# Yakama Nation's Wetlands and Riparian Restoration Project

**Project Number 1992-06200**

## Fiscal Year 2008 Annual Report Part 2

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**Monitoring of Yakama Nation Riparian Restoration Sites**
**Final Report Summary**

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## Introduction

Monitoring the successes and failures of riparian restoration techniques is rarely conducted even though millions of dollars are spent annually on these activities (Bernhardt et al. 2005). The overall goal of this project is to provide the Yakama Nation with the tools necessary to better make these management decisions. Crucial to the development of effective riparian and wetland restoration projects is an inventory and assessment of critical physical processes, biological features, and land use alterations. However, conservation planners are often overwhelmed by the sheer mass of information available, confounded by the inconsistent formats and spatial scales of the data, and uncertain of the appropriate analytical approaches to employ.

This year's project addressed four related objectives, including:

1) monitoring of short-term ecological changes in a reconnected side channel of the Wapato Floodplain, Yakima River Basin;

2) baseline characterization of the plant communities found at the Old Goldendale Riparian Restoration Project using a combination of remotely sensed imagery and field assessment;

3) update of a digital map portfolio of potential riparian restoration sites along the Satus Creek, Toppenish Creek, and Yakima River annexation corridors; and

4) preliminary development and implementation of a monitoring plan for the Lower Satus Creek Riparian Restoration Project.

## Objective 1: Monitoring Short-term Ecological Changes in a Reconnected Side Channel of the Wapato Floodplain, Yakima River Basin

We have previously described a hierarchical monitoring protocol that can be used to prioritize management decisions (Snyder et al. 2004). Faculty and graduate students from the Department of Geography and Land Studies at Central Washington University (CWU), and Grand Valley State University (GVSU) collaborated on executing this longterm monitoring protocol for a three year period on the Wapato reach on the Yakima River floodplain. A specific location within the Wapato Reach was identified for initial application of the monitoring protocol outlined in the first project report (Snyder et al. 2004). This site, the Meninick Wildlife Area, was recently acquired by the Yakama Nation and exhibits many of the properties considered to be ideal from the standpoint of the shifting habitat mosaic. There are numerous side channel complexes and spring brooks, as well as an abundance of large woody debris in the main river. Riparian and floodplain vegetation occur as multiple aged stands. The site also contains a substantial but short levee that has effectively disconnected a side channel complex.

Our goal was to monitor conditions in a 'reference' side channel vs. the disconnected side channel, prior to a planned levee breach designed to reconnect the channel with the main stem of the Yakima River. Our study design included multiple sample locations in four main areas; (i) the disconnected side channel (DSC), (ii) a connected spring brook upstream of the levee (CSB), (iii) a disconnected pond (DP), and (iv) the main stem (Fig. 1). At present, 3 years of base-line, pre-restoration data have been collected at the initial set of study sites on the Yakima River floodplain. This data set is essential to establishing the natural range of variability prior to additional floodplain reconnection work scheduled to occur in the near future. In addition, two years of data have been collected at a reconnected side channel site in the Satus Creek Wildlife Area, but for which no pre-restoration data were collected. As such, our experimental monitoring plan is as robust as possible, taking the form of a before-after, control-impacted, or BACI design (Underwood 1994) for the first site described above. Having been restored longer, the second study site provides some temporal context for patterns expected as restoration continues (separation in time vs. space).

The final report of pre-levee breach, baseline monitoring efforts provides a full analysis of the baseline differences in ecological parameters between the various study sites, including an identification of the parameters most salient for restoration monitoring and a prediction of expected changes in the disconnected channel once the levee breach was initiated (Gabriel and Snyder 2006). The summary statistics and associated statistical analysis of water quality parameters indicates a truly complex environmental heterogeneity of aquatic habitats within the Wapato reach of the Yakima River floodplain. Most water quality parameters differ significantly between study sites (with the notable exception of temperature), though not always consistently by season. These between-site differences are primarily driven by varying degrees of connectivity to the main channel; with the exception of conductivity, the reconnected channel sites tends to show the greatest similarity to the main channel, while the disconnected channel sites show the least. While significant differences in summer temperatures, percent saturation of DO, and pH were found along an expected environmental gradient at the connected springbrook site, most within-site differences were found associated with temperature, conductivity and DO measurements associated with a single sample location at the disconnected channel site. The resulting set of baseline data also provides the basis to statistically assess significant changes in fluvial geomorphologic features and measurements of environmental and biological attributes within and between different areas of the Wapato reach after the proposed restorative action.

With the levee fully breached in August 2007, we predicted the currently disconnected side channel would shift to a condition more similar to the main channel, though did not know how rapidly this transition would occur.  This year, we proposed to assess the short-term ecological impacts of this reconnection by collecting a set of post-restoration data to compare to the three years of baseline, pre-project data that we have collected. The first set of data necessary for this comparison was collected monthly between April and November 2008, including monitoring of physical (temperature) and chemical (pH, dissolved oxygen, and conductivity) parameters at representative reconnected channel (DSC 1-3), connected springbrook (CSB-1), reconnected pond (DP), and main channel (MC) sample sites, using several of the sites as well as the methods and protocol we used in the previous two years.  Specific methodological procedures are outlined in previous annual reports (e.g. Snyder et al. 2004).

We had also intended on collecting data on biological parameters to compare to the baseline data (i.e. algal pigment concentration and macroinvertebrate abundance). However, our field observations discovered the actual reconnection was only briefly evident for part of the spring and early summer, with water flowing through the breach for only two months of the field season.  While it is unclear whether this shorter than expected period of flow was due to design limitations or  considerable beaver activity further up the reconnected side channel, the likely changes to environmental conditions in the reconnected channel were likely also limited and short-lived, especially in terms of the biological parameters.  While we continued monitoring physical and chemical parameters throughout the field season in the hope that flows through the breach would return, we did not unnecessarily collect or analyze biological data as originally planned, given that the background environmental conditions, as evidenced by field observations and the water quality measurements, which were largely the same as those we collected prior to the reconnection.

Comparative graphs and tables of descriptive statistics have been completed for all the sites and parameters assessed, including annual and seasonal statistical summaries of water quality parameters sampled monthly at each sample location, as well as graphs comparing within-site and between-site differences (see Figs. 2-3 for examples). However, an initial analysis of the baseline differences in ecological parameters between the various sites types, including an analysis of the short-term ecological changes in the formerly disconnected channel and pond after reconnection, will be postponed until flows through the breach are increased.    At that time, and with another season of data collection, Kruskal-Wallis and Mann-Whitney U tests can be used to identify significant annual and seasonal differences in measured water quality parameters.  These tests will be used to identify significant differences between: 1) comparable sample locations at each study site; 2) sample locations within a study site; and 3) disconnected sample sites before and after the levee breach.

<u>Note</u>: due to the unanticipated reduction in sampling and analysis required for this objective, additional work, approved by Yakama Nation Wildlife staff, was conducted for the next objective focusing on a pilot project on how to effectively use remotely sensed

imagery to characterize and measure changes of vegetation communities in riparian restoration projects.

**Objective 2: Ecological Characterization of the Old Goldendale Riparian Restoration Project.**

The goal of this portion of the study was to use remotely sensed imagery to characterize the emergent vegetation on the Yakama Nation Wetlands and Riparian Restoration Project's Old Goldendale restoration site, thereby developing baseline information to monitor the changes in vegetation that are expected to occur due to a hydrologic reconnection to Toppenish Creek completed in August 2008. Remote sensing technologies have many applications in wetland vegetation analysis (e.g. Cowardin and Meyers, 1974; Hodgson et al., 1987; Jensen et al., 1991; Mead and Gammon, 1981; Ossinger, et al., 1993; Scarpace et al., 1981; Stewart et al., 1980; Welch, et al., 1995). With remotely sensed data such as aerial photographs as input of a geographic information system (GIS), the vegetation and habitat can be located and characterized as to type (Hu et al, 2000). A GIS vegetation database derived through the interpretation of large scale aerial photographs to date can provide current inventory of vegetation on the ground.

