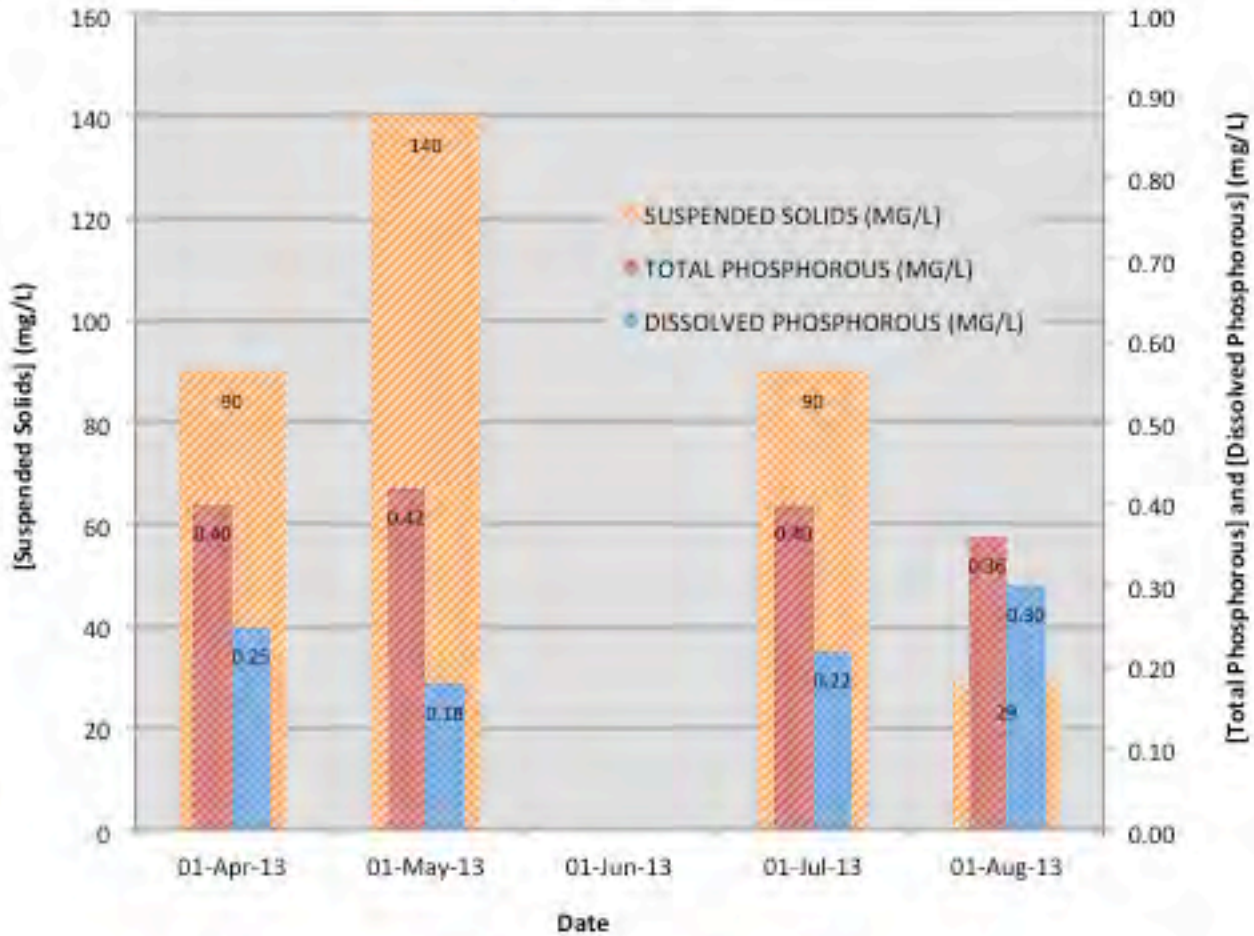


Figure 5
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
 Measured Suspended Solids in the North Alkali Drain and Outlet of the Project
 Prepared by Rob Tiedemann, Ph.D.

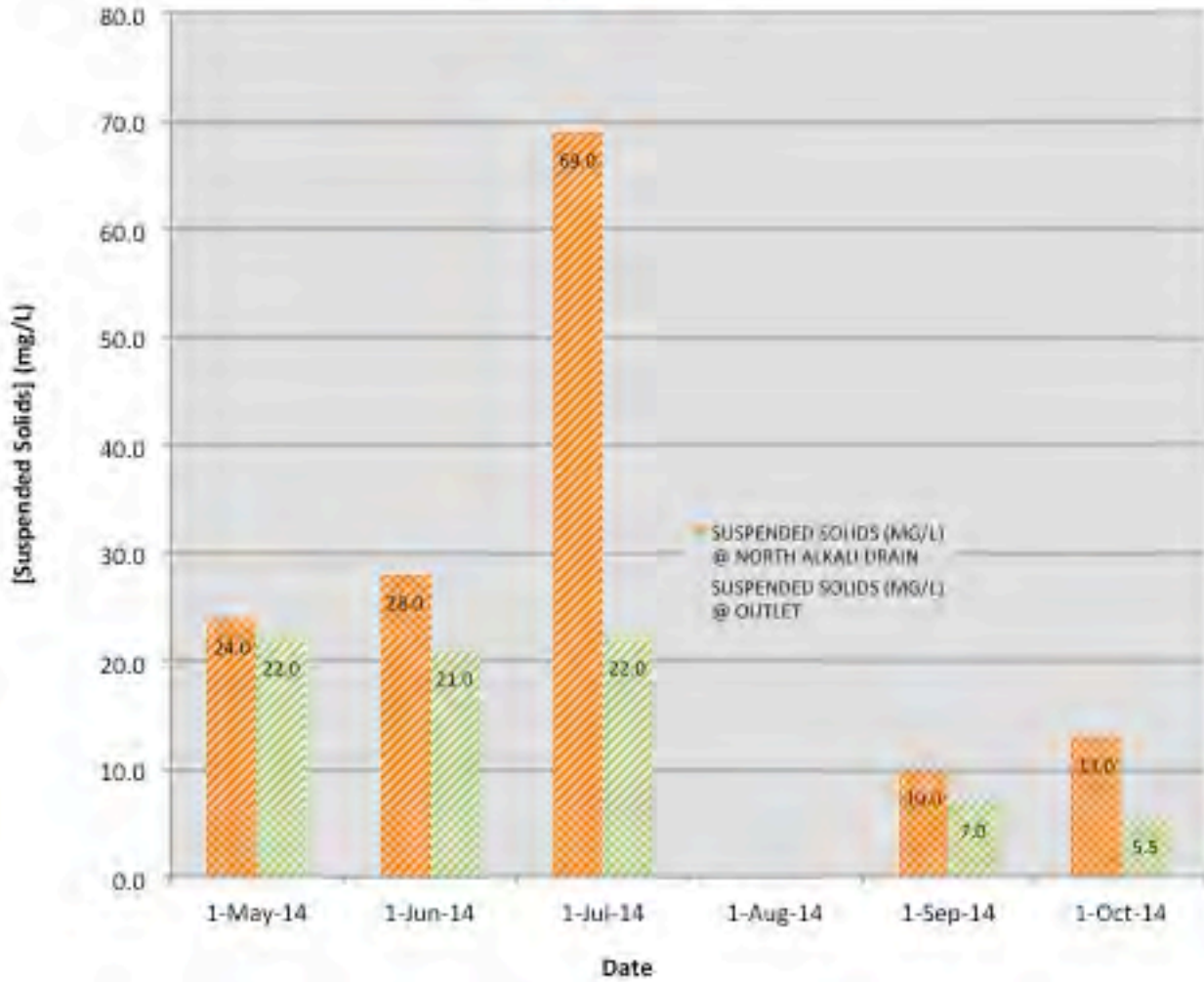


Figure 6
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
Measured Total Phosphorous in the North Alkali Drain and Outlet of the Project
 Prepared by Rob Tiedemann, Ph.D.

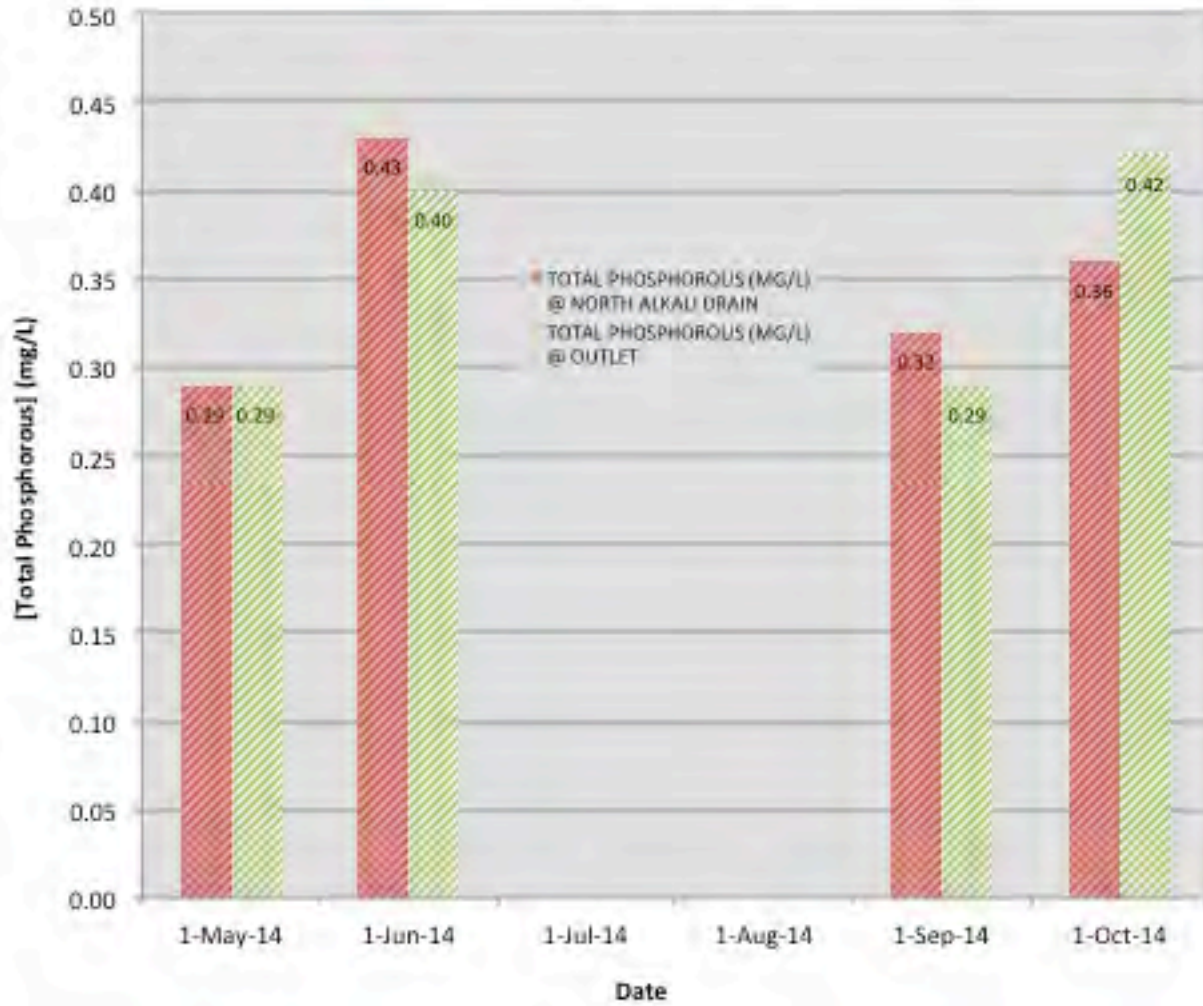
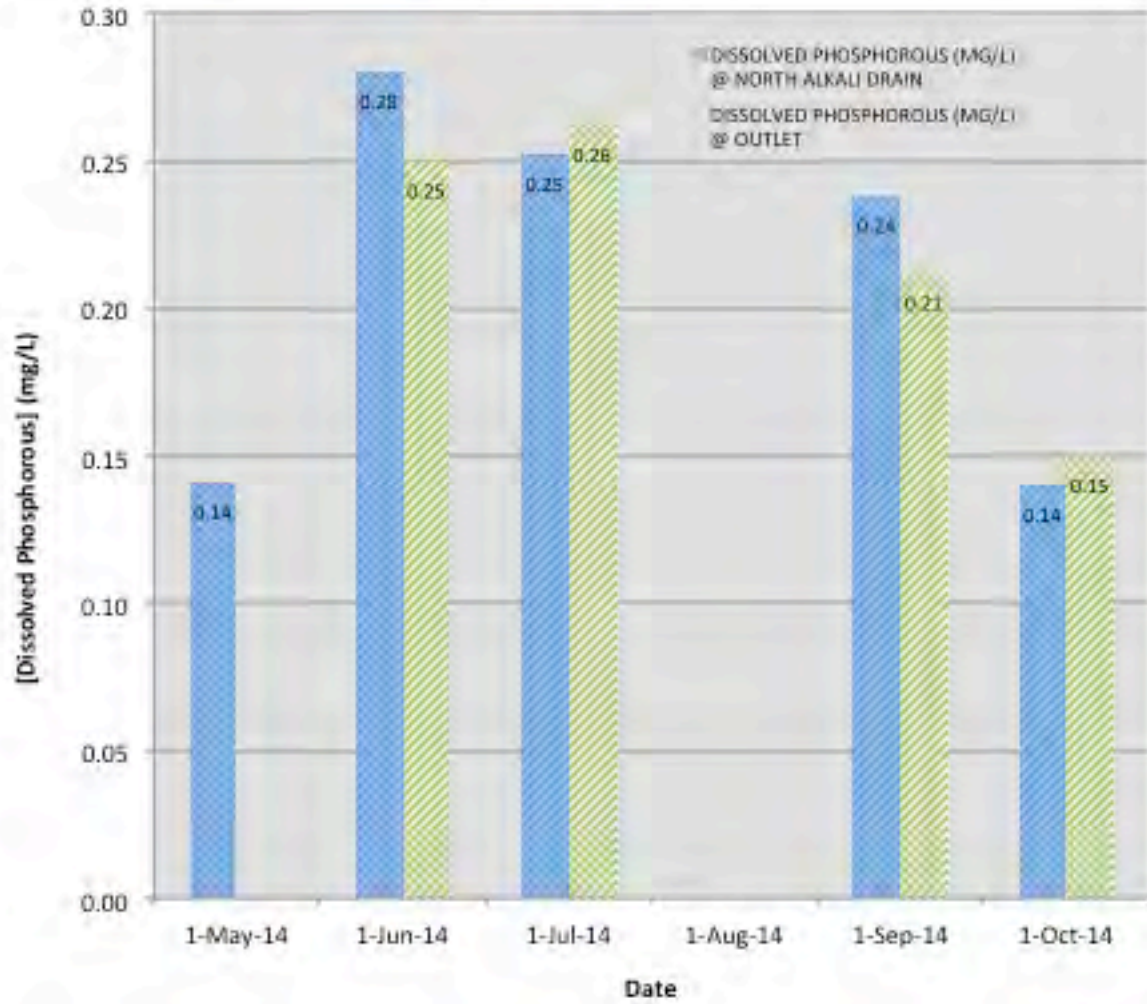


Figure 7
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
Measured Dissolved Phosphorous in the North Alkali Drain and Outlet of the Project
 Prepared by: Rob Tiedemann, Ph.D.



