DESIGN AND COST ANALYSIS OF A WETLAND PROJECT

by

Matthew Rolen

Agriculture Systems Management
BioResource and Agriculture Engineering Department
California Polytechnic State University
San Luis Obispo
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Author : Matthew Rolen

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Mr. Tom Mastin
Senior Project Advisor

Signature

Date

Dr. Kenneth Solomon
Department Head

Signature

Date
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ABSTRACT

This senior project discusses the cost and design of a thirty acre wetland habitat project. This project demonstrates the importance that wetlands play for waterfowl as well as wildlife. The project will also discuss the changes made to the habitat and the importance of that. Also the unique design of the habitat will be explained. The main purpose of the project is the cost analysis of it. The budget of the project and the funding it takes to develop or preserve such a project.
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INTRODUCTION

With more urban areas being developed and cities outgrowing their borders, the urban-interface between humans and the environment is becoming closer than ever. Especially in California, it is a careful balancing act to provide affordable housing and productive farmland while still protecting our precious natural resources. In previous years, the natural environment always took a ‘backseat’ to goals of wealth and prosper. But today, we realize the extensive damage we have caused reducing acreage of land that can take hundreds and even thousands of years for the earth to recreate. One landscape that it is essential to the preservation and conservation of our delicate wild lands are wetlands. Not only does it act as a natural water filtration system and game bird habitat, but also as safe haven for some of California’s most sensitive wildlife species (Smith et. al. 1994).

One project in particular that is seeking to preserve wetland areas, while also providing recreational uses is the Sikes WRP Enhancement. Located in California’s Colusa County, near the town of Colusa off California State Route 20 is a 30 acre parcel controlled by the managing board of the Sutter Butte Boy’s Club (SBBC). The project had the direction of restoring and enhancing a slowly deteriorating natural wetland, providing 11 new islands and to transform what is a now a loose collection of ponds to a fully functional and successful wetland habitat. This was accomplished by thoroughly clearing all swales of soil and debris, installing functioning drain boxes and the construction of a dike to control water flow. Furthermore, the thirty acre plot will be graded to meet a prescribed relatively flat gradient to keep unwanted prim roses from growing in areas that puddle up. Before construction began, the proposed project was intricately planned to meet all the requirements of various agencies and a multitude of legislative regulations, such as the United States Department of Agriculture (USDA), the Natural Resources Conservation Service (NRCS), California Department of Fish and Wildlife (CDFW) all why adhering to regulations provided by the National Environment Policy Act (NEPA) (EOP 2013) supplemented by the California Environmental Quality Act(CEQA) (CA. DNR 2013). With the latter two focusing on controlling all environmental damage of change and mitigating any foreseen or existing issues that would unnecessarily cause destruction or the hampering of wildlife populations.

The main direction of the applicant was to restore the specific wetland back to its natural state for the proliferation of game and sensitive species, while providing a rare facet of also maintaining a hunting area for Colusa County Residents. This report provides a look at the required steps for a project of this magnitude, its overwhelming benefits, and a cost analysis from its construction to its successful instillation and role of this wetland project in the future. Projects involved of this characteristic commonly cost hundreds if not thousands of dollars, routinely being between $3,500 and $80,00 dollars per acre (White 2013). Figure 1 below shows the specific project area, with some already in place components of this environmental venture.
For this paper, the scope of this project is to effectively show the required elements of completing a wetland restoration. Environmental planning steps and costs are outlined through the duration of this particular undertaking, culminating in a land area that perpetuates California’s natural habitat.
LITERATURE REVIEW

Background

Restoration of wetlands combine with suitable species habitat has overwhelmingly increased in popularity. Our society has realized that these areas are slowly becoming in progressively worse condition and actually disappearing, being overtaken by agricultural land, housing developments and urban projects. Even with environmentally concerned organizations, such as the Wild Turkey Federation and Sierra Club, donating large sums of funds for the goal of wetland creation and restoration, the area of these valuable land types is decreasing at an alarming rate (CA. DFG 2011). And even if these wetlands are restored or protected, the close proximity of human existence exposes them to the vulnerability of our population’s industry. With the ever pressing issue of damaging pesticides and agricultural chemicals, human waste, invasive plant species, and hazardous materials flowing uncontrolled into these lands, it is easy to see that we as a society are tasked with what sometimes seems like an insurmountable goal of enjoying our environment and decreasing its ruination. It is imperative that we increase, restore and also enjoy these priceless natural landscapes. The SBBC has realized that they are important players in the realm of keeping Colusa County’s Wetlands perpetuated in sound condition for generations to come. Located in the Butte-Sink Wildlife Management Area, which is most notably cited for having the highest concentration of waterfowl per acre in the world (USFWS 2013). Realizing how truly delicate and needed this area is for preservation of California’s resources, the United States Fish and Wildlife Service (USFWS) has been increasingly concerned about how they will be able to sustain it for the future. They have begun offering what is known as conservation easements to landowners for tax breaks or direct pay (CA. NRA 2007). These ‘Conservation Easements’ lock sensitive land areas into yearly terms or indefinitely to be a safe-harbor of protection for essential land areas. Although being an organization whom was established for the goal of game bird hunting and not environmental protected, the Club has become fully aware that if these land categories disappear, there richly enjoyed and cherished hobby will not exist. As noted above, they have undertaken a developmental plan to enhance an already existing wetland back to a pristine, fully-functional natural habitat for its use as a recreational area, specifically for raising the game bird population to a degree that will be currently unmatched to any project begun in the past. This project is outlined for to grading of the parcel, improvement of water drainage, planting native flora species crucial to wetland habitat and duck species existence, while all keeping within the boundaries of effective and healthy land restoration.