Based on previously developed methods (Hu et al. 2000), this study addressed the following objectives:
1) identify plant communities and habitats, including their location, general attributes and their spatial relationships to each other;
2) develop digital vegetation databases showing the spatial distribution of the plant communities as well as their characteristics; and
3) conduct Geographic Information System (GIS) spatial analysis for assessing habitat characteristics.

The timely development of an accurate, detailed vegetation GIS database requires the use of remotely sensed data of sufficient resolution to identify and delineate vegetation classes to an accuracy of approximately 90 percent or better on 10 m by 10 m plots. The primary sources for the development of GIS vegetation database were the low-altitude digital orthorectified 2006 National Agriculture Imagery Program aerial photographs provided by Yakama Nation Wildlife. The use of these low-altitude color aerial photographs of 1 m resolution was considered essential for this project. Vegetation classes were delineated manually on screen using ArcMap GIS software, creating polygons where boundaries between vegetation patches, potentially representing different plant communities, which were determined based on differences in color.

The study encompassed both the shrub-steppe and emergent wetland vegetative communities covering approximately 773,000 square meters at Old Goldendale restoration site, which is located in the Toppenish Creek riparian corridor. Approximately 28% of the site is classified as periodically to semi-permanently flooded emergent or forested wetland by the National Wetland Inventory (Gabriel 2007).

A systematic field vegetation survey was subsequently conducted in late July to identify and quantify the spatial extent of the types and kinds of emergent vegetation found at the Old Goldendale restoration site. This was done by field surveying and ground truthing 385 individual polygons identified through the initial aerial photo interpretation, including the identification of dominant plant communities and associated plant species. The field survey was conducted using a GeoXM GPS unit displaying the delineated vegetation polygons and 2006 aerial photography, thereby expediting data collection and verification in the field by allowing field researchers to know exactly which vegetation polygon they were field checking. The GeoXM GPS unit also allowed the use of ArcPad software to annotate vegetation polygons in the field, assigning attribute information (i.e., proportions of dominant plant communities and associate plant species) for each vegetation polygon.

A digital GIS vegetation database of field data and associated maps was developed using ArcMap GIS software (see Table 2 and Figs. 4-6). In addition, upon completion of the vegetation survey, descriptions of dominant plant communities were written to highlight their major characteristics, including species associations between dominant plant species (Table 2). These descriptions were combined with 225 representative digital ground photographs of each plant community type included in the GIS database. Several options for viewing hyperlinked photos are available depending on the platform one is viewing the data in. If the data is being viewed in ArcGIS 9.3, a new HTML popup dialog provides an elegant solution not requiring a browser. With this feature, both data and photos are viewable in a window with a 'spatial' callout to the hyperlinked feature. Both the photomonitoring points and the field-truthed vegetation polygon layers are set up for using the HTML popup dialog (Fig. 7). If the data is being viewed in ArcReader, the traditional hyperlink tool enables the user to view basic data and photos through pre-rendered HTML pages (Fig. 8). The methodology and data set created by this study provide the basis and baseline to monitor the changes in emergent wetland vegetation likely to occur as a result of hydrologic reconnection at the Old Goldendale riparian restoration site.

Additional research was conducted as part of this objective to identify species and conduct a comparison of results from in situ data and vegetation classifications derived from Landsat imagery. These datasets were used in a pilot study to test results from two different image-processing algorithms as way to determine the most accurate method of acquiring spectral signatures of wetland and riparian species. Using vegetation polygons derived from fieldwork performed during the summer of 2008 at the Old Goldendale restoration site, as well as additional vegetation mapping data from previous fieldwork conducted by the Geo-Ecology Research Group at the Wanity, North Meninick and Lower Satus restoration sites (Fig. 9), a spectral signature file was created for supervised classification of LandSat imagery.

The first step in this process involved the acquisition of the LandSat image for July 2008, coinciding with the collection of field data for the Old Goldendale site. Archival LandSat imagery has recently been made freely available by the USGS and can be ordered using the EarthExplorer website (http://edcsns17.cr.usgs.gov/EarthExplorer/). A Landsat 5 image was chosen for the study due to the presence of scan lines in the potentially higher-resolution LandSat 7 platform. Once the imagery was obtained, the individual bands 1,2,3,4,5 and 7 were clipped using FME and stacked using ArcGIS (Fig. 10). The ERDAS IMG format was chosen for its ability to contain more than three bands for selective viewing in ArcGIS and ERDAS. The image file was brought into ERDAS and rescaled from 1 to 255 in order to remove zero values that may be construed as "no data" in later processes.

In order to test the value of the normalized difference vegetation index (NDVI) algorithm in improving the remote sensing process, the NDVI process was performed and "stacked" in a copy of the original image stack (Fig. 11). This allowed for a comparison of analyses with and without the use of NDVI.

In addition, two methods were used in the classification of the NDVI and non-NDVI Landsat 5 image stacks. In the first method, the approximately 12 unique vegetation communities identified in the Old Goldendale vegetation survey were used to "reclassify" the digitized polygons. In order to "train" the classification and create the signature file, the vegetation polygons were brought into ERDAS and converted to areas of interest (AOI). At this step it was realized that the finer resolution of the Old Goldendale vegetation analysis would be greatly lost in the much coarser resolution (30 meter) LandSat imagery, and so only larger, reclassified polygons were used as AOIs (Fig. 12). Using the same AOI polygons to train both the NDVI accented stack and the basic stacked image, a unique signature file was created for both (Fig. 13). Eight areas of additional land cover were included in the signature files (three areas of agriculture and five areas of unknown land cover) in order to provide a more accurate classification.

Upon examining the results of this classification, a number of errors became apparent (Fig. 14) and so another method was developed and used for comparison. Instead of using the polygons to create verbatim AOIs in ERDAS, the polygons were instead used to guide the generation of AOIs using the region growing tool and adjusting the spectral Euclidean distance to a level that would generate a polygon within the existing polygons (Fig. 15-17). Additionally, multiple AOIs of similar vegetation were created throughout the study area, though this could only be done in areas of sagebrush, agriculture, open water and other areas where the vegetation or lack thereof, was easily identifiable in aerial photos or the LandSat image itself. With the presence of multiple classes for unique vegetation types, it was necessary to reclassify the images once the supervised classification was complete. This was performed in ArcGIS by editing the attribute table and performing a lookup-based reclassification. It was then necessary to delete the raster value attribute table (VAT), clip the image to the study area, re-calculate raster statistics and join the lookup table with corresponding values and text classes to the clipped image (Table 3).

Differences in the results of the NDVI and non-NDVI analyses for the entire Yakama Nation Wetlands and Riparian Restoration Project annexation corridors are summarized in Table 4 and Figures 18-20. The non-NDVI image indicated a higher frequency of bur-reed, greasewood alliance, agriculture and saltgrass cells whereas the likely more accurate NDVI image indicated a higher frequency of cottonwood gallery, bulrush, phalaris and kochia/knapweed. The preliminary methods developed by this pilot study will be further expanded and applied to additional restoration sites this coming year, including the use of higher resolution, remotely sensed ASTER data.

**Objective 3: Update of Yakama Nation Restoration Corridor Digital Atlas**

The Geo-Ecology Research Group (GRG) at Central Washington University has produced a digital map portfolio that provides an ecological characterization/inventory of existing and potential restoration sites along the Toppenish, Satus Creek and Yakima River annexation corridors (Fig. 7)(Gabriel et al. 2008). This digital map portfolio includes maps and aerial photographs divided into various sections along these corridors, and also incorporates General Land Office (GLO) historic maps into a GIS.