The data were also produced at a time when the vegetation in both grow plots was maturing in density and stature, and unlikely to yet have a notable effect on dissolved phosphorous as has been reported in the literature. With that caveat and the warning that the results must be viewed with great caution because the data are sparse, there are still interesting preliminary observations to be made:

1. There is considerable variability in the combined 2013 and 2014 data for measured concentrations of suspended solids (Mean = 55, SE Mean = 15, SE Mean / Mean = 27%) for the North Alkali Drain.

Lesser variability is shown for measured concentrations of total phosphorous (Mean = 0.37, SE Mean = 0.02, SE Mean / Mean = 5%) and dissolved phosphorous (Mean = 0.22, SE Mean = 0.02, SE Mean / Mean = 9%).

This variability may be due to a change in ambient conditions with time, sampling error, analytical error, or all three. We suspect a change in ambient conditions is the principal factor, and therefore of interest to us who must design systems for a range of concentrations of pollutants.

2. Particle size of suspended sediments may have had an influence on our results as detention time may have been sufficiently long to remove larger particles, but not to remove buoyant particles or those that were extremely small-in-size. Laboratory studies measuring sedimentation rates for water taken from the North Alkali Drain could answer this question.

Recommendation No. 4 - Conduct laboratory studies of representative samples of raw water to be treated using standard analytical methods prior to the design of more elaborate systems or systems on other waterways. This is often done with the use of Imhoff cones.

3. Suspended solids were reduced in all samples from 8 to 68 percent after water taken from the North Alkali Drain was “treated” by the project.

Total phosphorous was reduced 7 and 9 percent in two samples, and increased 17 percent in a third sample. We speculate that this is because on October 9, the date the sample was taken, filamentous algae growing profusely in grow plot B was decomposing and releasing phosphorous to the system due to a prior power failure that resulted in the pump not operating for approximately six days.

Dissolved phosphorous was reduced 11 percent in two samples and increased 4 and 7 percent in two samples. Perhaps also because of decomposing algae. In a “real world”, managed system vegetation would be harvested and therefore removed from any potential to re-introduce phosphorous to the system. However, this should normally be done only after the plant community has matured and reached a removal efficiency approaching an optimum.

4. The data plotted in Figures 6 and 7 for the months of June and September - showing reductions in the concentrations of total phosphorous equal to that of dissolved phosphorous - suggests that all of the phosphorous removed by the project was in dissolved form and little accomplished by the sedimentation basin. Or, that green algae and duckweed (*Lemna minor*) growing in the sedimentation basin was capable of removing notable amounts of dissolved phosphorous. This is contrary to conventional thinking, and again calls into question the use of this meager data set for interpretations beyond mere speculation.
5. Plots of load reductions for each of the three water quality parameters show the greatest reduction for suspended solids occurred in July (Figure 8), while for total phosphorous and dissolved phosphorous occurred in June and September (Figure 9).

Figure 8
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
 Calculated Load Reduction of Suspended Solids Attributable to the Project
 Prepared by: Rob Tiedemann, Ph.D.

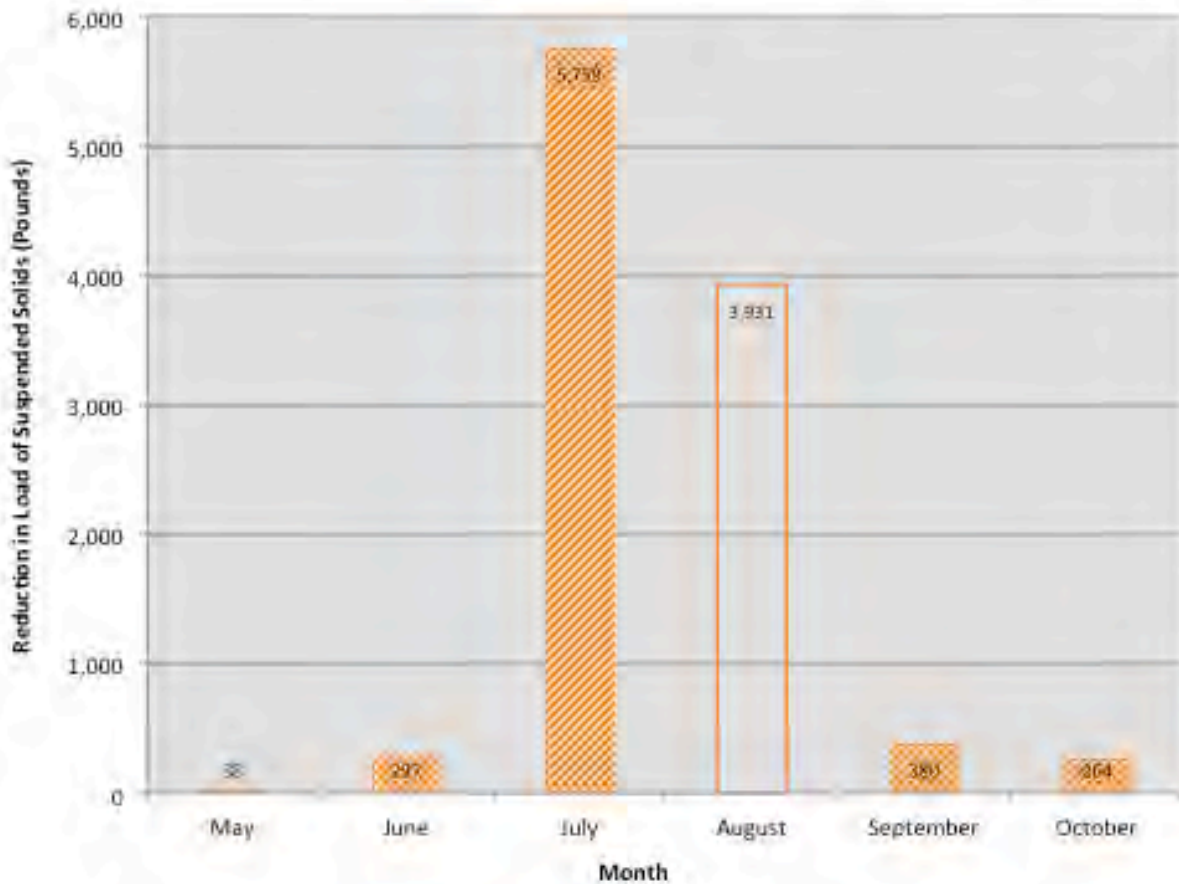
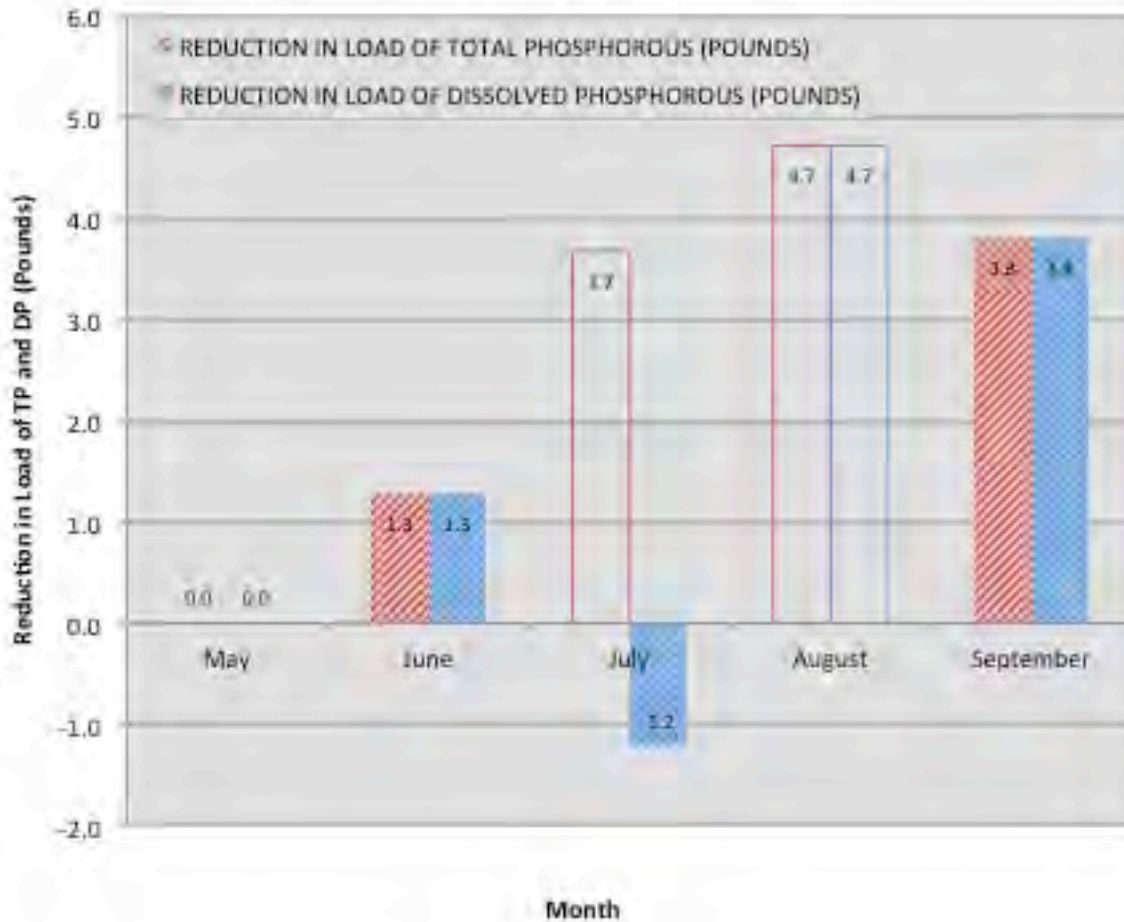


Figure 9
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
Calculated Load Reduction of Total Phosphorous (TP) and Dissolved Phosphorous (DP) Attributable to the Project
 Prepared by: Rob Tiedemann, Ph.D.



NOTE 1: Bars in Figures 8 and 9 lacking a fill pattern contain values that were assumed in the calculation of load reductions because no data were available for the months in which they are shown.

NOTE 2: Negative values for the month of October were ignored in the calculation of load reductions and are not displayed in Figure 9 because it is assumed in a "real world", managed system vegetation would be harvested and therefore removed from any potential to re-introduce phosphorous to the system.

2. Plant Community

Plant community data are shown in Appendix 6. Even without this numeric data, visual inspection of the two grow plots on-the-ground obviously shows that they differ from one another in both percent cover and species composition.

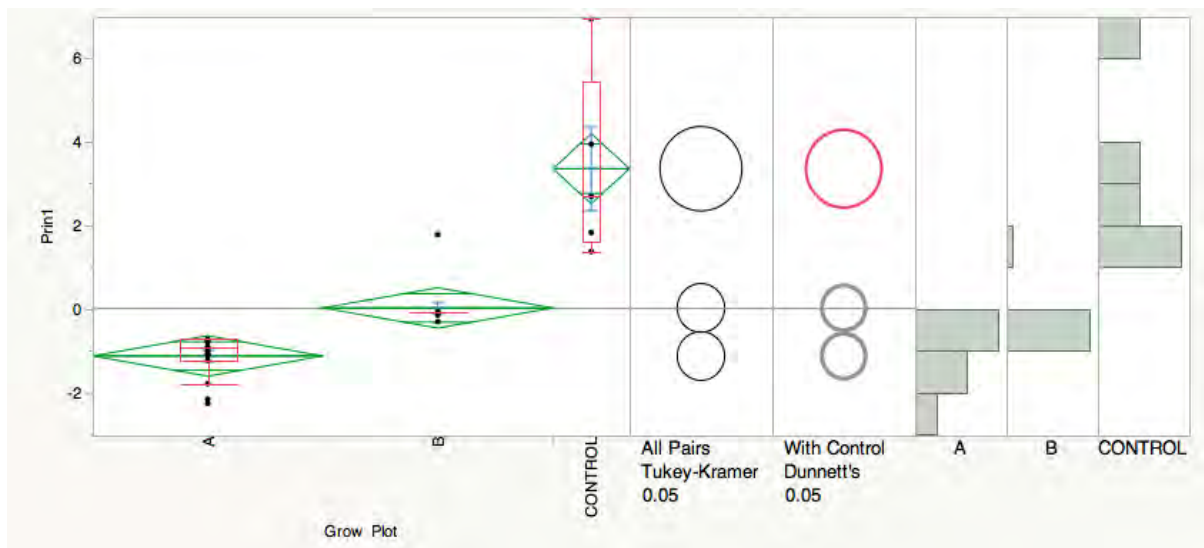
Grow plot A grew plants from both installed seed and as naturalized volunteers whose sources are unknown. We suspect their sources includes propagules (i.e. seed, tubers, roots) carried to the project area from other locations by waterfowl and shore birds, wind, and floating in the raw water of the North Alkali Drain. Over 100 percent cover was measured in almost all quadrats sampled.

Although they showed leaf buds, emerging leaves, and roots at the time of installation few of the willow cuttings were viability at the time of sampling (i.e. green leaves, supple stems) in grow plot B. We suspect this is due to the alkali soils exposed by excavation and earthwork. The presence of alkali was demonstrated by a white, crystalline crust on the surface of the soil and its “salty” taste. A white efflorescence is a common indicator of soda ash (i.e. Na_2CO_3). Volunteers of naturalized species grew in sparse single species stands throughout the grow plot in a mosaic patter. However, their cover was sparse.

No noxious species grow in either grow plot A or grow plot B, and only a single stem of barnyard grass (*Echinochloa crus-gaslii*), a somewhat weedy species, grows in grow plot B.

Results of PCA show the following: (1) over 50 percent of the variability in the plant community data is captured by P1 (21.4%), PC2 (17.2%), and PC3 (12.2%), the first three principal components, which is usual for a natural system; (2) the distributions of principal components scores for PC1, PC2, and PC3 are all normal and do not require a less powerful non-parametric comparisons of means; (3) when compared by PC1 values, grow plot A differs significantly (95 percent level of confidence) from grow plot B and the control; (4) grow plot B differs significantly from grow plot A and the control (Figure 10).

Figure 10
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
 Comparisons of Means of Principal Components Scores for PC1
 Prepared by: Rob Tiedemann, Ph.D.