Wetlands

Wetlands or wild life habitat areas have been defined as “land or water area designated by a board or council, after consulting with and considering the recommendation of the Department of Fish and Game, as an area of importance for the protection or enhancement of the wildlife resources of the state.” (CA. DEP 2013). This definition does not take into account whether the wetland is a fresh or saltwater hosting area. Both
mentioned successfully host all types of amphibians, waterfowl, and reptiles with most notably California’s being permeated with many of these belonging to protection categories of threatened or endangered species provided by State and Federal Government legislation (headlined by the Endangered Species Act, U.S. Public Law § 93-205) (USFWS 2013). Wetlands are composed of a few different distinct classes, including bogs, marshes, swamps and fens (U.S. EPA 2012). The Sutter Butte Boy’s project area falls under terrestrial, deriving its fresh-water saturation from the nearby Oroville Lake. Wetlands are an area that attracts and successfully provides healthy and suitable habitat for a large and distinct class of waterfowl and wildlife. Concerning Colusa County’s wetlands, they host surroundings which many species call home. These include the endangered Western pond turtle and Ca red-legged frog, waterfowl species including mallards, teals, pintails and geese, aquatic craniate groups, and rare/native plant types. Concerning wildlife that thrive in wetland landscape types is it essential to delineate that many, if not a majority, only can survive in these specific areas. Biological scientists refer to these as endemic species (USFWS 2013), that have been known only to perpetuate their populations in one area of a specific environmental description. Knowing how of vital importance preserving these endemic species, the SBBC has applied themselves to this concern of currently restoring this 30 acre parcel. The wetland was in poor condition before the improvements, prominently displaying features preventing sound water drainage exacerbated by invasive and/or weed flora, dead or dying trees, and providing low cover and nutritious feed for identified waterfowl populations. This project completed transformed what was previously considered poor and degenerate, to a suitable and enticing area for all local fauna.

Flood and Drainage Control

A very applaudable feature of wetlands, other that being fantastic wildlife habitat, is that they act as areas that control and dampen the sometimes destructive force of natural or synthetic flooding. They essentially act as a barrier to hamper flooding that has the potential to cause irreplaceable damage to valuable crop/orchard land impeding successful harvests, and also to keep from entering urban areas. These wetlands can hold large amounts of excess water if there is ever an occurrence of torrential rains or, in Colusa County’s close proximity to nearby dams, the unplanned happening of a possible dam break that could release untold amounts of previously held water. Species inhabiting the area have evolved key traits that allow them to accommodate for such situations (BBC 2013) involving a quick increase of water levels, such as plants being able to survive completely submerged for periods of time without substantial negative effects.

Water Filtration

Wetland habitat’s most notable contribution to current and human populations is their unmatched ability to effectively filter water before they are able to contaminate our ever diminishing fresh water supply. Their hosting of unique plants and soils capture pollutants and particulates that would have the potential of contaminating our water sources. With so many different synthetic chemicals used by society, particularly in agricultural and industrial applications, many of these lack the ability to naturally
degrade, some such as nitrogenous fertilizers, which are composed of triple nitrogen bonds, that are renowned for having a lengthy chemical half-life (Nasonqmi & Myrold 1992). Wetlands can naturally capture and retain these toxic chemicals, providing them an area where they can exist until they are broken down into less destructive components. Furthermore, human built water filtration systems, although much more effective, are extremely expensive and primarily produce industrial water (non-potable) versus drinking water, the latter taking much more time to produce (WA. DE 2013). Many of these filtration systems are built de facto, filtering out chemicals after they have already carved a path of environmental wrath. Preserving these wetlands are not only much cheaper over the long run, but also the amount of human effort to effectively and quickly serve fresh, clean water essential to our population’s flourish.

**Recreational**

Although wetlands are valuable and necessary to a multitude of species, they are particularly of vital importance to deeply cherished recreational hobbies. As it is easy to see as how famed and adored such recreational use facilities including Yosemite National Park (4,098,648 visitors in year 2011) (U.S. NPS 2013), The Sierra Mountain Range, etc.; most California citizens only are concerned when the proposition of land loss involves what they do for their enjoyment. That is where SBBC has really made their mark. Not only will they provide a parcel for their members and associates to partake in hunting, fishing, and wildlife watching activities, but will also maintain these areas so they will always be plentiful with abundant wildlife and plants species. It is truly commendable that a Club with the goal of hunting and fishing activities has put in the work to provide its members with a great recreational opportunity, but also to preserve land areas that are quickly descending closer and closer to a point of rarity.