The information gathered for the Yakama Nation Restoration Corridor Atlas was principally mapped using a hybrid of the Sensitive Shoreline Assessment (SSA) methodology (Gabriel et al. 2001; Hu et al. 2003), which was developed to designate lake shorelines in Wisconsin. SSA combines use of rapid assessment criteria and the ABC method, a spatial overlay technique which incorporates **Abiotic** (e.g. hydrology/geomorphology), **Biotic** (e.g. flora and fauna), and **Constructed landscape** information (e.g. land uses) to identify areas of environmental significance (essential to maintaining ecological processes) as well as environmental constraints (biophysical stresses, risks and sensitivity) (Bastedo et al. 1984). The resulting inventory of existing and potential restoration sites included consideration of the following:

1) land use patterns, including existing structures, transportation and utility facilities, impervious surfaces, and vegetation/shoreline modifications;
2) critical areas, including wetlands, aquifer recharge areas, fish and wildlife conservation areas, geologically hazardous areas, frequently flooded areas;
3) degraded and potential restoration sites (i.e. functional-at risk and nonfunctional sites)
4) areas of special interest, including priority habitats and hazardous waste sites;
5) public access sites; and
6) significant archaeologic, historic, or cultural resources.

To provide final synthesis maps at appropriate viewing scales, we used an electronic map portfolio accessed through ESRI ArcReader, a free, easy-to-use mapping application that allows users to view, explore, and print maps. Over the last 20 years, there has been increasing interest in utilizing multimedia in the form of text, photographs, digital video, sound in a geographic information system (Openshaw and Mounsey, 1987; Rhind et al., 1988; Lewis and Rhind, 1991; Shiffer and Wiggins, 1993; Hughes, 1996; Hu, 1999). Multiple data sources such as maps, aerial photographs, ground photographs, text, digital video and sound can be incorporated in a GIS to help planners and managers better understand the physical environment of the study area and the spatial problems of interest

(Hu, 1999; Hu et al. 2003). ArcReader © is a great way to deliver interactive mapping capabilities that access a wide variety of dynamic geographic information. Using ArcReader ©, anyone can view high-quality maps created using the ArcGIS© software (ESRI 2005).

A customized aerial photo viewer (***SyncMap***) was also developed within ArcReader to view historical and current photography in a geo-synchronized manner, including scale bars, coordinates, and zoom and pan functions. SyncMap enables the user to easily navigate and compare aerial photography from four different years, most commonly for the years 1947, 1949, 1992, 1996, 2002, and 2005. Navigational changes in one map panel are reflected in all the panels creating a dynamic interface. Each map panel includes all available years of photography allowing one to 'customize' the order, position and years visible in the map frame.

In this phase, GRG added 2006 National Agriculture Imagery Program aerial photo coverage provided by Yakama Nation Wildlife to the digital atlas, as well as General Land Office (GLO) historic maps for the remaining restoration sites, with names corresponding to township and range boundaries. In addition, topographic map coverage was switched from Digital Raster Graphics (DRGs) to National Geographic TOPO! to These topographic map layers were also brightened for legibility, and added to a raster catalog for better storage, labeling and display. Much of the raster data displays were also changed from "stretched" to none, resulting in a flatter by more continuous onscreen display across the entire catalog/mosaic. Some data was also reorganized or reclassified, including: 1) the creation of annotation feature classes for restoration sites; 2) grouping SSURGO derived soil information into group layers; 3) moving boundary information above basedata; and 4) changing labels of raster imagery in ArcMap mxd projects. In addition, the atlas was made compatible with ArcGis 9.3. Finally, raster data was resampled and compressed into MrSID format, saving roughly 30 GB of storage space and allowing the entire atlas to be saved to two DVD disks (or a small single flashdrive).

The updated and streamlined digital map portfolio will continue to assist the Yakama Nation Wildlife Resource Management Program with ongoing monitoring and reporting of their extensive riparian restoration efforts, as well as prioritizing future restoration efforts and land purchases along the Yakima River and surrounding floodplain reaches on Toppenish and Satus Creeks. As living documents, these critical resources will also be readily updated as new information and aerial photos continue to become available, making them a valuable monitoring tool.

**Objective 4: Monitoring Plan for the Lower Satus Creek Riparian Restoration Project.**

The goal of this portion of the study was to develop and begin implementing a monitoring plan that will characterize the ecological changes resulting from re-establishing hydrologic connections on the Yakama Nation Wetlands and Riparian Restoration Project's Lower Satus restoration site. In this phase of the study, a GRG summer research assistant worked with Yakama Nation Wildlife staff to implement a vegetation sampling protocol to collect a baseline of riparian woody vegetation in order to assess the changes in riparian woody vegetation that are likely to occur as the result of a hydrologic reconnection to be completed by the end of Summer 2009. The vegetation sampling transect locations will be tied together with information on soil and hydrologic characteristics, the latter which is being measured by a series of monitoring wells established by Yakama Nation Wildlife staff in consultation with GRG.

After the planned reconnection was delayed until Summer 2009, and based on field reconnaissance, aerial photography, and relevant GIS layers, sites to implement the water quality monitoring protocol developed by previous studies will also be established in consultation with Yakama Nation Wildlife staff, tied to the location of vegetation sampling transects, monitoring wells, reconnected channels, and the engineering structures such as check dams that will be implemented as part of the hydrologic reconnection.

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**Appendix**


Figure 1. Study sites on the Meninick Wildlife Area. CSB = connected spring brook, DSC = disconnected side channel, DP = disconnected pond.