3. Regulatory Requirements

The following permits were required by and successfully granted to the project, found to be exempt, or determined not to be within the jurisdiction of an agency:

a. Clean Water Act §404 and Idaho Stream Channel Alteration Permits

Provisions of the Clean Water Act §404 regulate certain activities in waters of the United States. A “dredge and fill” permit is normally required for placement of fill in waterways and wetlands from the US Army Corps of Engineers (COE). This project was determined by the US Army COE, Boise Regulatory Office to qualify for an exemption because it was consistent with one of the Natural Resources Conservation Service conservation practices exempt from permitting under Clean Water Act 404(f)(1)(a).

Provisions of the Idaho Stream Channel Protection Act regulate alterations below the mean high water mark of perennial streams with defined bed and bank. A Stream Channel Alteration permit is normally required for these activities from the Idaho Department of Water Resources, or written notice that a waterway is not within their jurisdiction because it is not a natural waterway, such as was done for this project.

b. Clean Water Act §401 Water Quality Certification

Provision of the Clean Water Act §401 require the state water quality agency to certify that an activity proposed in a Clean Water Act §404 application complies with state water quality standards. The Idaho Department of Environmental Quality is responsible for this task. Because the project is exempt from the Clean Water Act §404, no §401 water quality certification was required.

c. Clean Water Act §402 National Pollution Discharge Elimination System (NPDES), Construction General Permit

Provisions of the Clean Water Act §402 regulate non-point source runoff attributable to construction projects. Approval for use of the National Pollution Discharge Elimination System, Construction General Permit and preparation of a Stormwater Pollution Prevention Plan are required for construction projects, like this one, disturbing more than one acre. A Stormwater Pollution Prevention Plan was published, a Notice of Intent submitted electronically, and Construction General Permit granted by the US Environmental Protection Agency.

d. Clean Water Act §402 National Pollution Discharge Elimination System (NPDES), Individual Permit

Provisions of the Clean Water Act §402 regulate point source discharges such as those delivered by a pipe or ditch. Agricultural return water is exempt from this requirement, however its source must be from a legitimate farming operation. In meetings, and after much discussion with legal counsel from the US Environmental Protection Agency, Idaho Operations Office it was determined and confirmed in a verbal recording that the discharge from the grow plots was not regulated by the agency.

Mark Ryan (US Environmental Protection Agency - Idaho Operations Office) discussed the issue with both legal counsel and his program manager at Region 10 in Seattle. They determined the absence of need for a Clean Water Act §402 National Pollution Discharge Elimination System permit rests on the fact that no biological, chemical, or other additives

will be introduced to process water and will not be present in return water, whether it be agricultural return flow or not. This is presently an issue for the proposed treatment facility located on the Dixie Drain by the City of Boise. Our work to clarify what is regulated under the Clean Water Act is an important contribution to the process.

Further, they determined if agricultural crops are grown in the grow plots, then the return water would be considered agricultural return flow and is not regulated by the Clean Water Act. If wetland plants only are grown in the grow plots then return water would be considered to be from a natural feature of the landscape and also not regulated. Although, the argument could be made by a litigant that both temperature and fecal coliforms are potential pollutants attributable to the proposed project, the US Environmental Protection Agency is not likely to consider a violation of this kind to be a priority enforcement action. Our conclusion is the issue lies within the regulatory “grey zone” and should be further discussed with the agency to understand current policy and avoid an alleged violation.

e. Idaho Water Right

Idaho law requires filing an application for a water right permit for any diversion of water, with the exception of small domestic and stock water uses. On August 26, 2013 an application for Permit to Appropriate Water was filed with the Idaho Department of Water Resources in the name of the land owner for 1 CFS of water for the purpose of water quality improvement, water quality improvement storage, and diversion to storage. The sedimentation basin made necessary the need for storage to be a component of the application. On May 1, 2014 the Idaho Department of Water Resources Regional Manager issued permit No. 63-33843 for the project.

f. Riverside Irrigation and Drainage District

The Riverside Irrigation District operates the Riverside Drainage District. Riverside Irrigation District provides irrigation water to the farm and surrounding area. Agricultural return water managed by the Riverside Drainage District is the source of water to the North Alkali Drain. Although the project was found to be outside the boundary of the drainage district, it has historically cleaned the North Alkali Drain as a way to maintain the South Boise Drain. The Board of Directors of the district had some concern that any modification to the drain might cause back water, hindering drainage from adjacent lands. They were assured by the design team that this would not occur.

g. Canyon County Highway District

Canyon County Highway District owns and maintains Brumbach Lane. Temporary access to the project area from Brumbach Lane during the period of construction was approved by the district.

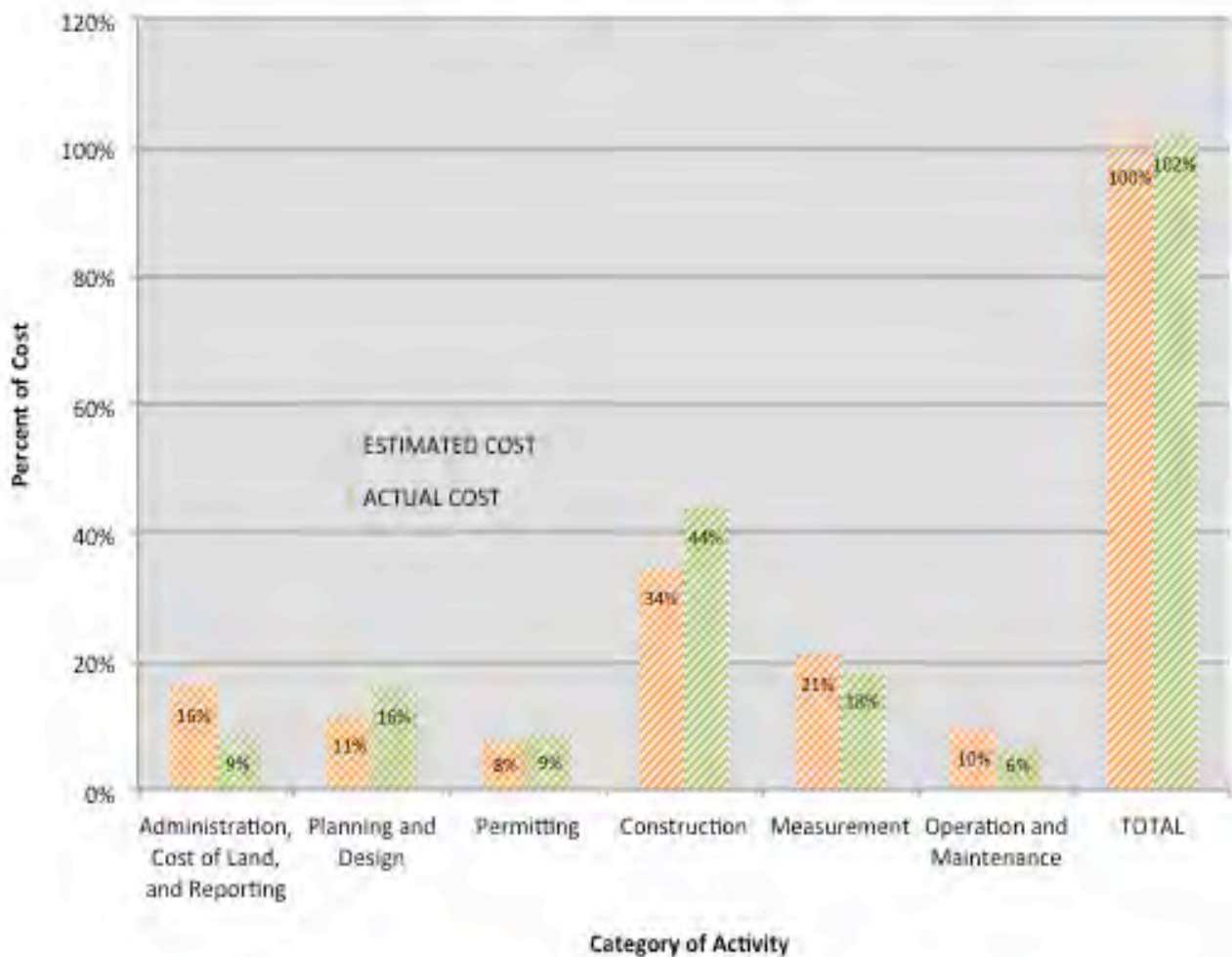
G. PARTIAL AND PRELIMINARY COST / BENEFIT ANALYSIS

While a complete accounting of actual costs is not yet available because some Phase 4 tasks have yet to be completed and / or billed, a partial and preliminary accounting that is accurate to date is shown in Appendix 7. A graphical comparison of estimated and actual costs is shown in Figure 11.

Estimated costs are those presented to and approved by the Lower Boise Watershed Council in our agreement and include the required match. For some categories of tasks

this match exceeds the required 60 / 40 ratio. Exhibit C of our agreement shows a total projected cost of the project equal to \$105,000 of which no more than \$60,000 is paid for by Clean Water Act §319 funds and the balance the responsibility of Integrated Watershed Solutions, Inc. We have honored that agreement with donations of labor and materials by Parma Company; Boise River Enhancement Network; Idaho Water Engineering, LLC; Ecological Design, Inc.; Quadrant Consulting, Inc.; Rapid Creek Research; and Mike and Joan Boren.

Figure 11
North Alkali Drain
Water Quality Improvement Pilot Project at the Boren Family Farm
 Comparison of Estimated and Actual Costs by Category
 Prepared by Hal Anderson



We have included some, but not all, of these donations of labor and materials in our calculation of actual costs, and therefore comparisons of this project to others that operate in the fee market may not be fully appropriate.

With this caveat and the cautions stated in NOTE 1 and NOTE 2 for Figures 8 and 9, what we can say with certainty is that for an accountable expenditure of \$105,000 we have removed approximately 10,668 pounds of suspended sediment, 13.5 pounds of total phosphorous, and 8.6 pounds of dissolved phosphorous over a six-month period of time (Appendix 5). If amortized over a 20-year period - and assuming a six month period of operation per year - this equates to \$0.49 per pound of suspended sediments, \$388.89 per pound of total phosphorous, and \$610.47 per pound of dissolved phosphorous removed. This is accomplished, after construction, for our estimated annual operation and maintenance cost of \$3,500 per year.

Even greater efficiency is achieved if one considers the fact that this project, unlike conventional mechanical and chemical treatment methods, is likely to have a useful life far beyond a 20-year period because there are no mechanical parts, other than the pump, that require replacement.

H. SUMMARY OF RECOMMENDATIONS

Recommendation No. 1 - As early in the design process as possible, complete a detailed ground survey and calculate quantities of earthwork in the detail required to estimate costs with some accuracy. Prepare a “value engineering” estimate of cost of each alternative to best determine those that should be eliminated from further consideration because of expense or other factors. An example is shown in Appendix 2.

Recommendation No. 2 - Reduce operation and maintenance costs by: (1) installing an automatic pump restart switch to activate the pump when power is restored after a disruption and (2) at times when raw water is not greatly impaired, reduce the time the pump is operating to 12 hours on and 12 hours off. Although this will result in lesser removal of loads of sediment and total phosphorous from the raw water, it will not harm hydrophytic, or wetland, plants in the grow plots. Because flows in the North Alkali Drain are variable - we measured rates between <1 to 9 CFS - install a float or other switch linked to the pressure transducer that measures flow in the North Alkali Drain to turn the pump off at low flows that can cause damage.

Recommendation No. 3 - Design and implement a robust sampling protocol that includes, at a minimum, the following locations where samples are taken: (1) the waterway from which raw water is delivered to the project, (2) the inlet and outlet of the sedimentation basin, and (3) the inlet and the outlet of each grow plot. Samples should be taken on a weekly schedule to provide a large enough data set for statistical analysis and to capture variability over the growing season. If budget allows: (1) multiple samples may be taken at a single time, at a single location to allow for an assessment of sampling error, (2) samples may be taken both day and night to assess diurnal changes in the rate of removal of dissolved phosphorous due to changes in metabolic activity of plants, and (3) sub-surface samples may be taken to assess the effect of infiltration of phosphorous laden water into the shallow groundwater table.

Recommendation No. 4 - Conduct laboratory studies of representative samples of raw water to be treated using standard methods prior to the design of more elaborate systems or systems on other waterways. This is often done with the use of Imhoff cones.

Recommendation No. 5 - Parlay the work done to date at the North Alkali Drain into a more complete picture of the efficacy of using sustainable features on the landscape to remove phosphorous from the ecosystem, as compared to more conventional mechanical and chemical treatment facilities at the “end of pipe” of a point source discharge and still-to-be prescribed “Best Management Practices” for non-point source discharges. In particular: (1) continue to fund water quality sampling and analysis at the North Alkali Drain according to the protocol described in Recommendation No. 3; (2) explore the use of solar or other power options to reduce the cost of operation when pumping is required; and (3) perform economic evaluations of both sustainable and conventional treatment methods, and compare both their operation and maintenance costs and their benefits - including wetland functions and services - to society.

H. CONCLUDING REMARKS

The Lower Boise Watershed Council has proactively funded the North Alkali Drain Water Quality Improvement Pilot Project, before the promulgation of Total Maximum Daily Loads on the lower Boise River. Together we have taken knowledge gained in other agricultural communities and other environments in the United States and tested its applicability to southwest Idaho. In doing so, we have contributed to the body of knowledge that allows us to better evaluate the costs and benefits of local and regional treatment alternatives.

We believe a diversified approach and various methods, both on and off the farm, are needed to achieve improvements in water quality, especially for non-point sources of pollutants. Projects like that at the Boren Family Farm are not the only solution, but when combined with greater efficiency and reuse of irrigation water can provide measurable, cost effective means to restore the health of rivers and streams in southwest Idaho.

Integrated Watershed Solutions, Inc. is grateful for the opportunity to partner with the Lower Boise Watershed Council, Inc.; will continue to operate this pilot project for a five year period, and both measure and report results; and with your cooperation will seek the resources needed to implement other projects like this one, and fund future research.

I certify that I have prepared this document and that I am a qualified expert, as demonstrated by the following professional certifications.



Ecological Design, Inc. by
Robert B. Tiedemann, Ph.D.
Principal

Certified Professional Wetland Scientist - Society of Wetland Scientists No. 0000702
Certified Wetland Delineator - US Army Corps of Engineers April 15, 1994
Certified Fisheries Scientist - American Fisheries Society No. 1,717
Certified Wildlife Biologist - The Wildlife Society December 10, 1986
Certified NPDES BMP Designer - Idaho Transportation Department 1996

References

Hammer, M.J. 1975. Water & Waste-water Technology. John Wiley and Sons, Inc. New York 502 pp.

Idaho Water Engineering, LLC. 2013. North Alkali Drain Quality Assurance Project Plan. 13 pp.

Subramaniam V. and B.R. Singh. 1997. Phosphorous supply capacity of heavily fertilized soils I. Phosphorous adsorption characteristics and phosphorous fractionation. Nutrient Cycling in Agroecosystems. Vol. 47, pp. 115-122.