**Project Managing**

Effective project management employed in this 30 acre restoration process, helps to expedite total time of completion, reduce unnecessary delays, keeps within environmental regulations and ultimately reduces expenditures. The first most pressing issue when hoping to complete this certain project is to select a location that will not be the most economically feasible, but that also has the potential to provide all the end results the SBBC or organization wishes to ascertain. In the SBBC’s case, they eventually chose an area that would provide fantastic recreational benefits to their members and associates, and that would also protect a limited landscape type that would allow populations of endemic species to bloom. Secondly, before a location was even proposed, they had to have the required funds. These are most commonly attained by the lead party providing public relations outreach to agencies, governments, and organizations that would be excited and approving of such proposal. Many non-profit organizations, and governmental agencies are established and funded for issues in being donors for environmental preservation/conservation efforts. While the SBBC was primarily established for the taking of fish and waterfowl species, which many environmental watch-dog groups would be highly opposed of, if groups resembling the SBCC actively notify such environmentally-concerned groups of their environmental goals, they can
benefit from funds that will help to offset direct costs. Good public relations is essential in making projects regarding landscape restoration possible. Although, many times such groups looking to immerse themselves into such developments need to be wary of how those funds are given, and what restrictions may be placed onto them. For example, any funds provided by the U.S. Federal Government for any environmental developmental/restoration activities, must adhere to the standards enforced in the National Environment Policy Act of 1970 (Public Law 43-32). This may cost the project more time, effort and expenditures than the lead party had previously wished to partake in. Moreover, if and when the project has been approved and started, the lead party must establish a good workforce of labor and equipment. In the arena of environmental restoration projects, it is indispensable to hire a company that specialize in this type of construction, so that they are aware of environmental regulations and standards when completing a project. This is very important to protect the lead party from citizen lawsuits and agencies that have authority to stall, delay, or indefinitely stop all operations for lack of environmental regulation adherence. But before any of this can be accomplished, proper surveying and project design must be comprised to find the most viable option. Wildlife surveys for protected plants, animals and areas completed by qualified biological technicians, professional land surveys, soils surveys to establish whether or not a certain soil type can handle such a project, and consultation of construction experts on whether a project is feasible and can be concluded within a set budget and timeframe. When all of these required components of a successful environmental project are completed, one must take into account the scheduling of each detail of a restoration initiative. Adequate timeframes must be established for each individual task, also taking into account wetlands natural behavior of seasonal low and high water levels (Eulis & Mushet 1996). Additionally due to being within the bounds of a waterfowl area, ample time must be allocated to each species, as to not disturb their normal migration and nesting periods during development and involved construction activities (Scientific American 2010). This has the capacity to possibly ruin the SBBC’s desired objective of increasing suitable habitat for waterfowl/avian species, potentially having certain populations never return to the area.

When setting out to complete any project of this sort, the applicant must realize that they are completing a project that seeks to restore something that is priceless and extremely delicate. A project of this sort cannot be rushed or quickly planned, having the possibility of ruining something we cannot salvage, opening up the lead party to lawsuits, controversy and negative press. Projects such as this are extremely sensitive, and one must grapple that they are not just completing a project for their gain, but for the gain of their fellow citizens and future generations seeking to enjoy California’s beautiful landscape.
PROCEDURES AND METHODS

Designs and Specs

The Natural Resource Conservation Service (NRCS) was the designer of the overall project. The NRCS surveys the field and determines the best possible design option. By surveying the field of the Sutter Buttes Boys Club (SBBC) determined that the grade for the field is set at 72.0’. The field was to be leveled flat across the entire field. Swales that are in the existing field will be reconstructed and sloped to proper degree. The field survey shows the field is thirty acres.

The main design criteria for the thirty acre field are: a grade of 72.0’ flat, twelve new islands throughout the field, re-sloped swales, a new dike, planting of natural grasses and transplanting tules. The cut and fill areas of the field consist of high areas of the field where it should be flat and the fill areas are the new dike and new islands. The grade must be consistent across the entire field or water will not be able to flow and drain properly. Swales are surveyed and sloped to the proper degree to ensure drainage of the field. The Topcon GPS unit within the tractor maintains the correct slopes. Figure 2 shows the display of this Topcon unit in the tractor as well as the highs and lows of the field.

The dike that is being inserted into this project is 1,666 feet long. The dike will be twelve feet across the top with a 2:1 slope on the sides of it. The dike is two and a half feet tall. At two dollars a cubic foot a dike of this magnitude can be very expensive. One option that was consider was, design the new dike to be two feet high, therefore making for less earthwork and could cut cost up to a little more than $4,000. This is furthered discussed in the recommendation part of the report. The material shall be suitable material for proper construction. The material shall contain no sod, brush, roots or other unsuitable
material. Rocks with the diameter of six inches shall not be in the material as well. The moisture content of the fill material shall be adequate to obtain the proper degree of compaction with the equipment used. To reach the proper moisture level a water truck will be used to wet down the dike as it is being constructed. The surface of the finished dike shall be graded smooth. Shaping of the dike should break up lumps and clods to yield a smooth surface and finish to the lines and grades.

The natural (native) grasses that were used and planted were blue wildrye, creeping wildrye, meadow barley, purple needlegrass, gum plant and tomcat clover. These grasses are planted on the new dike and islands as well as nesting areas surrounding the field. The total number of planted acres is two acres. The method of planting these grasses is with a no-till seed drill. The seed is planted at ¼ - ½ inches into the ground. No fertilizer will be used for planting. Tule transplants will be placed properly throughout the field. The planting of these native grasses and the transplanting of tules cost the NRCS nearly $3,000.00 or $100 per acre. One option that has been used in other projects would be not to plant anything and just let whatever grasses grow back on their own. This process could have saved money, but would not have been the best thing for the newly enhanced habitat. To spend all this money on earthwork and not replenish it with the proper grasses for a conservation project to this magnitude would not be wise. The application process of the planting could have been different and money could have been saved. Instead of seed drilling the grasses into the ground which gives a high yield of the grasses, a seed spreader could have been used and down quicker therefore taking less time and saving money. The yield of the grasses would not be as strong and seed cost would be wasted.

New pipes and drain outlets are inserted in the field format to ensure water control. There are two new drain outlets along the north and south areas of the new dike. There are total of six water structures that are installed for this project. The water structure consisted of two 3’x3’ twin track weirs, three 3’x4’ twin track weirs, and one 3’x5’ twin track weir. 18’’ pipe and 24’’ pipe as well as poly seal couplers are also materials used for these water structures. These structures cost $1,500.00 per unit and cost $5,000.00 to install. Figure 3 displays a one of the two water structures inserted into the field design through the new dike. These water structures are used to hold water levels within the field as well as the draining the field. Without these structures proper water elevation cannot be reached and water control would be difficult.
Construction

Several different types of equipment are used in projects. For this project we use two tractors that have fifteen yard scrapers. One tractor is a John Deere 9320 and the other one is John Deere 8420. The scrapers run off a Topcon global positioning system (GPS). The scrapers move dirt from high positions in the fields to low areas or to new islands or dikes. One of the tractors as well as the scraper can be seen in Figure 4 below. A water truck was used to spray down the new dike. This allows for proper soil moisture and compaction in the dike. A backhoe was used to takeout small trees that need to be removed for the new dike. It is also used to take out old water structures such as the drain pipes as well as putting in new ones. For preparation of the field a chopper and a disk was used to open the field up. They are also used for preparation for the planting of the natural grasses. A roller is used to give it a nice finish look and for a nice seed bed. To plant the natural grasses a seed drill is used.