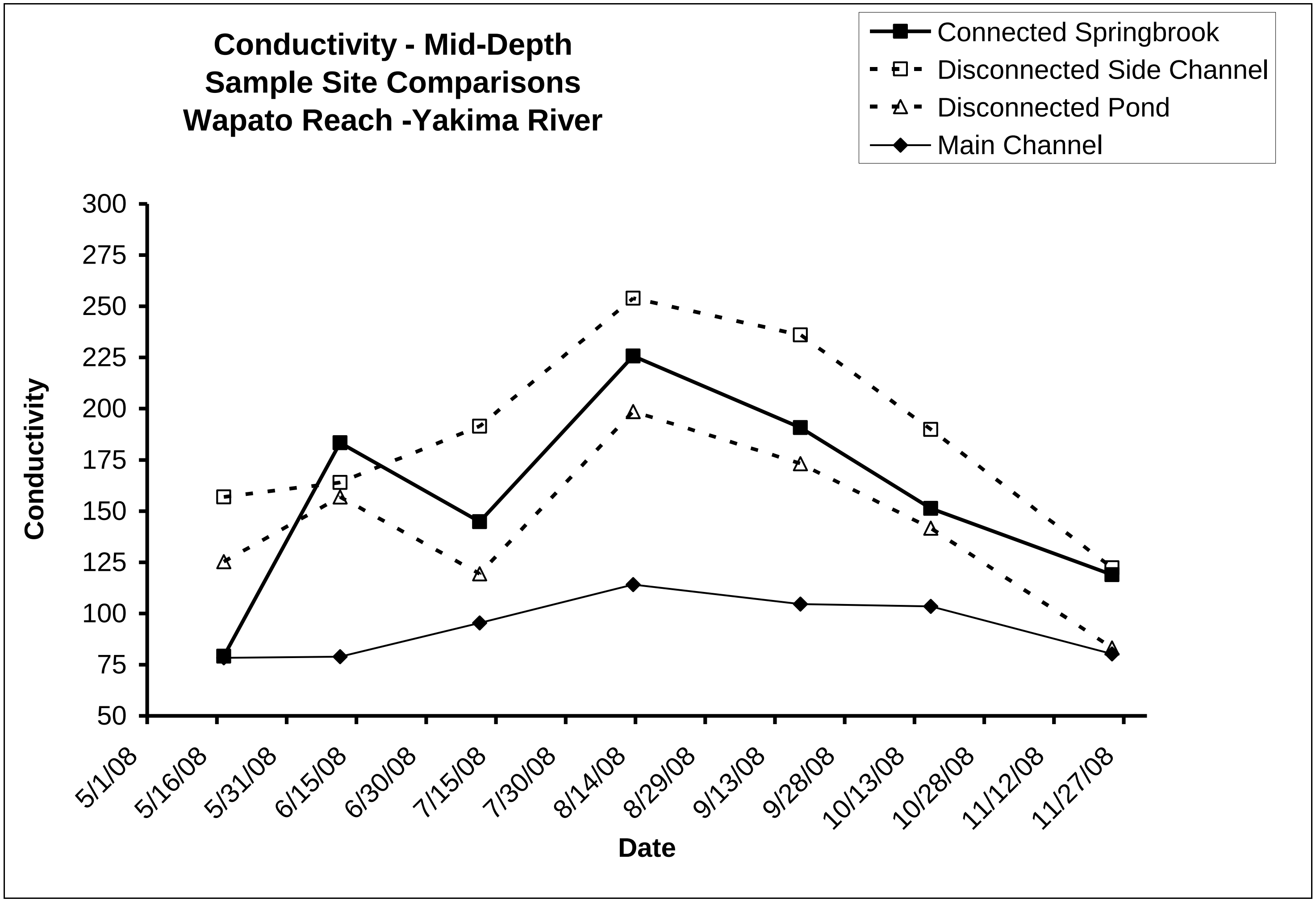



Fig 2. Conductivity measurements from representative Wapato Reach study sites (2008).

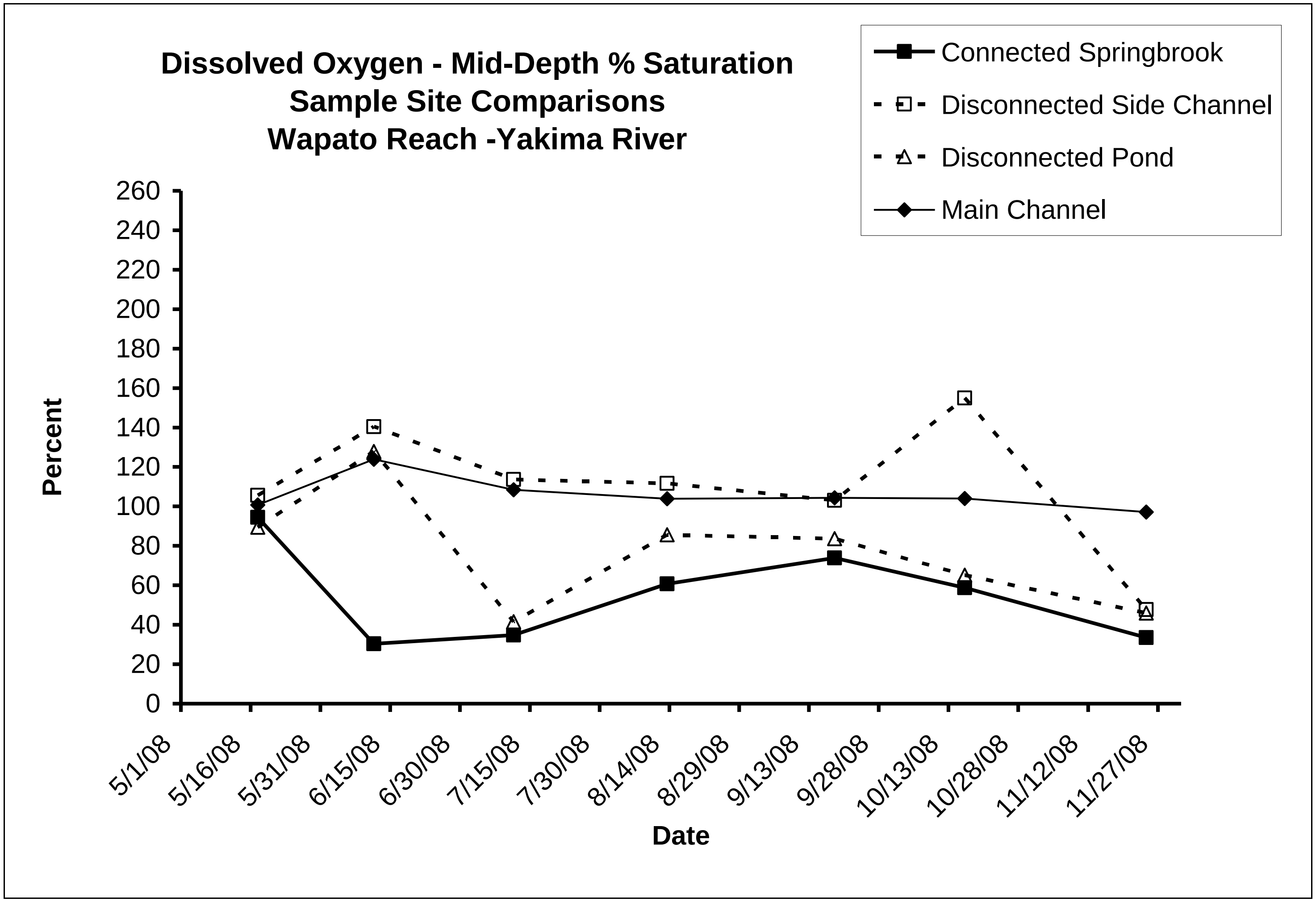



Fig. 3. Dissolved oxygen measurements from representative Wapato Reach study sites (2008).

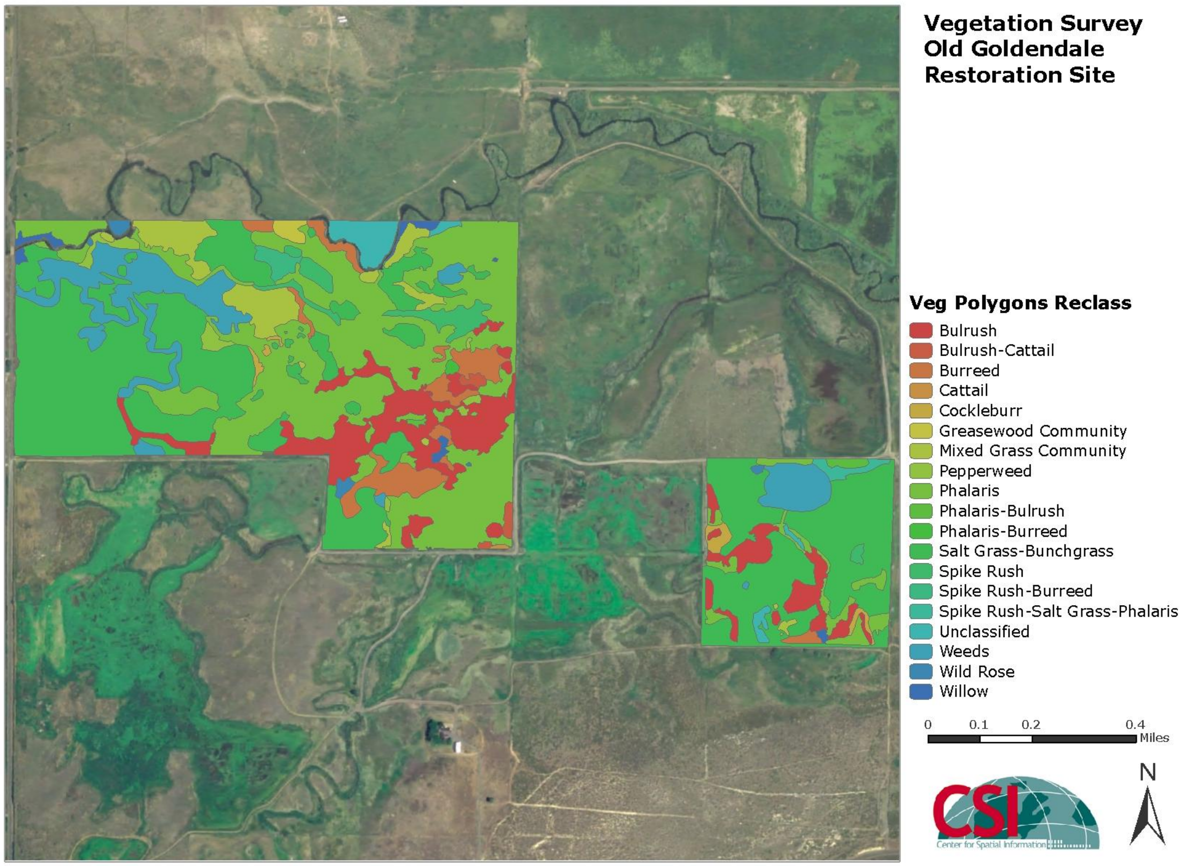



Fig. 4. Distribution of Old Goldendale restoration site vegetation communities, Summer 2008.