US Department of Agriculture, Natural Resources Conservation Service, Plants Database.
<http://plants.usda.gov>

Appendix 1 - Documents Describing Conceptual Design and Preliminary Design Alternatives

Appendix 2 - Selected Design Alternative and Example of a Value Engineering Estimate of Costs

Appendix 3 - Final Design of the Project

Appendix 4 - Documents Describing Selection and Installation of Plant Materials

Appendix 5 - Water Quality Data

Appendix 6 - Plant Community Data

Appendix 7 – Estimated and Actual Costs

Appendix 8 - Photographs of Important Features and Outcomes of the Project



ECOLOGICAL DESIGN, INC.

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MEMO TO: Hal Anderson
Program Manager
Boren Family Farm
Integrated Watershed Solutions, Inc.

FROM: Rob Tiedemann, Ph.D.
Principal
Ecological Design, Inc.
Certified Professional Wetland Scientist - Society of Wetland Scientists No. 0000702
Certified Wetland Delineator - US Army Corps of Engineers April 15, 1994
Certified Fisheries Scientist - American Fisheries Society No. 1,717
Certified Wildlife Biologist - The Wildlife Society December 10, 1986
Certified NPDES BMP Designer - Idaho Transportation Department 1996

DATE: March 18, 2013

RE: Constructed Sedimentation Basin and Wetland Design Considerations

I have given considerable thought to our project and suggest we discuss the following design considerations prior to our Monday, March 25 meeting with Mike Boren. I have provided my thoughts to some of these considerations. Included with this memo is a very preliminary conceptual design for us to use as a straw man in that discussion.

1. Use of runoff from the farm field as an alternative to pumping from the Alkali Drain and to avoid the need for a Clean Water Act §404 permit.
Check the contract between Integrated Watershed Solutions, Inc. and the Lower Boise River Watershed Council to determine if this is permissible and discuss.
2. Seasonal depth to groundwater and its constraint on the location and depth of the sedimentation basin.
NRCS Soil Survey reports 137 cm (4.5 feet) east of Alkali Drain, >200 cm (6.6 feet) west of Alkali Drain.
3. Dimensions of the sedimentation basin to remove particulates of the anticipated size.
To be determined after: (1) a review of the literature to determine the relationship between particle size and its affinity for phosphorous, and (2) a determination of the distribution of particle sizes in Alkali Drain by laboratory sedimentation studies using Imhoff cones.
4. Location(s) for dewatering and disposal of sediment removed from the sedimentation basin.
Preferred alternative is to distribute on farm fields.
5. Selection of an agricultural crop for removal of dissolved phosphorous.
To be determined by Mike Boren.

6. Selection of location(s) for harvest of willow cuttings for removal of dissolved phosphorous.
Preferred alternative is the Weiser River on the Weiser River Ranches property near Cove Creek.
7. Machine access to periodically remove sediment from the constructed basin.
To be provided in final design after discussion with Mike Boren.
8. Machine access to periodically harvest vegetation from the agricultural and willow plots.
To be provided in final design after discussion with Mike Boren.
9. Armoring of the apron from the lip of the sedimentation basin to the plot with an agricultural crop.
See preliminary conceptual design drawing showing rock armor as one alternative and piping as a second using a standpipe inlet with debris shield.
10. Distribution of water from the lip of the sedimentation basin to the agricultural plot.
See preliminary conceptual design drawing showing gated pipe manifold with elevated center and flow to ends.
11. Distribution of water from the agricultural plot to the willow plot.
See preliminary conceptual design drawing showing rock armor as one alternative.
12. Collection of surface water at the end of the run within the willow plot.
See preliminary conceptual design drawing showing half pipe to encourage distribution across a calculated width of ground required for infiltration.
13. Collection of sub-surface water at various depths at the end of the run within the willow plot.
Install slotted pipe at desired elevations.
14. Water sampling locations at the: (1) entrance to the sedimentation basin, (2) exit of the sedimentation basin, (3) exit of the agricultural plot, and (4) surface and sub-surface at the exit of the willow plot.
To be discussed.
15. Discharge the remaining surface water at the exit of the willow plot to a sub-surface drain to avoid the need for a Clean Water Act §402 National Pollution Discharge Elimination System Permit for a point source discharge.
Discharge any remainder to the farm fields to also avoid the need for this permit.
16. Limiting ground disturbance to one acre to be within the exemption of the Clean Water Act §402 and the need for a Stormwater Pollution Prevention Plan.
To be discussed.

The locations of several of these considerations within the sequential process of removal of phosphorous are shown in the following graphic.





ECOLOGICAL DESIGN, INC.

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MEMO TO: Hal Anderson
Program Manager
Boren Family Farm
Integrated Watershed Solutions, Inc.

FROM: Rob Tiedemann, Ph.D.
Principal
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Certified Fisheries Scientist - American Fisheries Society No. 1,717
Certified Wildlife Biologist - The Wildlife Society December 10, 1986
Certified NPDES BMP Designer - Idaho Transportation Department 1996

DATE: May 24, 2013

RE: Preliminary Design Alternatives for Constructed Sedimentation Basins and Wetlands

This memo provides background and introduces others to the four preliminary design alternatives proposed for the project.

You recently shared with me after meeting with the Lower Boise River Watershed Council (LBRWC), that PROCESS is as important as PRODUCT in their assessment of the results of our project. Meaning, in part, the knowledge we share with them should demonstrate to the farm community both the practicality (e.g. scalable to available land area, use of readily available equipment, and compliance with regulatory requirements) and feasibility (e.g. constructability, efficacy in removing phosphorous, and cost) of the project.

The four preliminary design alternatives included with this package are based on the design considerations described in a memo dated March 18, 2013 and also included with this package. Each alternative meets the evaluation criteria of the LBRWC to differing degrees. Because of complexity, I look forward to meeting with you to discuss these differences in detail.

As to process, I spoke with Mark Ryan (US EPA - Idaho Operations Office) earlier today and learned in detail of his discussion with both legal counsel and his program manager at Region 10 in Seattle.

The project's absence of need for a Clean Water Act (CWA) §402 National Pollution Discharge Elimination System (NPDES) permit rests on the fact that no biological, chemical, or other additives will be introduced to process water and will not be present in return water, whether it be agricultural return flow (ARF) or not. This is presently an issue for the proposed treatment facility located on the Dixie Drain by the City of Boise. Our work to clarify what is regulated under the CWA is an important contribution to the process.

If agricultural crops are grown in the grow plots, as is proposed for Alternatives 1, 2A, and 2B, then the return water would be considered ARF and is not regulated by the CWA. If wetland plants only are grown in the grow plots, as is proposed for Alternative 3, then return water would be considered to be from a natural feature of the landscape and also is not regulated. Although, the argument could be made by a litigant that both temperature and fecal coliforms are potential pollutants attributable to the proposed project, the US EPA is not likely to consider a violation of this kind to be a priority enforcement action. The take home message is that this lies within the regulatory "grey zone".

As to product, shown with this memo is a graph allowing you to explore differing flow rates for a design that includes two sedimentation basins sized 180 feet long x 40 wide x 5 deep. The basins of all four preliminary design alternatives are drawn to this size.

Without the benefit of knowing the distribution of sediment sizes flowing in the North Alkali Drain - which is required to accurately predict the detention time required for a given sediment removal efficiency - we have selected a flow rate (i.e. 2.5 CFS) to achieve a detention time of 4 hours, as recommended by others.

Please note depth to groundwater is not a design constraint, as standing groundwater was not found to a depth of 12 feet at the time of installation of the six piezometers. As such, if additional volume is need it could be found by deepening one or both sedimentation basins.

I received one comment from reviewers to Alternative 2A, which was sent to you in an e-mail dated May 23, 2013. It is printed below in its entirety.

Rob-

Quick look @ Plan 2A:

The assumption appears to be made that both ponds will be utilized to alternately settle out the 2.5 cfs. If the ponds have vertical sides, the total pond volume for each pond would be 36,000 cf (36kcf), resulting in a 4 hr detention time & 0.0125fps average velocity.

However, going with the 5:1 (h:v) max side slopes (note 1), 40-ft wide ponds can only be 4 ft deep. This would result in one pond being ~12.5kcf and a detention time of 1.4 hrs.

I suggest that, in order to hit the magic 4 hrs, the ponds should have 2:1 slopes on the two sides and on one end. On the end where access is gained, 5:1 can work. As a result, the ponds will need to be closer to 200-225 feet long in order account for end slopes and keep the volume up to the target.

Also, 2.5 cfs for 180 days (an estimated available crop irrigation usage time), that's ~360 ac-ft that we're going to be dealing with. Assuming a duty of water @ 3-ft/ac/season, we're going to need to irrigate 120 ac to dispose of the water. I question the feasibility of "return water to existing agricultural field" without a pumping scheme to lift the water around 10-ft to get it back in the farm distribution system. I'm concerned that the discharge permit will be necessary under this scenario.

Steve

My response to Steve's design question is this. Water in excess of usage by crops would comingle with other ARFs in the adjacent field and then discharge to the North Alkali Drain. Because it is ARF there is no need for a CWA §402 NPDES permit.

My response to Steve's regulatory question is this. ARFs are expressly exempt from the Clean Water Act (CWA). To be recognized as an ARF return flow must be from a legitimate agricultural operation.

Lastly, each of the preliminary design alternatives is shown in one of the enclosed graphics and is briefly described as follows:

"Alternative 1 - All East of the North Alkali Drain" is a design concept that avoids any impact on the farm operation, as it is located entirely in existing non-farm, scrub-shrub vegetation. It is based on a concept developed by Steve and Hal in response to Alternative 2A.

"Alternative 2A - All West of the North Alkali Drain " is a design concept that places all features in existing disturbed ground that is a dirt road and parking area, and a storage area for materials. An existing inactive well would have to be retained and protected. In the event there is water remaining beyond the grow plots, it could be discharged to adjacent farm fields and avoid the need for a NPDES permit from the US EPA.

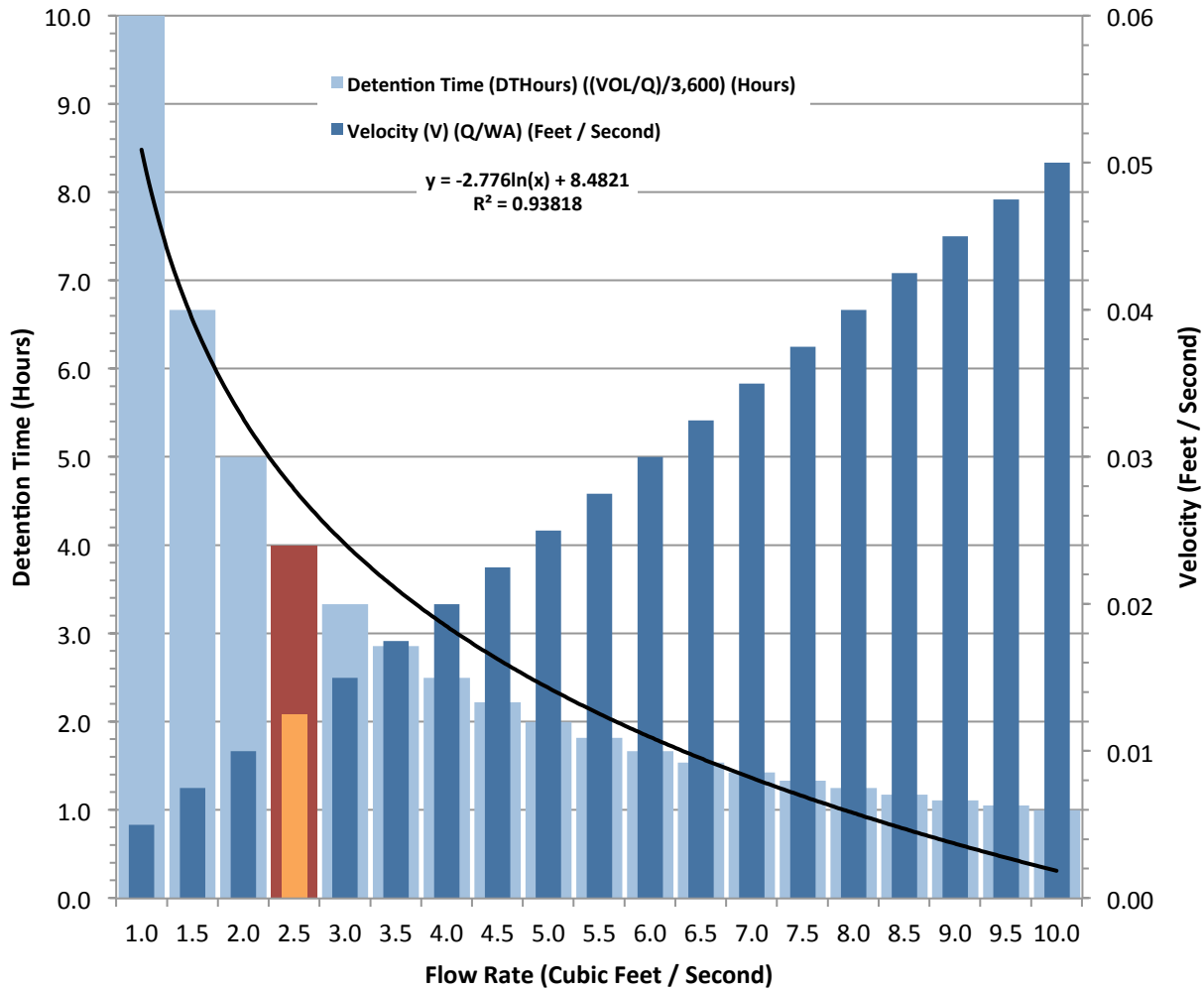
"Alternative 2B - All West of the North Alkali Drain (Expanded)" is the same as Alternative 2A, but the two plots growing an agricultural crop and native willows are expanded to accommodate a greater flow rate at the inlet of the sedimentation basins.

"Alternative 3 - Both East and West of the North Alkali Drain " is a design concept that combines features of each of the previous alternatives, and amends the design of the grow plots. In this alternative, they are scalable, excavations-and-berms that meander as would a natural stream. In the event there is water remaining beyond the grow plots, it could either be piped to the existing pump at the mouth of North Alkali Drain and avoid the need for a NPDES permit from the US EPA or directly discharged, with some risk, directly to the North Alkali Drain.

Although not perfect, I thought it more important to get the preliminary design drawings to you as soon as possible. Please carefully review them and the other information in this package in preparation for a future meeting, soon to be announced.