Figure 4

The first step in a project like this to survey the field to see how much dirt work will need to be done. The NRCS choose the grade for the field, the heights and positioning of all the islands and the big dike that runs along the east side of the field. The survey also shows the highs and lows of the field that need to be adjusted. The NRCS used a Topcon GPS to complete this process. The main cost of this project was the earthwork which is directly related to the design of the project. How many islands and how big the new dike is effects how much the project can cost. By limiting the amount and sizing of the islands money can be saved by not having to move an excessive amount of dirt.
The next step that is taken is the preparation to the field before any dirt can be moved. Depending how tall the weeds and grass are determines if the field needs to be mowed. For this project the fielded needed to be chopped. Chopping the field will help in the long run by breaking down the organic material and working it into the soil. When the field is disked it will mix in better with the soil and break the organic material down. It is also very hard to move dirt that has a lot of organic material and the new dike that is being constructed should not have any trash in it. After chopping is completed a disk needs to run across the field. Depending on hardness of the soil and how well the ground worked up a second disking may be needed. For this project a second disking was needed. Some other preparation for this project was the clearing of trees that stood in the way of the new dike. After all the preparation to the field is completed dirt work can start.

To start the leveling and construction of the field the GPS units the must be on and running. A bench mark must be set and the grade of the field must be set to meet the NRCS specification of 72.0'. After all systems are set and operating correctly construction can start. With a map provided by the NRCS of the fields survey will determine where the most dirt needs to be moved and where it needs to be moved to. Filling in the lows of the field are first areas where the dirt needs to be moved because there is not that much dirt that needs to be moved to the spots. After the lows in the field are filled in and brought to the proper grade, dirt can then begin moving to the new dike. For loads that contain a lot of trash in them, islands can be formed with that soil in spots where the NRCS wants them to go. While the construction of the dike is being done the water truck will be running water over the soil for proper compaction of the dike. After all the dirt work is completed; the dike, islands and nesting grounds are completed the shaping of them needs to be done. No sharp walls or fall offs should be formed. Everything must be smooth and slope neatly.

The swales in the field need to be cleaned out and re-sloped so proper water drainage can occur. With the GPS system in the tractors surveys can be conducted using the Topcon system to determine the proper slope of the swale. After the survey is completed constructing on the swales can start. After the proper grade and slope is reached the shaping of the swale needs to be done. No sharp edges with everything sloping in nice and smooth for easy and proper drainage.

After all dirt work is completed the project still is not complete. New drain pipes and water structures are installed using a backhoe to do so. Proper leveling and insertion of the pipe is important for water correct drainage. The installations of the pipes are very important; if not done correctly washouts are very prone to happen. Washouts are a failure or breach of levy or dike that is holding water. There are six new twin track weirs that are installed in the field.

After all construction has been completed and the field has been rolled smooth or floated it is time to plant the native grasses. A seed drill specially made for jobs like this is used to plant native grasses on all the new islands, nesting areas and dike. Figure 5 displays the seed drill that was used. Also the transplanting of several tule bushes is inserted into the field layout. That is done by using the front bucket of the backhoe. The project is then
Irrigation needs to occur as soon as the project is completed. The flooding of the field is started as soon as all the equipment has been removed from field. Even though there is a lot of new dirt, there are still trees within the field’s layout that need water immediately as well as germinating new feed for the waterfowl and wildlife.

Figure 5
RESULTS

Design Results

The result of the Sutter Buttes Boys Club conservation project was completed with a new dike system running north to south along the east side of the field. There were several new islands places strategically placed throughout the field. Low and high elevations were brought to the grade of 72.0’. New swales were inserted into the field layout as well as enhancing the swales that already exist. Table 1 displays the cuts of dirt in cubic yards for the swales, potholes and pond floors. It also displays how much cubic yards of fill there was for the dike and islands. There is a shrinkage factor when cutting in filling soil. The shrinkage factor varies from soil type and is affect through soil compaction and moister content. The shrinkage factor used for this project was 1.3 for the dike and 1.15 for the island. There is a difference in the shrinkage factor due to the dikes compaction process and moister level. The reason the cut and fill totals do not make up maybe due to the surveying process error and the shrinkage factor adjustment of the dike and islands.

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</table>

Table 1

The dike that was inserted into the field layout used 3927 cubic yards of fill soil. The dike runs along the east side of the field and stretches 1666 ft. It two and half feet high and is twelve feet wide on top. On both sides of the dike it has a 1:6 slope ratio which means for every six feet the dike slopes down one foot. The slopes are twelve feet long. Table 2 displays these numbers of the new dike. Majority of the dirt that was cut from the field was used for the dikes construction. With the proper formation of the dikes compaction and moisture content, erosion will not be a factor for the dike. After the construction of the dike it was then tilled and planted with native grasses. The native grasses consisted of blue wildrye, creeping wildrye, meadow barley, purple needlegrass, gum plant and tomcat clover. Also some tule clumps were placed on both sides of the dike. Two water control structures were placed on the north and south parts of the dike. New and already existing swales meet up with these new water outlets.
There were a total of twelve new islands that were inserted into the field layout. Seven of these islands were small islands used for added tule clumps. Other islands that were formed are meant for tree growth and native grasses as well as loafing and nesting areas for waterfowl and other wildlife. In table 3 it shows the elevation, size, height and the volume of soil for each island made. These measurements are often estimations and are not crucial if not meeting the island size spec. As the table shows the numbers can be rounded estimated. These numbers differ due to shrinkage factor as well as human error of the survey taken.