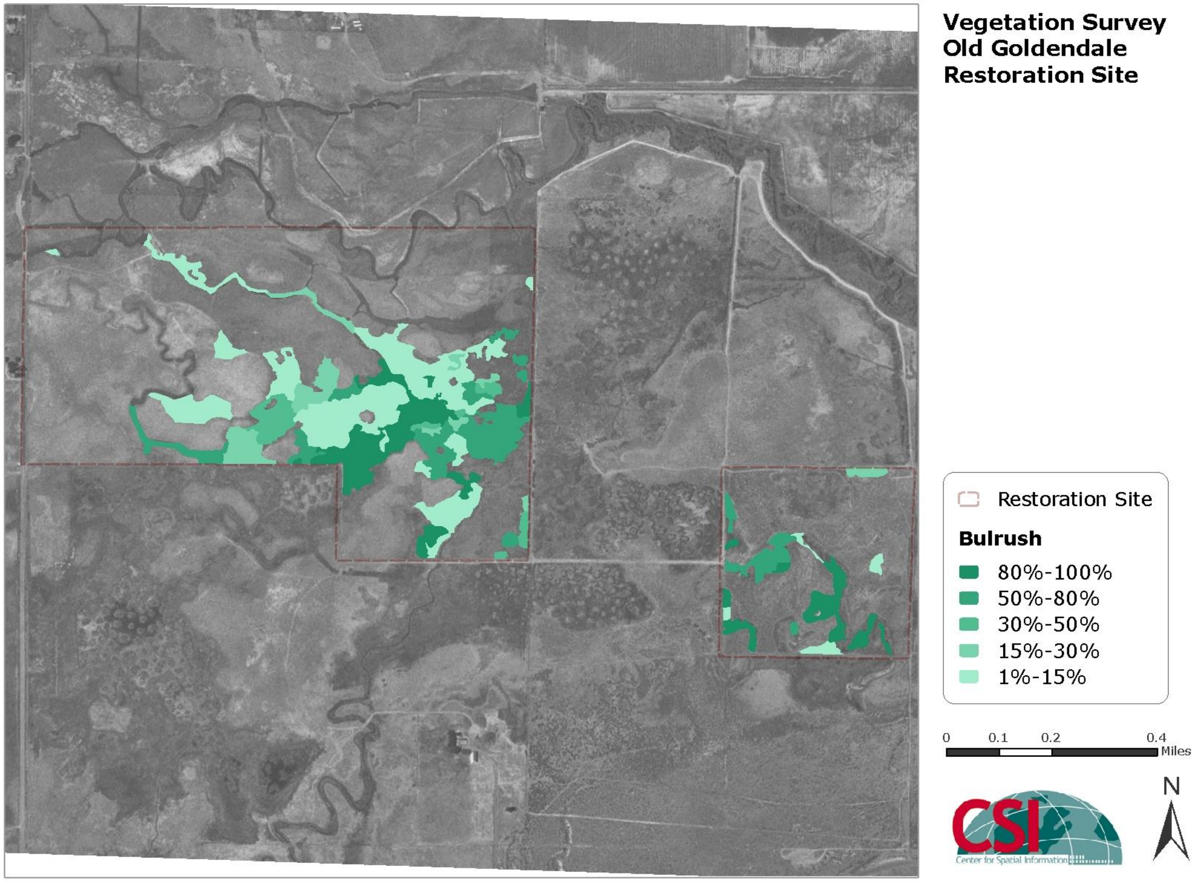



Fig. 5.  Distribution of Old Goldendale restoration site bulrush communities, Summer 2008.

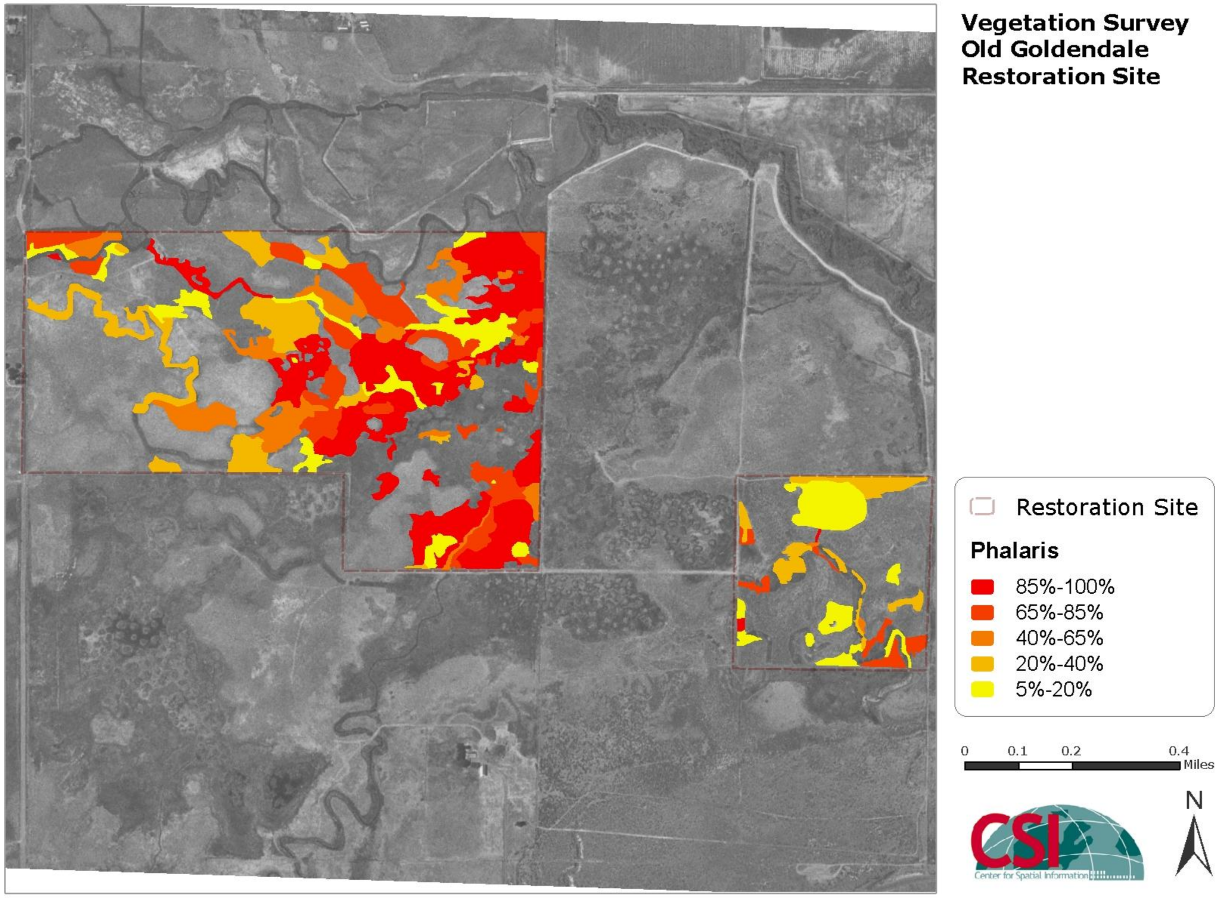



Fig. 6. Distribution of Old Goldendale restoration site reed canary grass communities, Summer 2008.