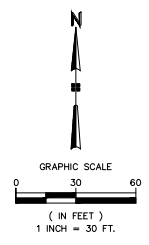
**Comparison of Detention Time and Velocity at Various Flow Rates
for a Sedimentation Basin Sized 180 Feet Long, 40 Feet Wide, and 5 Feet Deep**

Prepared by Rob Tiedemann, Ph.D.
Integrated Watershed Solutions, Inc.
April 8, 2013



NOTES

- This preliminary design is based on the following variables:
 - Flow Rate (Q) = 2.5 Cubic Feet Per Second (CFS).
 - Dimensions of Sedimentation Basin = 180 feet long x 40 feet wide x 5 feet deep.
 - Side slopes of each Sedimentation Basin to be final graded to no greater than a 5:1 slope.
- Calculations based on these dimensions (see results of numeric model and graphical display):
 - Detention Time (DTHours) = 4.00 hours.
 - Velocity (V) = 0.0125 feet / second.
- Collection and Distribution Manifold (serving also as a water quality sampling location) specifications are as follows:
 - PVC open half pipe diameter (minimum) = 18 inches.
 - Crushed rock will be placed in the placed pipe from its invert to top edge and will have a diameter = 6± inches.
 - Gated perforations of a dimension and a distant apart to be determined by the Engineer.
- Rock Apron (allowing for low maintenance sheet flow between processes) specifications are as follows:
 - Crushed rock will be placed to a minimum depth of 2 feet and will have a diameter = 6± inches.
 - The bottom and sides of the rock apron will be wrapped in geotextile fabric as specified by the Engineer.
- No-Till Harvest Plots dimensioned as follows:
 - Arbitrarily set to a depth = 1 foot to contain water.
 - Otherwise, dimensioned to accommodate the footprint of the project area and desired Detention Time. May be increased, but not decreased in size.
- Willow cuttings will be gathered, treated, and installed through placed landscape fabric in accord with the directions of the Ecologist.
- Machine Access will be maintained as a running surface for equipment and a physical barrier preventing stream capture of the Alkali Drain.
- Flow of process water purposely designed as follows:
 - To run in a linear direction so removal processes (i.e. sedimentation and biological uptake) are least likely to be influenced by one another, which could confound sampling and results of analyses of total and dissolved phosphorous.

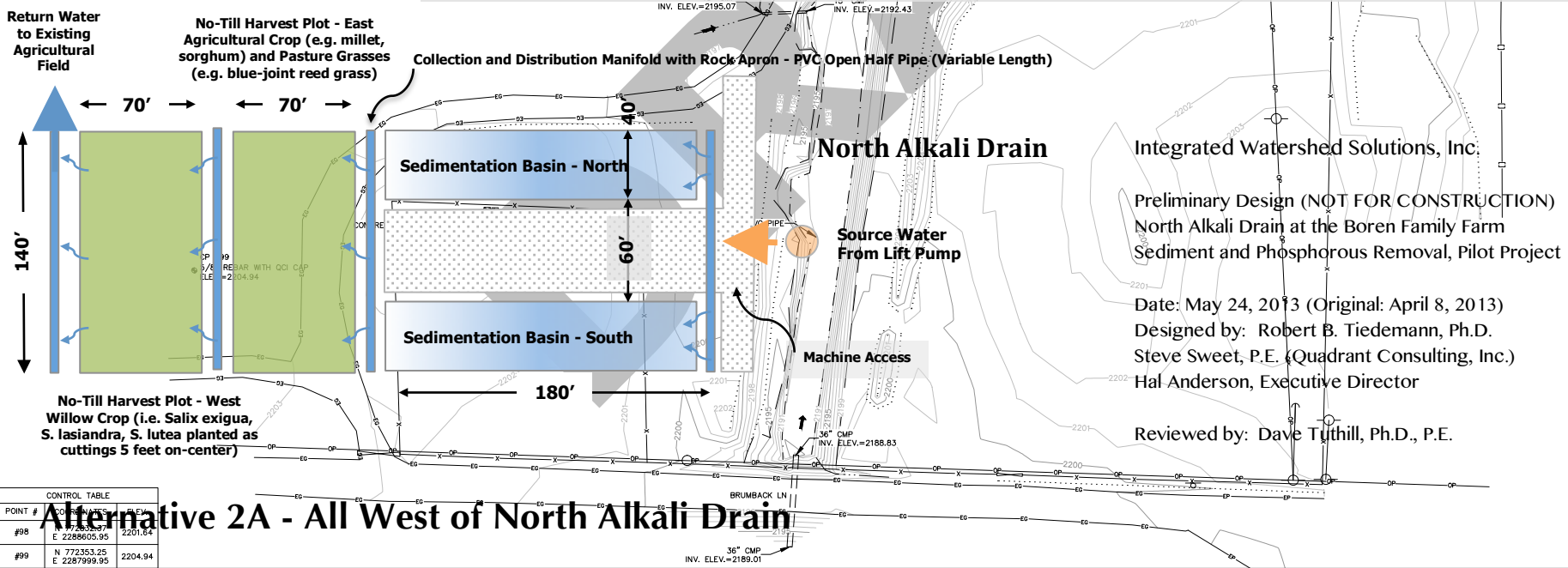


LEGEND

●	CONTROL POINT
→	FLOW ARROW
---	FLOW LINE
---	TOP BANK OF DRAIN
---	TOE OF DRAIN
---	GRADE BREAK
---	CONTOUR LINE
□	STEEL FENCE
X	BARBED WIRE FENCE
OP	OVERHEAD POWER
Eg	EDGE OF GRAVEL
EP	EDGE OF PAVEMENT

DATUM

- HORIZONTAL - NAD83(CORS 96) IDAHO STATE PLANE, WEST ZONE.
- VERTICAL - NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 1988), COMPUTED USING GEOID 12.



CONTROL TABLE

POINT #	N	E	ELEV.
#98	772353.25	228605.95	2201.64
#99	772353.25	2287999.95	2204.94

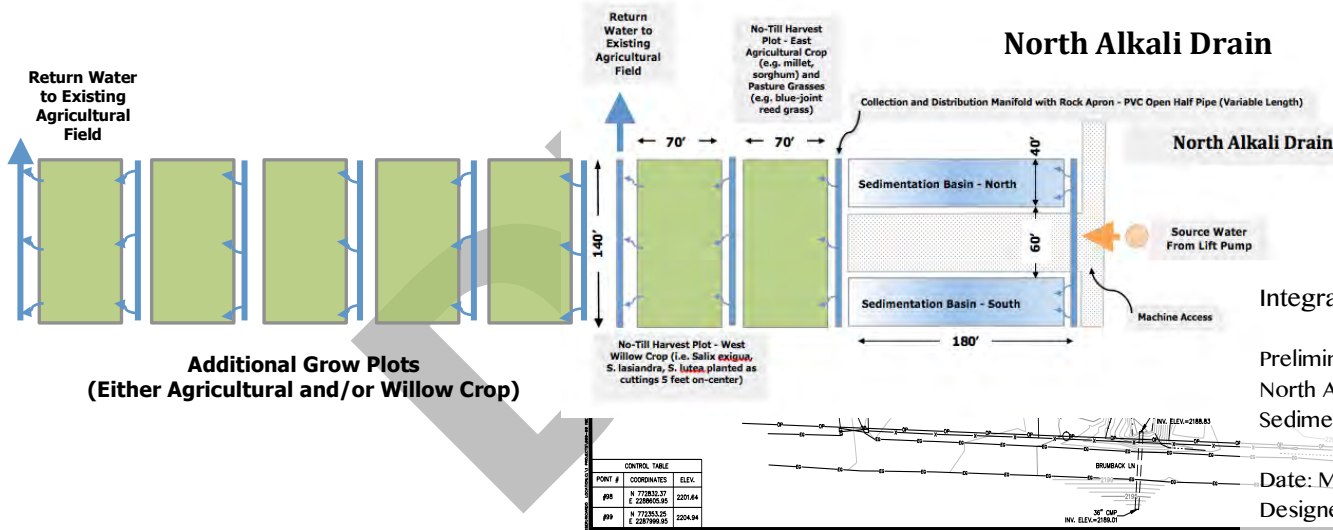
Alternative 2A - All West of North Alkali Drain

Integrated Watershed Solutions, Inc.
 Preliminary Design (NOT FOR CONSTRUCTION)
 North Alkali Drain at the Boren Family Farm
 Sediment and Phosphorous Removal, Pilot Project
 Date: May 24, 2013 (Original: April 8, 2013)
 Designed by: Robert B. Tiedemann, Ph.D.
 Steve Sweet, P.E. (Quadrant Consulting, Inc.)
 Hal Anderson, Executive Director
 Reviewed by: Dave Tutthill, Ph.D., P.E.

Approximate Property Line

NOTES

- This preliminary design is based on the following variables:
 - Flow Rate (Q) = 2.5 Cubic Feet Per Second (CFS).
 - Dimensions of Sedimentation Basin = 180 feet long x 40 feet wide x 5 feet deep.
 - Side slopes of each Sedimentation Basin to be final graded to no greater than a 5:1 slope.
- Calculations based on these dimensions (see results of numeric model and graphical display):
 - Detention Time (DTHours) = 4.00 hours.
 - Velocity (V) = 0.0125 feet / second.
- Collection and Distribution Manifold (serving also as a water quality sampling location) specifications are as follows:
 - PVC open half pipe diameter (minimum) = 18 inches.
 - Crushed rock will be placed in the placed pipe from its invert to top edge and will have a diameter = 6± inches.
 - Gated perforations of a dimension and a distant apart to be determined by the Engineer.
- Rock Apron (allowing for low maintenance sheet flow between processes) specifications are as follows:
 - Crushed rock will be placed to a minimum depth of 2 feet and will have a diameter = 6± inches.
 - The bottom and sides of the rock apron will be wrapped in geotextile fabric as specified by the Engineer.
- No-Till Harvest Plots dimensioned as follows:
 - Arbitrarily set to a depth = 1 foot to contain water.
 - Otherwise, dimensioned to accommodate the footprint of the project area and desired Detention Time. May be increased, but not decreased in size.
- Willow cuttings will be gathered, treated, and installed through placed landscape fabric in accord with the directions of the Ecologist.
- Machine Access will be maintained as a running surface for equipment and a physical barrier preventing stream capture of the Alkali Drain.
- Flow of process water purposely designed as follows:
 - To run in a linear direction so removal processes (i.e. sedimentation and biological uptake) are least likely to be influenced by one another, which could confound sampling and results of analyses of total and dissolved phosphorous.



North Alkali Drain

Integrated Watershed Solutions, Inc.

Preliminary Design (NOT FOR CONSTRUCTION)
North Alkali Drain at the Boren Family Farm
Sediment and Phosphorous Removal, Pilot Project

Date: May 24, 2013
Designed by: Robert B. Tiedemann, Ph.D.
Steve Sweet, P.E. (Quadrant Consulting, Inc.)
Hal Anderson, Executive Director

Reviewed by: Dave Tuthill, Ph.D., P.E.

QUADRANT CONSULTING, INC.
 1000 N. 10TH ST., SUITE 100
 DENVER, CO 80202-3444
 TEL: 303.733.0800 FAX: 303.733.0801
 WWW.QUADRANTCONSULTING.COM

PROJECT NO. 13-001
 SHEET NO. 1 OF 1

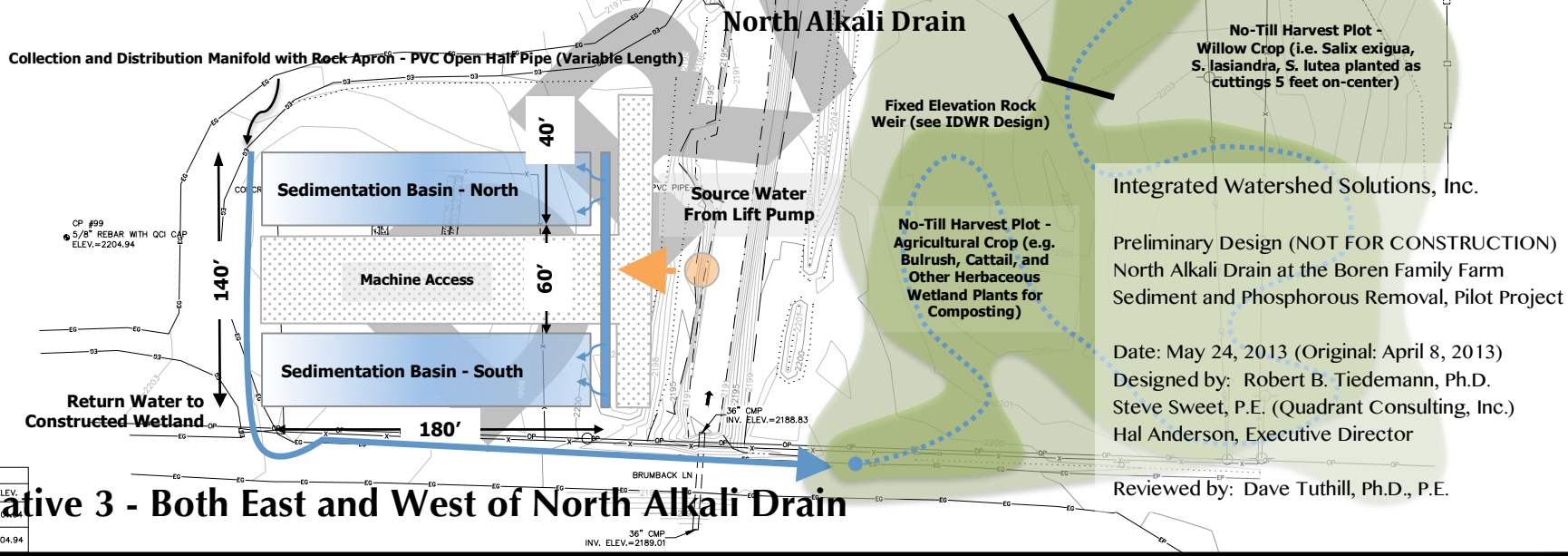
BOREN
 ALKALI DRAIN TOPOGRAPHIC SURVEY
 BOARD

CANYON COUNTY
 11/12/13

Alternative 2B - All West of North Alkali Drain (Expanded)

NOTES

- This preliminary design is based on the following variables:
 - Flow Rate (Q) = 2.5 Cubic Feet Per Second (CFS).
 - Dimensions of Sedimentation Basin = 180 feet long x 40 feet wide x 5 feet deep.
 - Side slopes of each Sedimentation Basin to be final graded to no greater than a 5:1 slope.
- Calculations based on these dimensions (see results of numeric model and graphical display):
 - Detention Time (DTHours) = 4.00 hours.
 - Velocity (V) = 0.0125 feet / second.
- Collection and Distribution Manifold (serving also as a water quality sampling location) specifications are as follows:
 - PVC open half pipe diameter (minimum) = 18 inches.
 - Crushed rock will be placed in the placed pipe from its invert to top edge and will have a diameter = 6± inches.
 - Gated perforations of a dimension and a distant apart to be determined by the Engineer.
- Rock Apron (allowing for low maintenance sheet flow between processes) specifications are as follows:
 - Crushed rock will be placed to a minimum depth of 2 feet and will have a diameter = 6± inches.
 - The bottom and sides of the rock apron will be wrapped in geotextile fabric as specified by the Engineer.
- No-Till Harvest Plots dimensioned as follows:
 - Arbitrarily set to a depth = 1 foot to contain water.
 - Otherwise, dimensioned to accommodate the footprint of the project area and desired Detention Time.
 - May be increased, but not decreased in size.
- Willow cuttings will be gathered, treated, and installed through placed landscape fabric in accord with the directions of the Ecologist.
- Machine Access will be maintained as a running surface for equipment and a physical barrier preventing stream capture of the Alkali Drain.
- Flow of process water purposely designed as follows:
 - To run in a linear direction so removal processes (i.e. sedimentation and biological uptake) are least likely to be influenced by one another, which could confound sampling and results of analyses of total and dissolved phosphorous.