<table>
<thead>
<tr>
<th>Islands</th>
<th>Island</th>
<th>top area (sqft)</th>
<th>top el (ft)</th>
<th>Slope (1:x)</th>
<th>ground el (ft)</th>
<th>height (ft)</th>
<th>volume (cu yd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>900</td>
<td>73</td>
<td>6</td>
<td>72</td>
<td>1</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2400</td>
<td>73.5</td>
<td>6</td>
<td>72</td>
<td>1.5</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2400</td>
<td>73.5</td>
<td>6</td>
<td>72</td>
<td>1.5</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2400</td>
<td>73.5</td>
<td>6</td>
<td>72</td>
<td>1.5</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>3600</td>
<td>74</td>
<td>6</td>
<td>72</td>
<td>2</td>
<td>567</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>3600</td>
<td>74</td>
<td>6</td>
<td>72</td>
<td>2</td>
<td>567</td>
<td></td>
</tr>
</tbody>
</table>

Table 3

There were two new swales added to the field layout. These swales help better the water flow and drainage of the field. This helps keep unwanted weeds such as perm-rose from growing and increases feed for waterfowl to grow. The swales have 1:6 sloped walls. There was 190 cubic yard of dirt moved in the construction of the swale. Details such as length, width, and volumes can be found in table 4.
Swales- New

<table>
<thead>
<tr>
<th>length (ft)</th>
<th>bottom (ft)</th>
<th>cut (ft)</th>
<th>slopes (1:x)</th>
<th>volume (cu yd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>12</td>
<td>1</td>
<td>6</td>
<td>53</td>
</tr>
<tr>
<td>160</td>
<td>12</td>
<td>1.2</td>
<td>6</td>
<td>137</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>190</td>
</tr>
</tbody>
</table>

Table 4

The potholes and pond floor cuts can be seen in figure 6. Table 5 and Table 6 display numbers regarding areas in the field that had large cuts. The potholes had two main areas in which dirt was taken and used for the dike or islands. There was 2,789 cubic feet moved from these areas. These areas required a lot of time due to the heavy cuts. Also the pond floor cuts were large areas as well, but did not require as much cuts. There was more acres of the pond floor to cover which made for a lot of time. The potholes and pond floor was brought to the same grade of 72.0’. The entire field was level flat. This allows for easier water control as well as an equal irrigation.
<table>
<thead>
<tr>
<th>No.</th>
<th>bottom (sf-ft)</th>
<th>area (ac)</th>
<th>cut (ft)</th>
<th>volume (cuyd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>61450</td>
<td>1.41</td>
<td>1</td>
<td>2276</td>
</tr>
<tr>
<td>2</td>
<td>27725</td>
<td>0.64</td>
<td>0.5</td>
<td>513</td>
</tr>
</tbody>
</table>

**Table 5**

<table>
<thead>
<tr>
<th>No.</th>
<th>area (sf-ft)</th>
<th>area (ac)</th>
<th>cut (ft)</th>
<th>volume (cuyd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>0.3</td>
<td></td>
<td>579</td>
</tr>
<tr>
<td>2</td>
<td>1.87</td>
<td>0.3</td>
<td></td>
<td>904</td>
</tr>
<tr>
<td>3</td>
<td>1.62</td>
<td>0.3</td>
<td></td>
<td>783</td>
</tr>
<tr>
<td>4</td>
<td>0.96</td>
<td>0.3</td>
<td></td>
<td>463</td>
</tr>
<tr>
<td>5</td>
<td>2.37</td>
<td>0.2</td>
<td></td>
<td>763</td>
</tr>
<tr>
<td>6</td>
<td>0.36</td>
<td>0.2</td>
<td></td>
<td>115</td>
</tr>
<tr>
<td>7</td>
<td>1.31</td>
<td>0.2</td>
<td></td>
<td>423</td>
</tr>
<tr>
<td>8</td>
<td>1.55</td>
<td>0.3</td>
<td></td>
<td>748</td>
</tr>
<tr>
<td>9</td>
<td>0.18</td>
<td>0.3</td>
<td></td>
<td>86</td>
</tr>
</tbody>
</table>

**Table 6**

**Cost Results**

The Sutter Buttes Boys Duck Club wetland enhancement project cost a total $45,255.00. The biggest cost of the project was the earthwork. There was 10,000 cubic yards of dirt moved within this project. Although in the Earthwork Summary in Table 1 shows there was just under 8,000 cubic yards of dirt the contract that the NRCS had with Wetland Enhancement LLC stated the minimum amount of cubic yards of dirt that the NRCS will pay was 10,000 cubic yards. At two dollars a cubic yard that cost a total of $20,000. Site preparation was another expense of the project. The site preparation consisted mowing of the field, diskng, removing trees and old water structures. For thirty acres at fifty dollars an acre it cost $1,500.00 for the site preparation. Mobilization which is the moving of equipment to the site and servicing of the equipment cost $5,000. The transplanting of tule clumps took two hours to do and cost $100.00 per hour totaling up to $2,000.00. Planting native grasses on the new dike, islands and nesting areas around the habitat cost $880.00. It took 8.8 hours of ground preparation for a proper seed bed and drilling of the seed. The new water structures that were inserted into the project weighed a heavy cost on the project. There were six new water structures added to the projects. They were either replacing old and outdated structures or were new additions that were added for
better drainage. These new structures cost $9,000. The labor it cost to remove old structure and insert new ones totaled up $6,875.00 bring the total water structure portion of the project to $15,875.00. The earthwork and water structures of the project were the two most expensive parts of the project. Table 7 displays the cost for each of the jobs that were completed for the project.