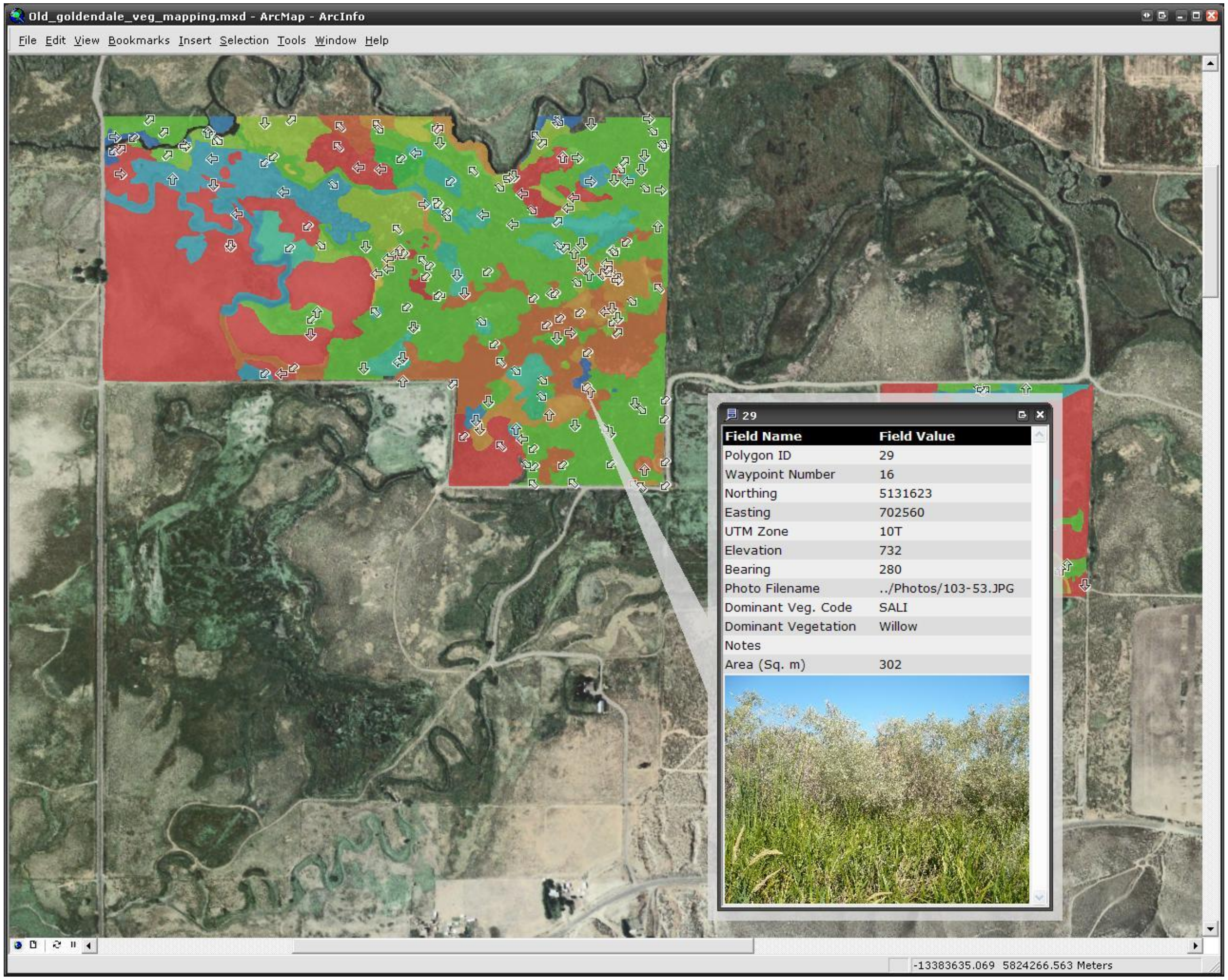



Fig. 7. Example of HTML popup window when viewing photomonitoring points in ArcGis 9.3.

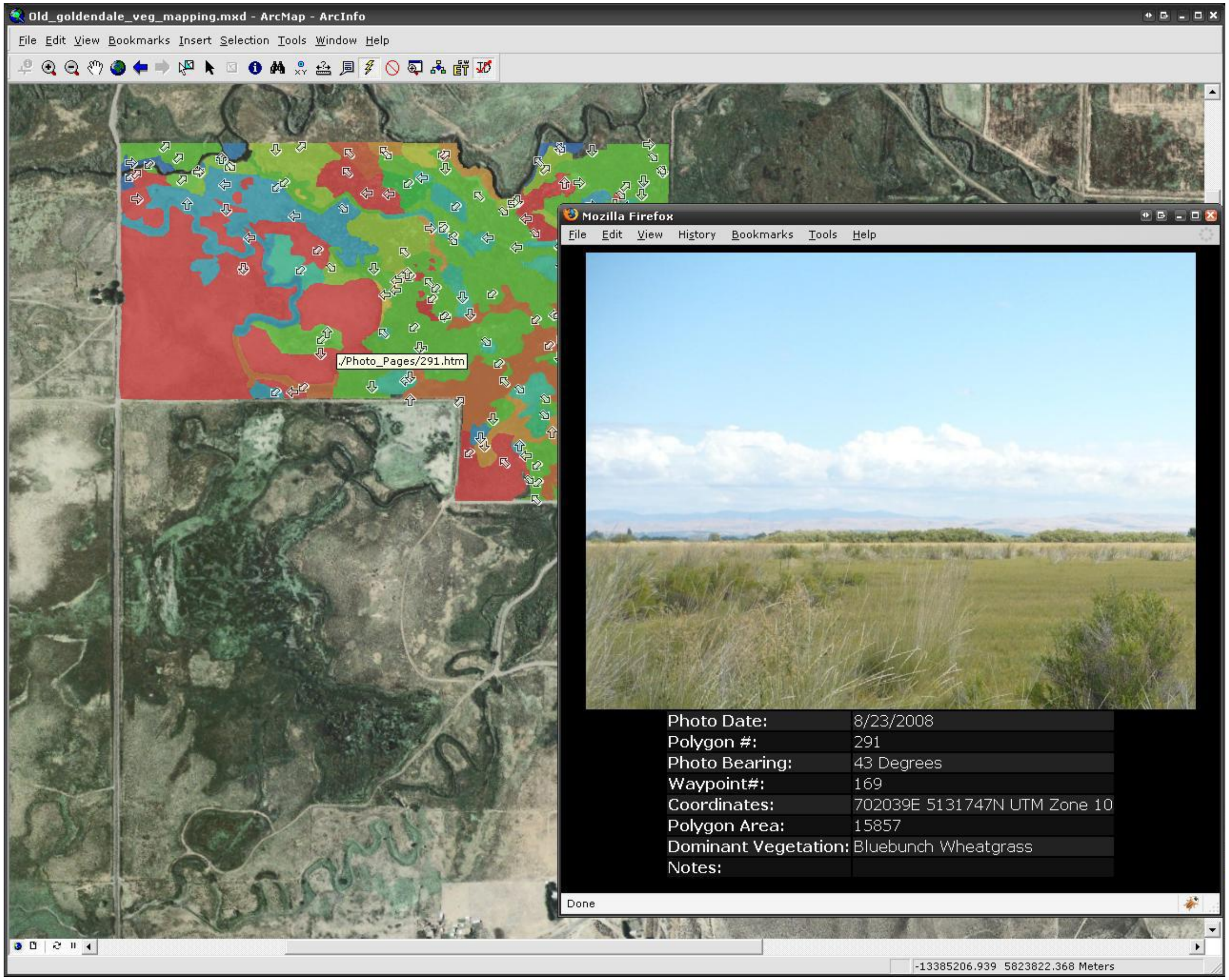



Fig. 7. Example of HTML popup window when viewing photomonitoring points produced with hyperlink tool in ArcReader.