Alternative 3 - Both East and West of North Alkali Drain

POINT #	C	COORDINATES	ELEV.
#98		N 2287999.95 E 2204.94	2201.64
#99		N 772353.25 E 2287999.95	2204.94

Integrated Watershed Solutions, Inc.
 Preliminary Design (NOT FOR CONSTRUCTION)
 North Alkali Drain at the Boren Family Farm
 Sediment and Phosphorous Removal, Pilot Project
 Date: May 24, 2013 (Original: April 8, 2013)
 Designed by: Robert B. Tiedemann, Ph.D.
 Steve Sweet, P.E. (Quadrant Consulting, Inc.)
 Hal Anderson, Executive Director
 Reviewed by: Dave Tuthill, Ph.D., P.E.

Quadrant Consulting, Inc.
 1804 W. Overland Rd.
 Suite 100
 Denver, Colorado 80202

BOREN
 ALKALAI DRAIN TOPOGRAPHIC SURVEY

PROJECT NO. _____
 SCALE _____

DESIGNED BY: RBT	DATE: 04/08/13
DRAWN BY: STS	DATE: 05/20/13
CHECKED BY: STS	DATE: 05/20/13
REVISION	

SHEET
1 OF 1

NOTES

- This preliminary design is based on the following variables:
 - Flow Rate (Q) = 1.0 Cubic Foot Per Second (CFS).
 - Dimensions of Sedimentation Basin = 180 feet long x 40 feet wide x 5 feet deep.
 - Side slopes of each Sedimentation Basin to be final graded to no greater than a 3:1 slope.
- Calculations based on these dimensions (see results of numeric model and graphical display):
 - Detention Time (DTHours) = 10.00 hours.
 - Velocity (V) = 0.06 feet / second.
- Collection and Distribution Manifold (serving also as a water quality sampling location) specifications are as follows:
 - PVC perforated pipe diameter (minimum) = 18 inches.
 - Crushed rock will be placed around the placed pipe which will have a diameter = 6± inches.
- Rock Apron (allowing for low maintenance sheet flow between processes) specifications are as follows:
 - Crushed rock will be placed to a minimum depth of 2 feet and will have a diameter = 6± inches.
 - The bottom and sides of the rock apron will be wrapped in geotextile fabric as specified by the Engineer.
- No-Till Harvest Plots and Control dimensioned as follows:
 - Arbitrarily set to a depth = 1 foot to contain water.
 - Otherwise, dimensioned to accommodate the footprint of the project area and desired Detention Time.
 - May be increased, but not decreased in size.
- Willow cuttings will be gathered, treated, and installed in accord with the directions of the Ecologist.
- Machine Access will be maintained as a running surface for equipment.
 - Flow of process water purposely designed as follows:
 - To run in a linear direction so removal processes (i.e. sedimentation and biological uptake) are least likely to be influenced by one another, which could confound sampling and results of analyses of total and dissolved phosphorous.

Integrated Watershed Solutions, Inc.

Preliminary Design (NOT FOR CONSTRUCTION)

North Alkali Drain at the Boren Family Farm
Sediment and Phosphorous Removal Pilot Project

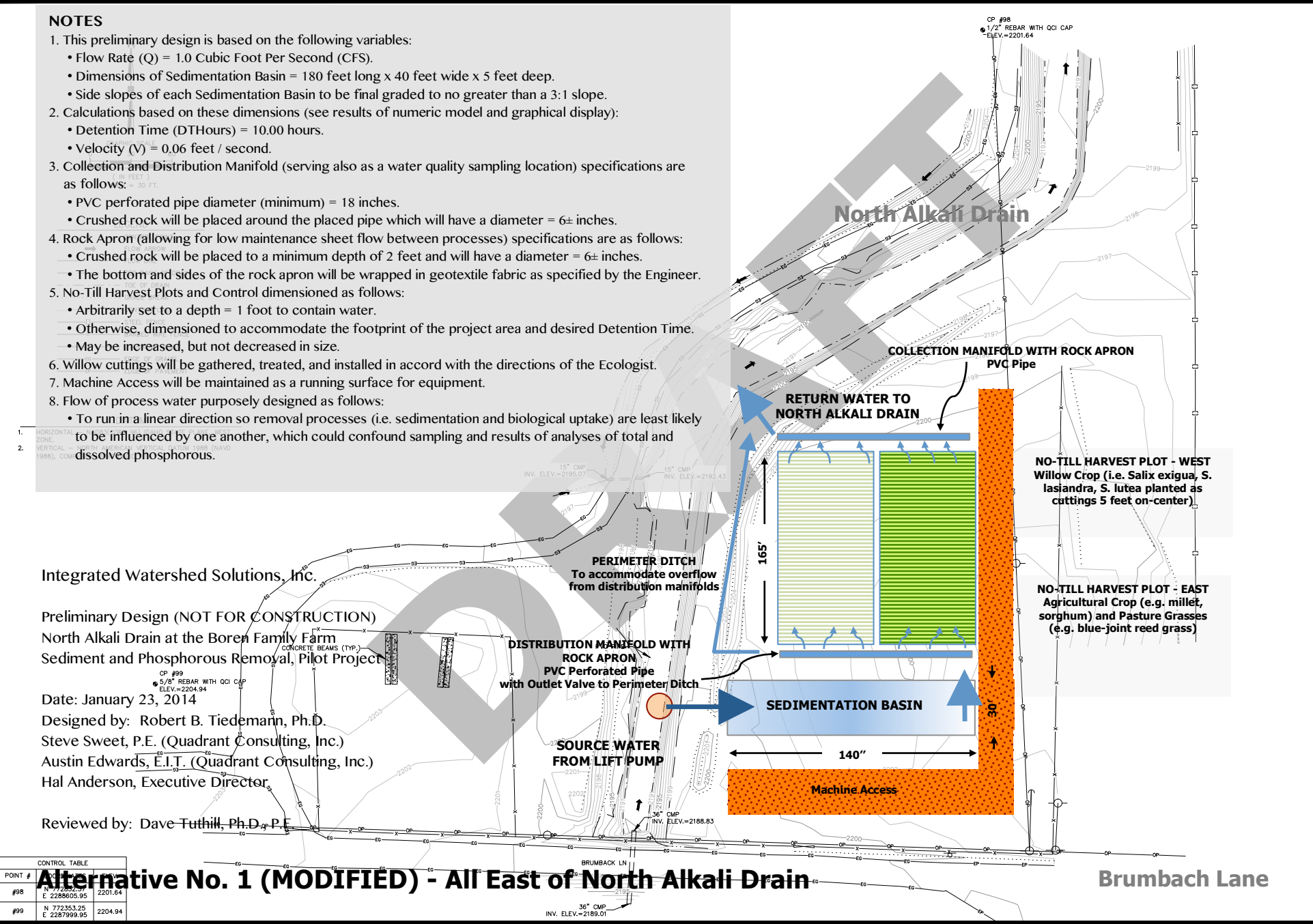
Date: January 23, 2014

Designed by: Robert B. Tiedemann, Ph.D.
Steve Sweet, P.E. (Quadrant Consulting, Inc.)
Austin Edwards, E.I.T. (Quadrant Consulting, Inc.)
Hal Anderson, Executive Director

Reviewed by: Dave Tuthill, Ph.D., P.E.

POINT #	N	E	ELEV.
#98	7228799.95	2288605.95	2201.64
#99	722353.25	2287999.95	2204.94

Alternative No. 1 (MODIFIED) - All East of North Alkali Drain



Quadrant Consulting, Inc.
1804 W. Coward Rd.
Mesa, AZ 85202
(202) 342-0091 PHONE (202) 342-0092 FAX
CIVIL ENGINEERING - SURVEYING

BOREN ALKALI DRAIN TOPOGRAPHIC SURVEY

CANYON COUNTY PROJECT NO. 999-99

SCALE: 1" = 30'

CHECKED BY: BSB	DATE: 10/29/12	DRAWN BY: BSB	DATE: 10/29/12
REVISION	BY	DATE	

SHEET
1 OF 1

Alkali Drain - Boren Family Farm
Canyon County, Idaho

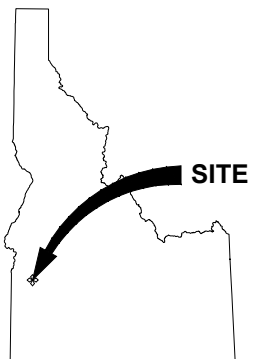
Preliminary Project Alternatives - Value Engineering Matrix
January 20, 2014

Prepared by:
Rob Tiedemann, Ph.D.
Ecological Design, Inc.

	ALTERNATIVE 1			ALTERNATIVE 2A			ALTERNATIVE 2B			ALTERNATIVE 3		
	UNIT COST	NUMBER OF UNITS	TOTAL COST	UNIT COST	NUMBER OF UNITS	TOTAL COST	UNIT COST	NUMBER OF UNITS	TOTAL COST	UNIT COST	NUMBER OF UNITS	TOTAL COST
A. TOTAL COST OF MATERIALS AND LABOR (UNIT)			\$0.00			\$0.00			\$0.00			\$0.00
1. Sedimentation ponds clearing and grubbing (acre)*			\$0.00			\$0.00			\$0.00			\$0.00
2. Sedimentation ponds earthwork (cubic yards)*			\$0.00			\$0.00			\$0.00			\$0.00
3. Grow plots clearing and grubbing (acre)*			\$0.00			\$0.00			\$0.00			\$0.00
4. Grow plots earthwork (cubic yards)*			\$0.00			\$0.00			\$0.00			\$0.00
5. Install the lift pump												
6. Install electrical power to the pump												
7. Purchase and install headgate(s), distribution manifold, rock, and piping												
8. Supervision of construction including installation of lift pump and earthwork (complete)*												
9. Purchase and installation of Best Management Practices (BMPs) for erosion control (linear foot)**	\$6.60		\$0.00	\$6.60		\$0.00	\$6.60		\$0.00	\$6.60		\$0.00
10. Monitoring and Maintenance of BMPs @ 3 Years, 26 inspections / year, 2 hours / inspection, \$50.00 / hour (complete)**			\$7,800.00			\$7,800.00			\$7,800.00			\$7,800.00
11. Purchase and installation of cuttings and container plants @800 Plants / Acre (acre)**	\$4,857.00		\$0.00	\$4,857.00		\$0.00	\$4,857.00		\$0.00	\$4,857.00		\$0.00
12. Purchase and installation of seed @ 70 Pounds / Acre (acre)**	\$1,704.00		\$0.00	\$1,704.00		\$0.00	\$1,704.00		\$0.00	\$1,704.00		\$0.00
13. Purchase and installation of soil amendments and binder (acre)**	\$1,864.00		\$0.00	\$1,864.00		\$0.00	\$1,864.00		\$0.00	\$1,864.00		\$0.00
14. Supervision of seedbed preparation and soil stabilization; installation of seed, cuttings, and container plants (complete)			\$2,000.00			\$2,000.00			\$2,000.00			\$2,000.00
TOTAL ESTIMATED COST OF MATERIALS AND LABOR			\$9,800.00			\$9,800.00			\$9,800.00			\$9,800.00
B. LEVEL OF EFFORT FOR PERMITS AND APPROVALS												
1. Clean Water Act §402 permit and Stormwater Pollution Prevention Plan (SWPPP)			2			2			2			2
2. Clean Water Act §404 permit			2			2			2			2
3. Canyon County grading permit			1			1			1			1
AVERAGE LEVEL OF EFFORT FOR PERMITS AND APPROVALS (1=Least, 2=Moderate, 3 = Greatest)			1.7			1.7			1.7			1.7
* SOURCE: Quadrant Consulting, Inc.												
**SOURCE: Itemized Costs for Indian Creek Restoration at Happy Valley Dairy, Nampa, ID Ecological Design, Inc. (2011)												
RESPONSIBILITIES:												
Mike Boren												
Quadrant Consulting, Inc.												
Ecological Design, Inc.												
Idaho Water Engineering, Inc.												

NORTH ALKALI

AERIAL MAP



INDEX OF SHEETS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	SURVEY
3	CIVIL PLAN
4	DIMENSION PLAN
5	DETAILS

DATUM

- HORIZONTAL - NAD83(CORS 96) IDAHO STATE PLANE, WEST ZONE.
 - VERTICAL - NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 1988), COMPUTED USING GEOID 12.
- APPROXIMATE GPS SITE COORDINATES**
 LATITUDE: 43°46'43.93" N LONGITUDE: 117°01'26.25" W



LEGEND

●	CONTROL POINT
▽	WATER SURFACE ELEVATION
→	FLOW ARROW
—	FLOW LINE
---	TOP BANK OF RIVER
- - -	TOE OF RIVER
- - -	TOP BANK OF DITCH
- - -	TOE OF DITCH
.....	GRADE BREAK
—2600—	CONTOUR LINE
□	WOODEN FENCE
x	BARBED WIRE FENCE
○—○	CHAIN LINK FENCE
⊕	OVERHEAD POWER
⊖	EDGE OF GRAVEL
⊕	EDGE OF PAVEMENT

Quadrant Consulting, Inc.
 2087 345-0992 FAX
 Boise, Idaho 83702
 208-342-0991 PHONE
 208-342-0992 FAX
 208-342-0992 FAX