<table>
<thead>
<tr>
<th>Item</th>
<th>sub-item</th>
<th>description</th>
<th>planned amount/qty</th>
<th>unit cost</th>
<th>cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland Enhancement</td>
<td>earthwork</td>
<td>short-haul</td>
<td>10000 cuyd</td>
<td>$2.00/cuyd</td>
<td>$20,000.00</td>
</tr>
<tr>
<td></td>
<td>site Prep</td>
<td>diskig mowing</td>
<td>30 ac</td>
<td>$50/ac</td>
<td>$1,500.00</td>
</tr>
<tr>
<td></td>
<td>mobilization</td>
<td>equipment</td>
<td></td>
<td>$5,000</td>
<td>$5,000.00</td>
</tr>
<tr>
<td></td>
<td>tule transplant</td>
<td>transplanting</td>
<td>20 hr</td>
<td>$100/hr</td>
<td>$2,000.00</td>
</tr>
<tr>
<td></td>
<td>native grasses</td>
<td>planting</td>
<td>8.8 hr</td>
<td>$100/hr</td>
<td>$880.00</td>
</tr>
<tr>
<td></td>
<td>concrete twin-track weir</td>
<td>flashboard risers w/ pipe</td>
<td>6 units</td>
<td>$1500/unit</td>
<td>$9,000.00</td>
</tr>
<tr>
<td></td>
<td>installation</td>
<td>inserting items/labor</td>
<td>40 hr</td>
<td>$125.00/hr</td>
<td>$5,000.00</td>
</tr>
<tr>
<td></td>
<td>old structure removal</td>
<td>labor</td>
<td>15 hr</td>
<td>$125.00/hr</td>
<td>$1,875.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$45,255.00</td>
</tr>
</tbody>
</table>

Table 7
DISCUSSION

Cost

Projects like this one, that are funded by the NRCS are bided jobs. Sutter Butte Boy’s Club did pay for the job, but was then fully reimbursed by the NRCS. Business such as the Wetland Enhancements LLC, the business hired to complete this project put bids in for projects such as this one. The NRCS study’s each of the bids and determines which business they feel can reach the specs of the project at the budget they expect it will cost them. Wetland Enhancements LLC a business created by Pat Colmer and Clark Becker was awarded this project of the Sutter Buttes Boys Club. The original budget setup by the NRCS was $43,987.50 and can be seen in Table 8. The final total cost of the project was $45,255.00. That is only a $1,268.50 difference which is a minimal amount with a project to this magnitude. The NRCS was pleased to see how close Wetland Enhancements LLC was to the budget.

Table 8

The budget that was set up by the NRCS was all the dirt work totaling $26,000.00 and the water structures totaling $11,750.00 with a contingency of 15% totaling $5,737.50 adding up to a total of $43,987.50. For the dirt work portion of the budget the NRCS did not calculate the cost of transporting tules as well as the planting of all the native grasses. The total cost for the actual dirt work of the project was $29,380.00. Nearly $30,000.00 and $3,380.00 more than the budget. The total cost of the actual water structure was $15,875.00 which was $4,125.00 more than expected. Due to contingency and knowing that some items maybe more costly, the budget and the overall cost of the project were close to each other.
Ways in which the project could have saved money and where the budget did not compensate was the water structures. The six new water structures that were inserted into the project which include (flashboard risers, pipe, couplers, and weirs, with a delivery fee) cost $9,000.00. Labor to install and remove cost $6,875.00 which cannot be changed, but where the structures were order can be. By using less expensive weirs, pipes and couplers the cost can be cut. The company may have the ability to choose where these items can be purchased or may not. The NRCS may want a certain water structure built by a particular company. Wetland Enhancements LLC was allowed the freedom to purchase water structures where they saw fit.

**Design**

The final field grade across the entire field was 72.0’. Stretching along the east side of the field is 1,666 foot new dike with two new water structures for outlets. The dike as well as the grade and two water structures can be seen in figure 2. The dike is twelve feet across the top with twelve feet sides that have a 1:6 slope. Nearly 4,000 cubic yards of dirt was used to construct the dike. The dike was compacted with the proper water ratio and used clean soil with little to no organic material or rocks in it. Figure 7 shows the new dike as well as the field grade. Twelve new islands were placed throughout the field. The islands are all different shapes and sizes and accounted for 2,323 cubic yards of earth fill. These islands were all shaped and sloped with a 6:1 ratio for erosion purposes. Two new swales were properly constructed with the cut of only 190 cubic feet of dirt used to construct them.

The planting of six different native grasses on the dike and new islands was done successfully. The grasses were blue wildrye, creeping wildrye, meadow barley, purple needlegrass, and tomcat clover. Surveys, examinations and test were conducted by the NRCS to check and see if all specifications were done correctly. All tests were conducted by the NRCS agent Tim Hermansen. Each specification was met and the job was fully funded by the Natural Resources Conservation Service.
RECOMMENDATIONS

Design

The new dike that was inserted into the project was the most time consuming and one of the most expensive parts of the project. Using more than 5,000 cubic yards of dirt to construct it was the most expensive part of the earthwork. At two dollars a cubic yard the dike cost the NRCS $10,210.00. That is a little less than a quarter of what the entire project cost itself. The specification dimensions of the dike were: height two and a half feet, top width twelve feet, sides 12 feet with 1:6 slopes. If the NRCS could change the height of the dike to two feet instead of two and a half, they could save some money. By eliminating six inches of dirt over 1,666 feet saves 2,143 cubic yards of dirt. With one cubic yard of dirt costing two dollars that saves $4,286.44. The same slopes can still be applied to the dike for erosion purposes. These slopes will still need to be applied or the dike could wash away. By changing the height of the dike, it would not allow proper water height for flooding and irrigating of the field. The field would look unattractive to waterfowl due to the low water and the purpose of the rehabilitation of the field would be gone.