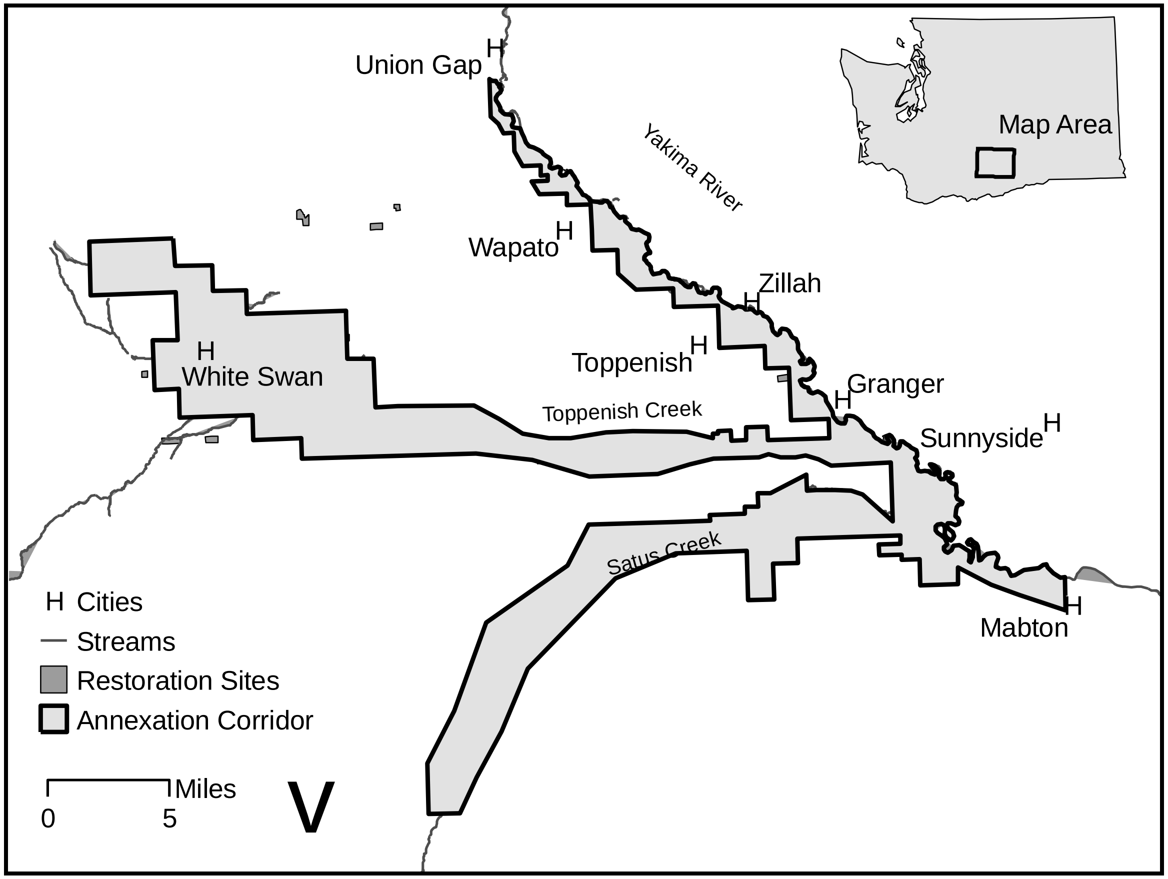



Fig. 9. Existing and potential riparian restoration sites for the Yakama Nation Wetlands and Riparian Restoration Project.

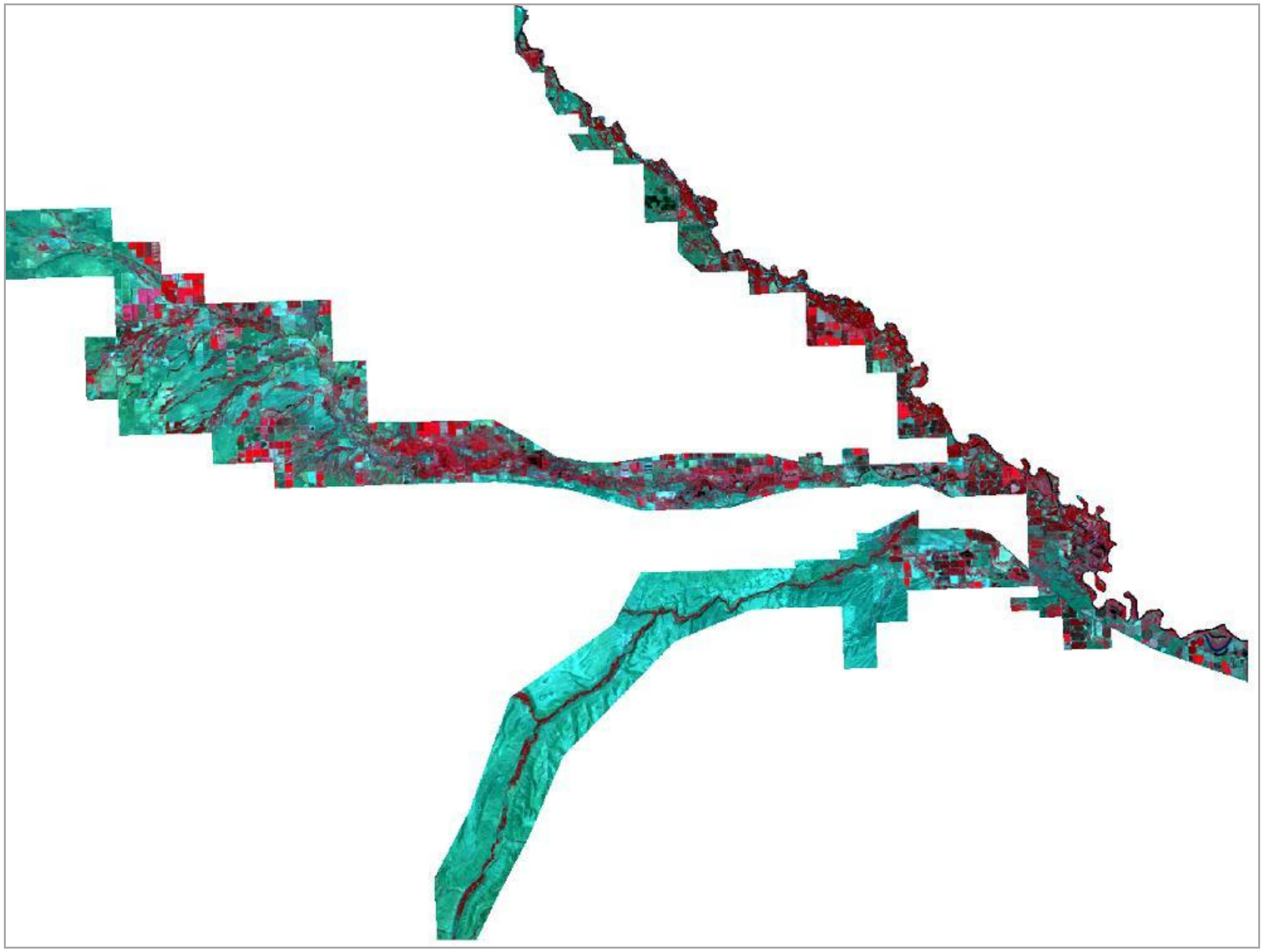


Fig. 10. Landsat image of Yakama Nation Wetlands and Riparian Restoration Project annexation corridor with bands 4 (infrared), 3, and 2 visible.