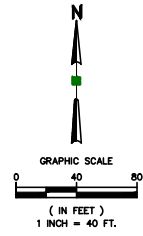


NORTH ALKALI DRAIN
TITLE SHEET

CANYON COUNTY
 SCALE: NTS
 PROJECT NO. 607-01
 IDAHO

DESIGNED BY	CHECKED BY	DATE	BY	REVISION	LOAD	PERF
AME	AME	2/23/24				

SHEET
C-1

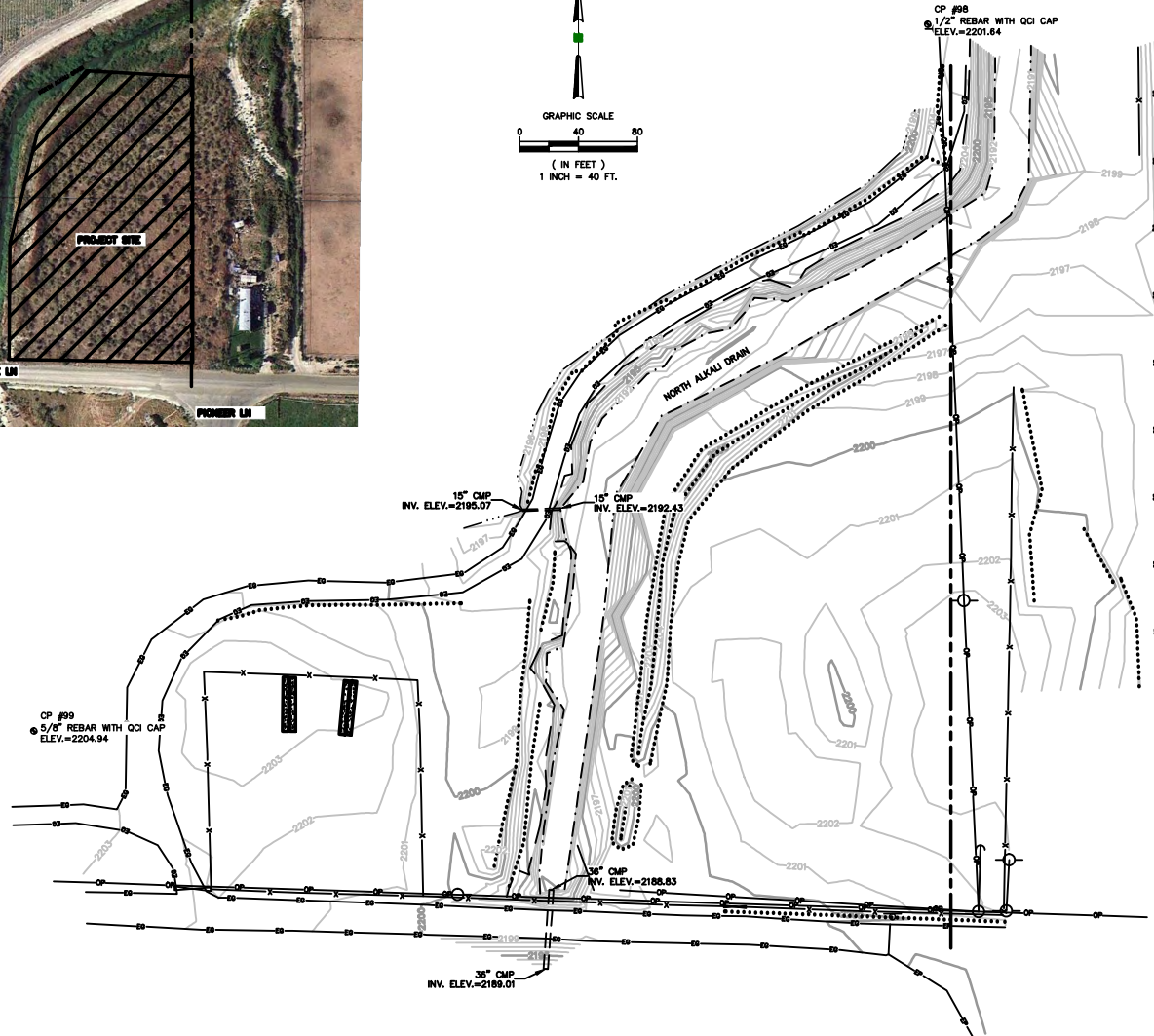


- LEGEND**
- ⊙ CONTROL POINT
 - FLOW ARROW
 - FLOW LINE
 - - - TOP BANK OF DRAIN
 - - - TOE OF DRAIN
 - ⋯ GRADE BREAK
 - 2200 CONTOUR LINE
 - X BARBED WIRE FENCE
 - ⊕ OVERHEAD POWER
 - EDGE OF GRAVEL
 - EDGE OF PAVEMENT

DATUM

1. HORIZONTAL - NAD83(CORS 96) IDAHO STATE PLANE, WEST ZONE.
2. VERTICAL - NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 1988), COMPUTED USING GEOID 12.

POINT #	COORDINATES	ELEV.
#98	N 772832.37 E 2288605.95	2201.64
#99	N 772353.25 E 2287999.95	2204.94



Quadrant Consulting, Inc.
 1000 S. 1000 E. Suite 100
 Provo, Utah 84601
 (801) 342-0000 FAX
 342-0000

NORTH ALKALI DRAIN SURVEY


PROJECT NO. 807-01

CANYON COUNTY SCALE: 1"=40'

IDAHO

DESIGNED BY	CHECKED BY	DATE	REVISION

SHEET C-2

From: Randy Gilmore rgilmore@turbonet.com 
Subject: RE: [Spam 3.00] Availability of Seed - Boren Family Farm
Date: March 11, 2014 at 11:02 AM
To: Robert Tiedemann ecodesigninc@mac.com



Rob, these seeding rates are based on drill seeding, if you are to broadcast then they should be doubled. I can get it all put together in a week or less.

Alkali bulrush (<i>Schoenoplectus maritimus</i>)	\$50.00 / PLS - \$45.00 / lb bulk	8
PLS / Acre		
Alkali Sacaton (<i>Sporobolu airoides</i>)	\$35.00 / PLS - \$32.00 / lb bulk	3
PLS / Acre		
Garrison creeping foxtail (<i>Alopecurus arundinaceus</i>)	\$10.00 / PLS - \$8.00 / lb bulk	3 PLS
/ Acre		
tall fescue (<i>Festuca arundinacea</i>)	\$2.00 / PLS - \$1.75 / lb bulk	15
PLS / Acre		
Blue-joint wheatgrass (<i>Calamagrostis canadensis</i>)	\$130.00 / PLS - \$95.00 / lb bulk	4 PLS
/ Acre		
Nuttall's alkali grass (<i>Puccinellia nuttallian</i>)	\$8.00 / PLS - \$7.00 / lb bulk	3
PLS / Acre		

Thanks, Randy Gilmore
Sun Mountain Natives
p. 208-883-7611
f. 208-882-6738

[Sun Mountain Natives](#)

From: Robert Tiedemann [mailto:ecodesigninc@mac.com]
Sent: Tuesday, March 11, 2014 9:36 AM
To: Gilmore Randy
Subject: Re: [Spam 3.00] Availability of Seed - Boren Family Farm

Good Morning Randy!

How much lead time will you require before delivery in Boise? Also, please recommend a planting rate for each species growing in an agricultural plot.

Rob Tiedemann, Ph.D.

Principal

Certified Professional Wetland Scientist - Society of Wetland Scientists No. 0000702

Certified Wetland Delineator - US Army Corps of Engineers April 15, 1994

Certified Fisheries Scientist - American Fisheries Society No. 1,717

Certified Wildlife Biologist - The Wildlife Society December 10, 1986

Certified NPDES BMP Designer - Idaho Transportation Department 1996

Ecological Design, Inc.
217 North Walnut Street
Boise, ID 83712
208.338.5852
ecodesigninc@mac.com

On Mar 11, 2014, at 9:39 AM, Randy Gilmore <rgilmore@turbonet.com> wrote:

Rob, sorry it took so long to get back to you, but here are the prices:

Alkali bulrush (<i>Schoenoplectus maritimus</i>)	\$50.00 / PLS - \$45.00 / lb bulk
Alkali Sacaton (<i>Sporobolu airoides</i>)	\$35.00 / PLS - \$32.00 / lb bulk
Garrison creeping foxtail (<i>Alopecurus arundinaceus</i>)	\$10.00 / PLS - \$8.00 / lb bulk
tall fescue (<i>Festuca arundinacea</i>)	\$2.00 / PLS - \$1.75 / lb bulk
Blue-joint wheatgrass (<i>Calamagrostis canadensis</i>)	\$130.00 / PLS - \$95.00 / lb bulk
Nuttall's alkali grass (<i>Puccinellia nuttallian</i>)	\$8.00 / PLS - \$7.00 / lb bulk

Thanks, Randy Gilmore
Sun Mountain Natives
p. 208-883-7611
f. 208-882-6738

[Sun Mountain Natives](#)

From: Robert Tiedemann [<mailto:ecodesigninc@mac.com>]
Sent: Friday, March 07, 2014 12:30 PM
To: Gilmore Randy
Cc: Anderson Hal; Sweet Steve; Edwards Austin
Subject: [Spam 3.00] Availability of Seed - Boren Family Farm

Good Afternoon Randy!

Please provide me availability and price of seed for the species shown below.

Boren Family Farm
North Alkali Drain
Candidate Plant Species for the Herbaceous Grow Plot
February 7, 2014

Alkali bulrush (*Schoenoplectus maritimus*)
Alkali Sacaton (*Sporobolu airoides*)
Garrison creeping foxtail (*Alopecurus arundinaceus*)
tall fescue (*Festuca arundinacea*)
Blue-joint wheatgrass (*Calamagrostis canadensis*)

Nuttall's alkali grass (*Puccinellia nuttallian*)

Rob Tiedemann, Ph.D.

Principal

Certified Professional Wetland Scientist - Society of Wetland Scientists No. 0000702

Certified Wetland Delineator - US Army Corps of Engineers April 15, 1994

Certified Fisheries Scientist - American Fisheries Society No. 1,717

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Certified NPDES BMP Designer - Idaho Transportation Department 1996

Ecological Design, Inc.

217 North Walnut Street

Boise, ID 83712

208.338.5852

ecodesigninc@mac.com

Guidelines for Taking Cottonwood (*Populus spp.*) Cuttings

1. Cuttings should be taken from 1 to 3 year old cottonwoods prior to the growing season, and should be planted as soon as possible.
2. The source of stock should be within the same elevation range as the planting site.
3. Select 60 to 90 cm (24 to 36 inches) sections of wood from stems 1.3 to 2.5 cm (0.5 to 1.0 inches) in diameter only. Discard crooked, split, or peeled sections of stem. Cut square with the stem (i.e. 90° from the axis of the stem) to remove cutting from the parent plant. Cut approximately 2.5 cm (1 inch) from the tip of the top end square with the stem (i.e. 90° from the axis of the stem).
4. Wrap cuttings in wet burlap to prevent them from drying. Soak cuttings in water prior to planting until they are saturated (approximately three days). Paint the top end of the cutting with latex paint or tree seal.
5. Plant cuttings as early as possible in the growing season. Plant by making a 2.5 cm (1 inch) hole with a steel rod. Insert the butt end of cuttings in the hole so they are planted 45 cm (18 inches) deep, with 5 cm (2 inches) exposed above the ground surface. Fill and tamp firm the surrounding soil. Water.
6. Cultivating a 1 meter (3.3 feet) diameter area around each cutting will control weeds and reduce competition.

Guidelines for Taking Willow (*Salix spp.*) Cuttings

1. Cuttings should be taken from 1 to 3 year old willows prior to the growing season, and should be planted as soon as possible.
2. The source of stock should be within the same elevation range as the planting site.
3. Select 60 to 90 cm (24 to 36 inches) sections of wood from stems with at least 3 buds. Cut square with the stem (i.e. 90° from the axis of the stem) to remove cutting from the parent plant. Cut approximately 2.5 cm (1 inch) from the tip of the top end square with the stem (i.e. 90° from the axis of the stem).
4. Cut the bottom of each cutting obliquely (i.e. 45° from the axis of the stem) at least 1 cm (0.4 inch) below the bottom most bud. Cut approximately 2.5 cm (1 inch) from the tip of the top end square with the stem (i.e. 90° from the axis of the stem). Paint the top end of the cutting with latex paint or tree seal.
5. Dip the bottom 5 cm (2 inches) of each cutting in rooting hormone (i.e. indolebutyric acid powder). Wrap cuttings in wet burlap to prevent drying and to allow healing and callus tissue to form, or store in moist sawdust, sand, or peatmoss. Store in open containers at 4.4°C (40°F) until favorable weather for planting, or at 12.8°C (55°F) for no more than four weeks.

6. Plant cuttings as early as possible in the growing season, before leaves appear. Plant by making a 2.5 cm (1 inch) diameter hole with a steel rod or auger. Insert the oblique cut end of cuttings in the hole so they are planted with at least 2/3 of the stem in the soil, and no more than 15 cm (6 inches) exposed above the ground surface. Fill and tamp firm the surrounding soil. Water.
7. Use of a root promoting fertilizer will improve survival.
8. Cultivating a 1 meter (3.3 feet) diameter area around each cutting will control weeds and reduce competition.

Source: Adapted by Robert B. Tiedemann, Ecological Design, Inc. Boise, ID from McKnight, J.S. 1970. *Planting Cottonwood Cuttings For Timber Production in the South*. USDA Forest Service Research Paper SO-60. South Forest Experiment Station, New Orleans LA. 17 pp.

North Alkali Drain
 Water Quality Improvement Pilot Project
 Water Quality Data (2013)

DATE OF SAMPLE	SUSPENDED SOLIDS (MG/L)	TOTAL PHOSPHOROUS (MG/L)	DISSOLVED PHOSPHOROUS (MG/L)	TOTAL COLIFORMS (MPN / 100ML)	E. COLI (MPN / 100ML)	SOURCE DOCUMENT
18-Apr-13	90	0.40	0.25			IBLWaterQualityResults1
17-May-13	140	0.42	0.18			IBLWaterQualityResults2
08-Jul-13	90	0.40	0.22			IBLWaterQualityResults3
21-Aug-13	29	0.36	0.30	24,196	2,755	IBLWaterQualityResults4

North Alkali Drain
Water Quality Improvement Pilot Project
Water Quality Data (2013)

DATE OF SAMPLE	LAB ID No. (Total Phosphorous)	LAB ID No. (Dissolved P)	LAB ID No. (Suspended Solids)	LAB ID No. (Total and E. coli)	LAST DATE OF ANALYSIS
18-Apr-13	E130400110-001	E130400110-002	E130400110-001		26-Apr-13
17-May-13	E130500128-001	E130400128-002	E130500128-001		29-May-13
08-Jul-13					
21-Aug-13	E130800189-001	E130800189-002	E130800189-001	E130800189-001	5-Sep-13

North Alkali Drain
Water Quality Improvement Pilot Project
Water Quality Data (2014)

DATE OF SAMPLE	SUSPENDED SOLIDS (MG/L) @ NORTH ALKALI DRAIN	SUSPENDED SOLIDS (MG/L) @ OUTLET	PERCENT REDUCTION SUSPENDED SOLIDS	TOTAL PHOSPHOROUS (MG/L) @ NORTH ALKALI DRAIN	TOTAL PHOSPHOROUS (MG/L) @ OUTLET	PERCENT REDUCTION TOTAL PHOSPHOROUS	DISSOLVED PHOSPHOROUS (MG/L) @ NORTH ALKALI DRAIN
22-May-14	24.0	22.0	8.3	0.29	0.29	0.00	0.14
27-Jun-14	28.0	21.0	25.0	0.43	0.40	6.98	0.28
27-Jul-14	69.0	22.0	68.1				0.25
10-Sep-14	10.0	7.0	30.0	0.32	0.29	9.38	0.24
9-Oct-14	13.0	5.5	57.7	0.36	0.42	-16.67	0.14

North Alkali Drain
Water Quality Improvement Pilot Project
Water Quality Data (2014)