Calculations of Cost Saving by Height of Dike:

\[
\frac{12ft \times 12ft}{2} + \frac{12ft \times 12ft}{2} + 12ft \times 12ft = 48ft^2
\]

\[
48ft^2 \times 1666ft = 79,968ft^3
\]

\[
79,968ft^3 \times \frac{1yd^3}{27ft^3} = 2,961yd^3
\]

\[
5,105yd^3 - 2,961yd^3 = 2,143 yd^3
\]

\[
2,143yd^3 \times $2.00/yd^3 = $4,286.44
\]

Other cost saving items the NRCS could have done in order to cut was ordering the water structure materials from a different company. The company the NRCS choose to purchase items from charged them $9,000.00. Had the NRCS ordered the water structure supplies from Briggs MFG. Company it would have only cost them $7,799.41. A copy of the invoice can be seen in appendix. The cost for 6 twin track weir systems along with pipe and couplers would have saved them $1,200.59.

Had the NRCS made these changes to the project several thousands of dollars could have been saved. These two simple changes to the projects would save the NRCS $5,487.03. With those savings the project would have cost $39,767.97. Two simple changes to the project could have gone a long way.
REFERENCES

Published Academic Articles

   http://www.dfg.ca.gov/lands/waterfowl/docs/WetlandinCentralValley.pdf


Journal Articles


Technical Report


Legal Publications

http://ceres.ca.gov/ceqa/

http://www.fws.gov/endangered/laws-policies/index.html

**Miscellaneous Publication**

www.dfg.ca.gov/biogeodata/cnndb/pdfs/spanimals.pdf

http://www.fws.gov/refuges/profiles/index.cfm?id=81624

http://easements.resources.ca.gov


http://www.ecy.wa.gov/programs/wq/wqhome.html

APPENDIX A

HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR
HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR

ASM Project Requirements

The ASM senior project must include a problem solving experience that incorporates the application of technology and the organization skills of business and management, and quantitative, analytical problem solving. This project address these issues as follows.

Application of Agriculture Technology. The project involves the application of mechanical systems and Global Positioning System (GPS).

Application of Business and/or Management Skills. The project involves business/management skills in the area of wetland designs and machinery management.

Quantitative, Analytical Problem Solving. Quantitative problem solving technique of the cost analysis of the project.

Capstone Project Experience

The ASM senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE course). This project incorporates knowledge/skills from these key courses.

- BRAE 129 Lab Skills/Safety
- BRAE 141 Agriculture Machinery Safety
- BRAE 203 Agriculture Systems Analysis
- BRAE 237 Introduction to Engineer Surveying
- BRAE 321 Agriculture Safety
- BRAE 418/419 Agriculture System Management
- AGB 440 Field Studies in Agriculture
- ENGL 148 Technical Writing

ASM Approach

Agriculture Systems Management involves the development of solutions to technological, business or management problems associated with agriculture or related industries. A systems approach, interdisciplinary experience, and agriculture training in specialized areas are common features of this type of problem solving. This project addresses these issues as follows.

Systems approach. The project involves the integration of multiple functions (GPS, topcom, and equipment operation) and the integration of machine/operator/wetlands systems to enhance wetland habitat.

Specialized Agriculture Knowledge. The project applies specialized knowledge in equipment operations and Global Positioning system devices.
APPENDIX B

DESIGN SPECIFICATION
DIKE
(feet)
CODE 356

DEFINITION
A barrier constructed of earth or manufactured materials.

PURPOSE
- To protect people and property from floods.
- To control water level in connection with crop production; fish and wildlife management; or wetland maintenance, improvement, restoration, or construction.

CONDITIONS WHERE PRACTICE APPLIES
All sites that are subject to damage by flooding or inundation and where it is desired to reduce the hazard to people and to reduce damage to land and property.

Sites where the control of water level is desired.

The dike standard does not apply to sites where NRCS conservation practice standards Pond (378), Water and Sediment Control Basin (638), Diversion (362), or Terrace (600) are appropriate. Dikes used to reduce flooding are normally constructed adjacent and/or parallel to a stream, river, wetland or water body and are not constructed across the stream, river or water body. Dikes used to control water levels usually have small interior drainage areas in relation to the surface area of the regulated water level.

CRITERIA
Classification - The dike classification is determined by the hazard to life, the design water height, and the value of the protected land, crops, and property. Classification must consider land use changes likely to occur over the life of the dike.

Dikes are classified as Class I when located on sites where failure may cause loss of life or serious damage to homes, primary highways, industrial buildings, commercial buildings, major railroads or important public utilities.

All dikes with a design water height of more than 12 feet above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas shall be classified as Class I.

Dikes are classified as Class II when located on sites where failure may cause damage to isolated homes, secondary highways, minor railroads, relatively important public utilities, high value land, or high value crops.

Dikes are classified as Class III when located on sites where damage likely to occur from failure will be minimal.

Dikes, classified as Class IV-A, are those constructed for wetland and wildlife areas where damage likely to occur from failure will be minimal and frequent overtopping of the dike is expected.

Dikes, classified as Class IV-B, are those constructed for wetland and wildlife areas where damage likely to occur from failure will be minimal and dikes are not expected to overtop.

Construced Elevation - The constructed elevation of a dike whose purpose is to prevent flooding shall be the sum of the following:
- The water elevation attained by a flood or high tide of the design frequency shown in Table 1 with the critical duration and timing. This is the design high water.