DATE OF SAMPLE	DISSOLVED PHOSPHOROUS (MG/L) @ OUTLET	PERCENT REDUCTION DISSOLVED PHOSPHOROUS	Report ID No.	LAB ID No. (All Parameters)	DATE OF ANALYSIS
22-May-14				E140500217-001 and E140500217-002	23-May-14, 28-May-14, and 4-Jun-14
27-Jun-14	0.25	10.71	164927-2166615	E140600256-001 and E140600256-002	26-Jun-14*, 1-Jul-14, and 11-Jul-14
27-Jul-14	0.26	-3.97	165733-2173412	E140700264-001 and E140700264-002	28-Jul-14
10-Sep-14	0.21	10.92	167068-2206071	E140900077-001 and E140900077-002	18-Sep-14
9-Oct-14	0.15	-7.14	167859-2220900	E141000073-001 and E141000073-002	10-Oct-14
					* Apparent Reporting Error

North Alkali Drain
Water Quality Improvement Pilot Project
Calculated Load Reductions Data (2014)

MONTH	VOLUME OF WATER FLOWING THROUGH SEDIMENTATION BASIN AND GROW PLOTS (ACRE FEET)	VOLUME OF WATER FLOWING THROUGH SEDIMENTATION BASIN AND GROW PLOTS (CUBIC FEET)	VOLUME OF WATER FLOWING THROUGH SEDIMENTATION BASIN AND GROW PLOTS (GALLONS)	VOLUME OF WATER FLOWING THROUGH SEDIMENTATION BASIN AND GROW PLOTS (LITERS)	REDUCTION IN CONCENTRATION OF SUSPENDED SOLIDS (MG/L)	REDUCTION IN LOAD OF SUSPENDED SOLIDS (POUNDS)
May	6.92	301,435	2,254,735	8,545,447	2.0	38
June	15.59	679,100	5,079,671	19,251,953	7.0	297
July	45.01	1,960,636	14,665,554	55,582,451	47.0	5,759
August	57.75	2,515,590	18,816,613	71,314,964	25.0	3,931
September	46.52	2,026,411	15,157,556	57,447,136	3.0	380
October	12.92	562,795	4,209,708	15,954,794	7.5	264
TOTALS	184.71	8,045,968	60,183,838	228,096,745		10,668
NOTE 1: Cells highlighted in orange contain values that were assumed in the calculation of load reductions because no data were available for the months shown.						
NOTE 2: Cells highlighted in red contain values that were ignored in the calculation of load reductions because it is assumed in a "real world", managed system vegetation						

North Alkali Drain
 Water Quality Improvement Pilot Project
 Calculated Load Reductions Data (2014)

MONTH	REDUCTION IN CONCENTRATION OF TOTAL PHOSPHOROUS (MG/L)	REDUCTION IN LOAD OF TOTAL PHOSPHOROUS (POUNDS)	REDUCTION IN CONCENTRATION OF DISSOLVED PHOSPHOROUS (MG/L)	REDUCTION IN LOAD OF DISSOLVED PHOSPHOROUS (POUNDS)
May	0.00	0.0	0.00	0.0
June	0.03	1.3	0.03	1.3
July	0.03	3.7	-0.01	-1.2
August	0.03	4.7	0.03	4.7
September	0.03	3.8	0.03	3.8
October	-0.06		-0.01	
TOTALS		13.5		8.6
NOTE 1: Cells				
NOTE 2: Cells would be harvested and therefore removed from any potential to re-introduce phosphorous to the system.				

Boren Family Farm
Water Quality Improvement Pilot Project
Stratified Random Plant Sample Data (2014)

Grow Plot	Transect Number	Quadrat Number	Alkali bulrush	Alkali sacaton	Garrison creeping foxtail	Tall fescue	Inland Saltgrass	Broad-leaf cattail	Water smartweed	Willow	Kochia
			Schoenoplectus maritimus	Sporobolus airoides	Alopecurus arundinaceus	Festuca arundinacea	Distichlis strict	Typha latifolia	Polygonum sp.	Salix sp.	Kochia scoparia
A	1	1	0	0	0	100	0	0	0	0	0
A	1	2	10	0	0	100	0	0	0	0	0
A	1	3	0	0	0	100	0	0	0	0	0
A	1	4	50	0	5	50	0	0	0	0	0
A	1	5	15	0	0	80	0	0	0	1	0
B	2	1	0	0	0	0	0	0	0	0	0
B	2	2	0	0	0	0	0	0	0	0	0
B	2	3	0	0	0	0	0	0	0	0	0
B	2	4	0	0	0	0	0	0	0	0	0
B	2	5	0	0	0	0	0	0	0	0	0
A	3	1	25	0	0	75	0	0	0	0	0
A	3	2	0	0	0	100	0	0	0	0	0
A	3	3	0	0	0	100	0	10	0	5	0
A	3	4	0	0	0	100	0	1	0	0	0
A	3	5	20	0	0	80	0	0	0	0	0
B	4	1	0	0	0	0	0	0	0	0	0
B	4	2	0	0	0	0	0	0	0	0	0
B	4	3	0	0	0	0	0	0	0	0	0
B	4	4	0	0	0	0	0	0	0	20	0
B	4	5	0	0	0	0	0	0	0	0	0
A	5	1	25	0	0	80	0	0	0	0	0
A	5	2	0	0	0	100	0	0	0	0	0
A	5	3	2	2	0	100	0	0	1	0	0
A	5	4	20	2	0	90	0	0	0	0	0
A	5	5	10	0	0	80	0	0	0	0	0
B	6	1	0	0	0	0	80	0	0	0	0
B	6	2	0	0	0	0	0	0	0	0	0
B	6	3	0	0	0	0	0	0	0	0	0
B	6	4	0	0	0	0	0	0	0	0	0
B	6	5	0	0	0	0	0	0	0	0	0
CONTROL	7	1	0	0	0	0	50	0	0	0	20
CONTROL	7	2	0	0	0	0	50	0	0	0	10
CONTROL	7	3	0	0	0	0	50	0	0	0	0
CONTROL	7	4	0	0	0	0	40	0	0	0	0
CONTROL	7	5	0	0	0	0	20	0	0	0	0
TOTAL			177	4	5	1,335	290	11	1	26	30
*a.k.a. Sandberg bluegrass (Poa secunda)											

Boren Family Farm
Water Quality Improvement Pilot Project
Stratified Random Plant Sample Data (2014)

Grow Plot	Transect Number	Quadrat Number	Filamentous algae Chlorophyta sp.	Resin birch Betula glandulosa	Barnyard grass Echinochloa crus-gaslii	Pepper weed Lepidium latifolium	Cheatgrass Bromus tectorum	Bare Ground	TOTAL
A	1	1	0	0	0	0	0	0	100
A	1	2	0	0	0	0	0	0	110
A	1	3	0	0	0	0	0	0	100
A	1	4	0	0	0	0	0	0	105
A	1	5	0	0	0	0	0	4	100
B	2	1	20	0	80	0	0	0	100
B	2	2	100	0	0	0	0	0	100
B	2	3	100	0	0	0	0	0	100
B	2	4	100	0	0	0	0	0	100
B	2	5	100	0	0	0	0	0	100
A	3	1	0	0	0	0	0	0	100
A	3	2	0	0	0	0	0	0	100
A	3	3	0	0	0	0	0	0	115
A	3	4	0	0	0	0	0	0	101
A	3	5	0	0	0	0	0	0	100
B	4	1	100	0	0	0	0	0	100
B	4	2	100	0	0	0	0	0	100
B	4	3	100	1	0	0	0	0	101
B	4	4	100	1	0	0	0	0	121
B	4	5	100	10	0	0	0	0	110
A	5	1	0	0	0	0	0	0	105
A	5	2	0	0	0	0	0	0	100
A	5	3	0	0	0	0	0	0	105
A	5	4	0	0	0	0	0	0	112
A	5	5	10	0	0	0	0	0	100
B	6	1	20	0	0	0	0	0	100
B	6	2	100	0	0	0	0	0	100
B	6	3	100	0	0	0	0	0	100
B	6	4	100	0	0	0	0	0	100
B	6	5	100	0	0	0	0	0	100
CONTROL	7	1	0	0	0	10	30	0	110
CONTROL	7	2	0	0	0	0	50	0	110
CONTROL	7	3	0	0	0	0	50	0	100
CONTROL	7	4	0	0	0	0	30	30	100
CONTROL	7	5	0	0	0	0	30	50	100
TOTAL			1,350	12	80	10	190	84	3,605
*a.k.a. Sandberg bluegrass (Poa secu									

North Alkali Drain
Water Quality Improvement Pilot Project
Comparison of Estimated and Actual Costs

TASKS WITHIN EACH PHASE OF THE PROJECT	ESTIMATED COST	ACTUAL COST
Project Administration	\$5,000.00	\$5,055.00
Prepare Concept Plan	\$2,000.00	\$2,750.00
Prepare Preliminary Design Alternatives	\$2,000.00	\$2,750.00
Prepare Final Design	\$2,000.00	\$2,750.00
Survey and Map the Project Area	\$3,000.00	\$2,550.90
Prepare the Design and Details of Earthwork	\$3,000.00	\$6,000.00
Prepare Monitoring Plan and Quality Assurance / Quality Control Protocol	\$3,000.00	\$3,175.00
Prepare Stormwater Pollution Prevention Plan	\$3,000.00	\$4,000.00
Obtain Water Right Permit	\$2,000.00	\$2,175.00
Measure Flow and Temperature	\$7,500.00	\$7,591.57
Sample Water Quality	\$2,500.00	\$2,770.91
Analyze Water Quality Samples	\$1,000.00	\$1,125.00
TOTAL FOR PHASE 1 OF THE PROJECT	\$36,000.00	\$42,693.38
Provide Land for Pilot	\$4,000.00	\$4,000.00
Stake and Supervise Pond Construction	\$5,000.00	\$11,740.25
Construct Ponds	\$8,000.00	\$16,500.00
Supervise Plantings	\$2,000.00	\$2,914.73
Provide Cuttings	\$8,000.00	\$2,175.00
Install Cuttings	\$5,000.00	\$5,027.76
Rent and Install Pump	\$8,000.00	\$7,720.74
Provide Power for Pump	\$5,000.00	\$5,000.00
TOTAL FOR PHASE 2 OF THE PROJECT	\$45,000.00	\$55,078.48
Operating and Maintenance Costs	\$5,000.00	\$1,500.00
Measure Flow and Temperature	\$7,500.00	\$4,825.09
Sample Water Quality	\$2,500.00	\$2,300.00
Analyze Water Quality Samples	\$1,000.00	\$643.00
TOTAL FOR PHASE 3 OF THE PROJECT	\$16,000.00	\$9,268.09
Analyze Data and Prepare Report	\$5,000.00	To Be Determined
Present Report	\$1,000.00	To Be Determined
Peer Review of Report	\$2,000.00	To Be Determined
TOTAL FOR PHASE 4 OF THE PROJECT	\$8,000.00	To Be Determined
TOTAL FOR ALL PHASES OF THE PROJECT	\$105,000.00	To Be Determined



Figure 1 - Boren Family Farm



Figure 2 - North Alkali Drain



Figures 3A and 3B - Excavation and Operation of the Sedimentation Basin



Figures 4A and 4B - Rough Grading and Operation of the Grow Plots



Figures 5A and 5B - Cipolletti Weir at the Outlet of the Sedimentation Basin



Figures 6A and 6B - Distribution Manifold at the Head of the Grow Plots



Figures 7A and 7B - Bypass Ditch and Standpipe With Boards That Portion Flows Between Ditch and Grow Plots



Figures 8A and 8B - Bypass Ditch, Flow Measurement Device, and Calibrated Weir



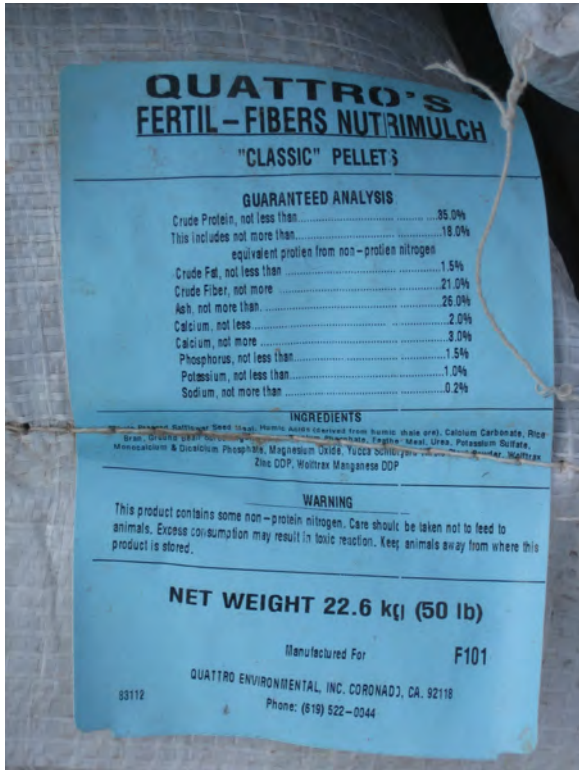
Figures 9A and 9B - Distribution Manifold, Bypass Standpipe, and Flow Measurement Device



Figures 10A and 10B - Installation of the Pump and Pump Well at North Alkali Drain



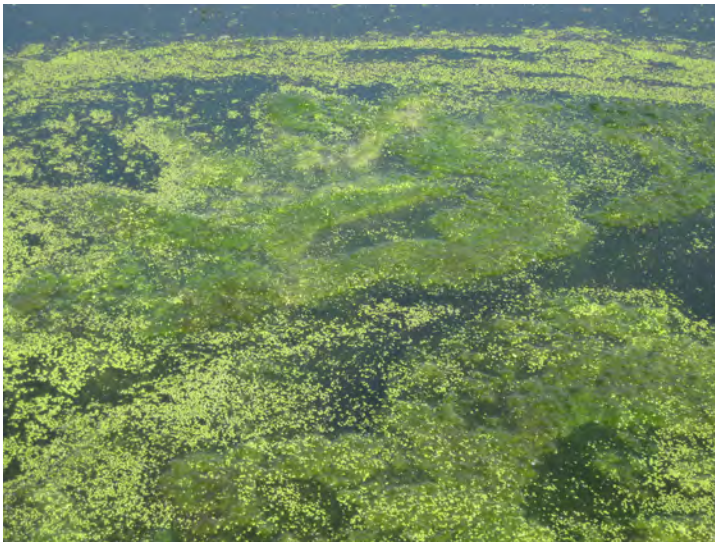
Figures 11A through 11D - Harvest, Installation, and Surviving Willow Cuttings in Grow Plot B



Figures 12A through 12D - Installation of Seed and Soil Amendments, and Robust Growth in Grow Plot A



Figures 13A and 13B - Alkali Soils Exposed After Excavation and their Effect on Grow Plot B



Figures 14A and 14B - Floating Macrophytes Growing in the Sedimentation Basin
Similar to those Found in Portions of the North Alkali Drain