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the electronic Field Office Technical Guide.
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
356 – DIKE

For: Customer Name  Sikes and Parachini WRP 2011 Enhancement
Job Location  Approx. 3 miles south of Gridley Road on the Morgan Levee Road
County  Colusa  RCD  Colusa  Farm/Tract No. F3861, T9S65
Referral No.  Prepared By  Scott Turnquist  Date 06/28/2011

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No. “TITLE-1”, “PLAN-2” & “PLAN-3”

2. Practice Specifications  356 – Dike  903 – Earthfill  587 – Structure For Water Control

3. Special Requirements: Dike dimensions per “Typical Dike” detail in drawing “PLAN-3”

(12’ topwidth, 6:1 sideslope, typ.) See Construction specifications for subgrade & site preparation. Fill materials shall contain no sod, brush, roots, or other perishable or unsuitable material. Compaction shall be achieved by pneumatically tired (Method B) or track laying equipment (Method C) per the construction specification. Moisture content shall be maintained during compaction (earthfill should hold a ball shape when squeezed in the hand). See Practice Requirement for Structure for Water Control for additional information about setting water control structures in Dike.


NRCS, CA
October, 2003
I. SCOPE
The work shall consist of borrow excavation, hauling, placing and compacting earthfills required to construct the earthfills as shown on the drawings, or as staked in the field.

II. SUBGRADE PREPARATION
Subgrades for earthfill shall be stripped to remove vegetation and other unsuitable materials. The subgrade surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the subgrade shall be compacted and bonded with the first layer of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to ensure a good bond between the fill and the abutments. Subgrade and abutment surfaces shall not be steeper than 1 horizontal to 1 vertical.

The sites of the borrow area shall be stripped to sufficient depth to remove all vegetation, roots, brush, sod and other objectionable material. Clearing and disposal methods shall be in accordance with applicable state and county laws with due regards to the safety of persons and property.

III. EXCAVATION
Excaved Material
To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill. The suitability of materials for specific purposes will be determined by an Engineer.

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the locations shown on the drawings or at sites remote from the project.

Borrow Excavation
When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as shown on the drawings.

Borrow pits shall be excavated and finally dressed in manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions, and shall be free draining of any water ponding.

Bracing and Shoring
Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations.

Structure or Trench Excavation
Structure or trenched excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, as necessary, before any concrete or earthfill is placed or any piles are driven within the limits of the excavation.

IV. PLACEMENT
Material
All material shall be obtained from selected areas as shown on the drawings. Fill materials shall contain no sod, brush, roots, or other perishable or unsuitable material. Cobbles and rock fragments over 3 inches in diameter shall be removed from the material prior to compaction and be disposed of or placed in areas designated.

Fill shall not be placed until the required excavation and subgrade preparation has been completed. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

NRCS, CA
July 2005
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
for
587B - STRUCTURE FOR WATER CONTROL
FLASHBOARD RISERS & PLASTIC PIPE CULVERTS

For: Customer Name: Sikes and Parachini WRP 2011 Enhancement

Job Location: Approx. 3 miles south of Gridley Road on the Morgan Levee Road

County: Colusa RCD: Colusa Farm/Tract No.: E3861, T9565

Referral No.: Prepared By: Scott Turnquist Date: 06/28/2011

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.


3. Special Requirements: Weirs (concrete twin-track flashboard risers) shall be pre-manufactured items specifically designed for use in low-head water control scenarios. Conduit shall be corrugated (smooth interior) high density polyethylene (HDPE) pipe. Set structures to location and grade as indicated in the drawings.

4. Special Maintenance Requirements: Refer to attached “Operation & Maintenance” Document

NRCS, CA
December 2004
For: Customer Name: Sikes and Parmehill WRP 2011 Enhancement

Job Location: Approx. 3 miles south of Gridley Road on the Morgan Levee Road

County: Colusa RCD: Colusa Farm/Tract No.: E3861, T9565

Referral No.: Prepared By: Scott Turnquist Date: 06/28/2011

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No. “TITLE-1”, “PLAN-2” & “PLAN-3”


3. Special Requirements: All work shall be done in accordance with the construction drawings and NRCS specs.

   1.) Earthwork shall be constructed in accordance with the 356 Dike & 903 Earthfill specifications.

   2.) Water Control Structures shall be installed in accordance with the specification for 587 – Structure for W.C.


NRCS, CA
October, 2003
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

PRACTICE REQUIREMENTS
FOR
327 - CONSERVATION COVER

For: Customer Name, Sikes and Parachini WRP 2011 Enhancement Seeding

Job Location, Approx. 3 miles south of Gridley Road on the Morgan Levee Road

County, Colusa RCD, Colusa Farm/Tract No., F3861, T9565

Referral No., Prepared By, T. Hermansen Date, 06/28/2011

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No. 1, Practice Specifications 327

2. Seedbed Preparation, Ensure clean, weed free seedbed prior to planting.

3. Seed, Blue wildrye rate 1.2 lbs/ac of PLS

Seed, Creeping wildrye rate 1.9 lbs/ac of PLS

Seed, Meadow barley rate 0.5 lbs/ac of PLS

Seed, Purple needlegrass rate 1.9 lbs/ac of PLS

Seed, Gumplant rate 0.5 lbs/ac of PLS

Seed, Tomcat clover rate 0.3 lbs/ac of PLS

4. Fertilizer, none rate

5. Method of Seeding, no-till drill

Depth of Seeding, 1/4 to 1/2 inches

6. Planting shall be performed within the period, October 1 to November 30, 2011

7. Last mowing before seed set, May 31, Minimum mowing height, 6 inches

8. The desirable resident species are:

9. Special Requirements, with NRCS prescription management practices may include mowing, burning, spraying, and disking. After initial planting disking shall occur only between April 1 and October 1. A copy of the seed tags must be provided with invoices for certification purposes.

NRCS, CA
July, 2000