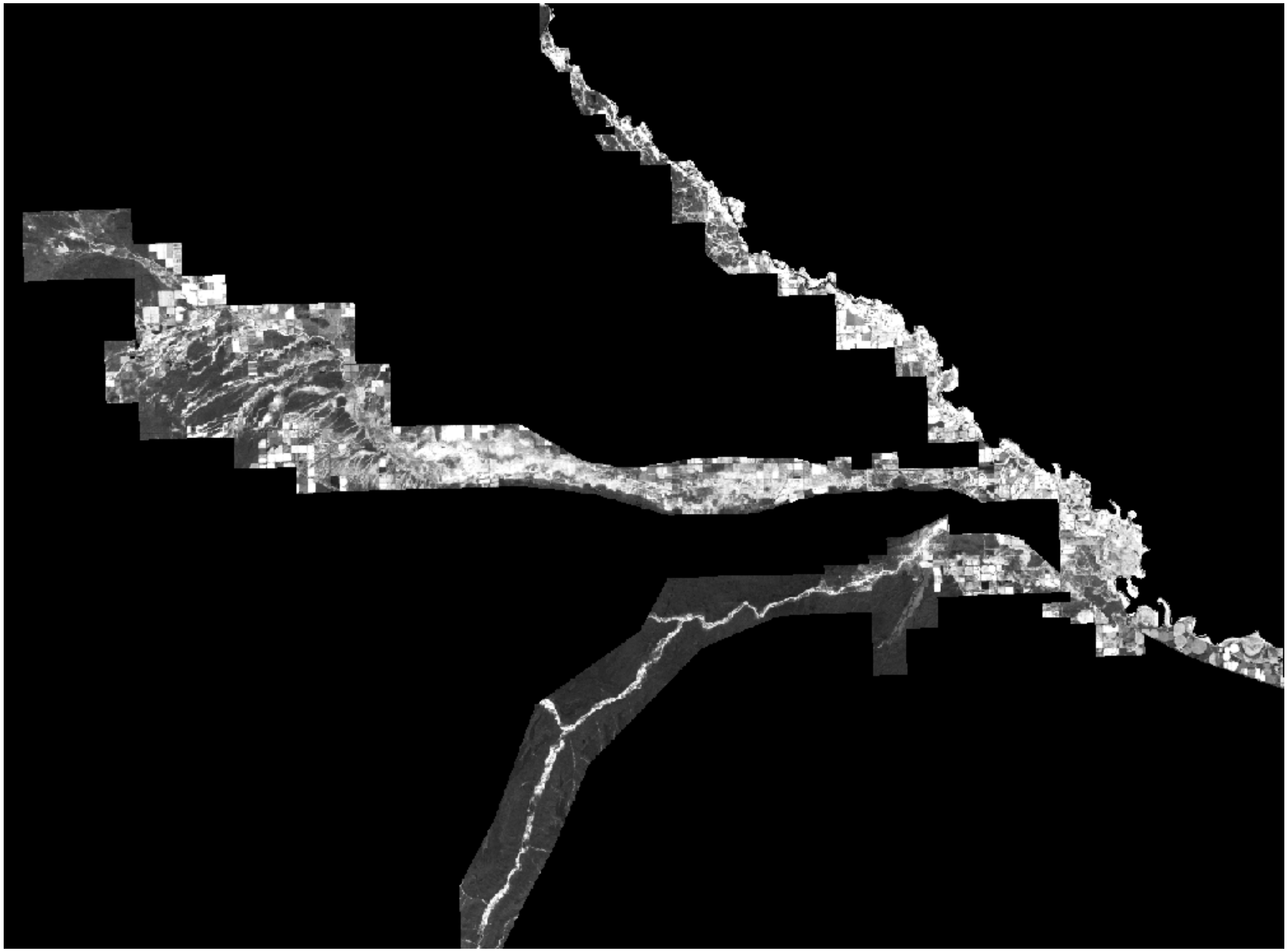


Fig. 11. Study area after normalized difference vegetation index (NDVI) reclassification; white areas represent higher vegetation frequencies.

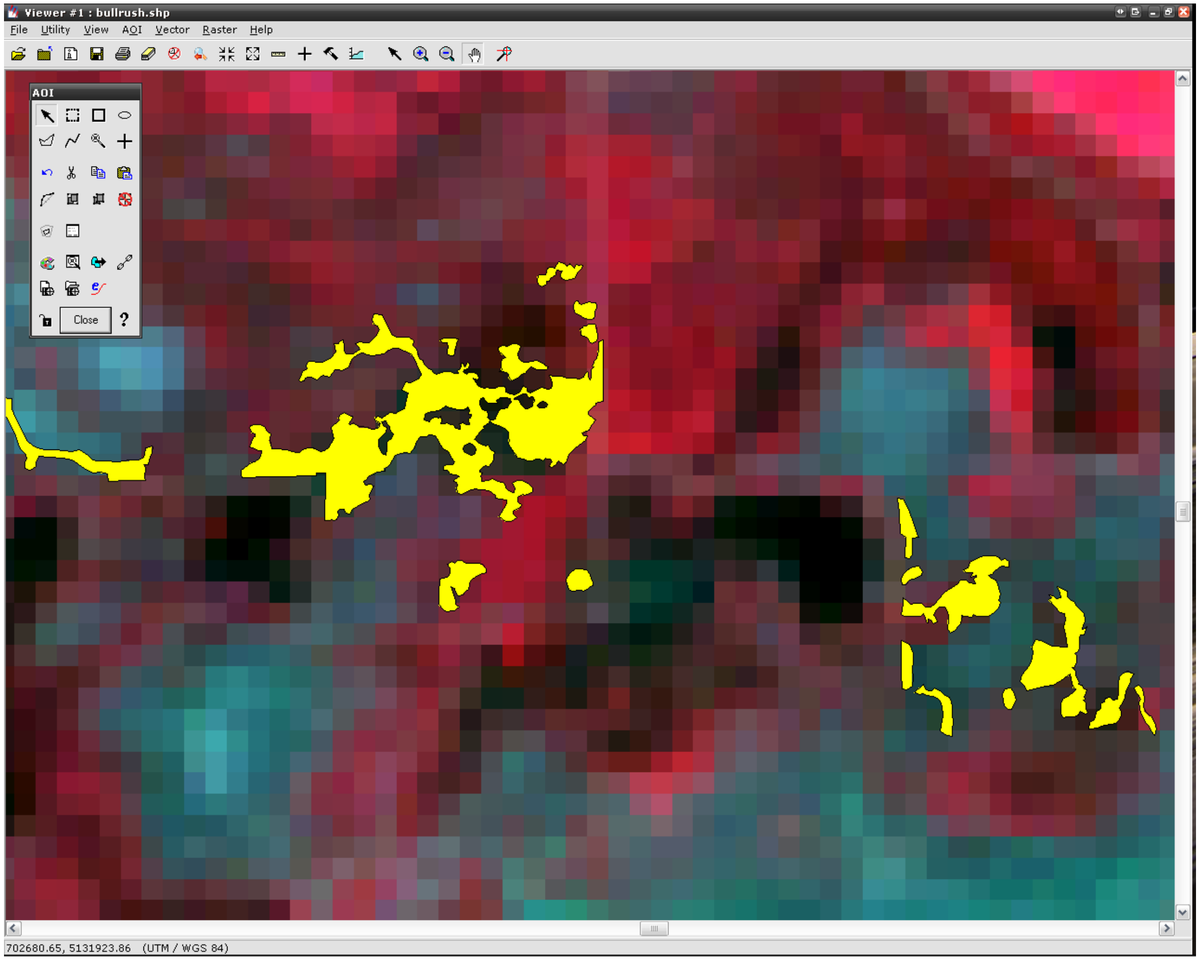
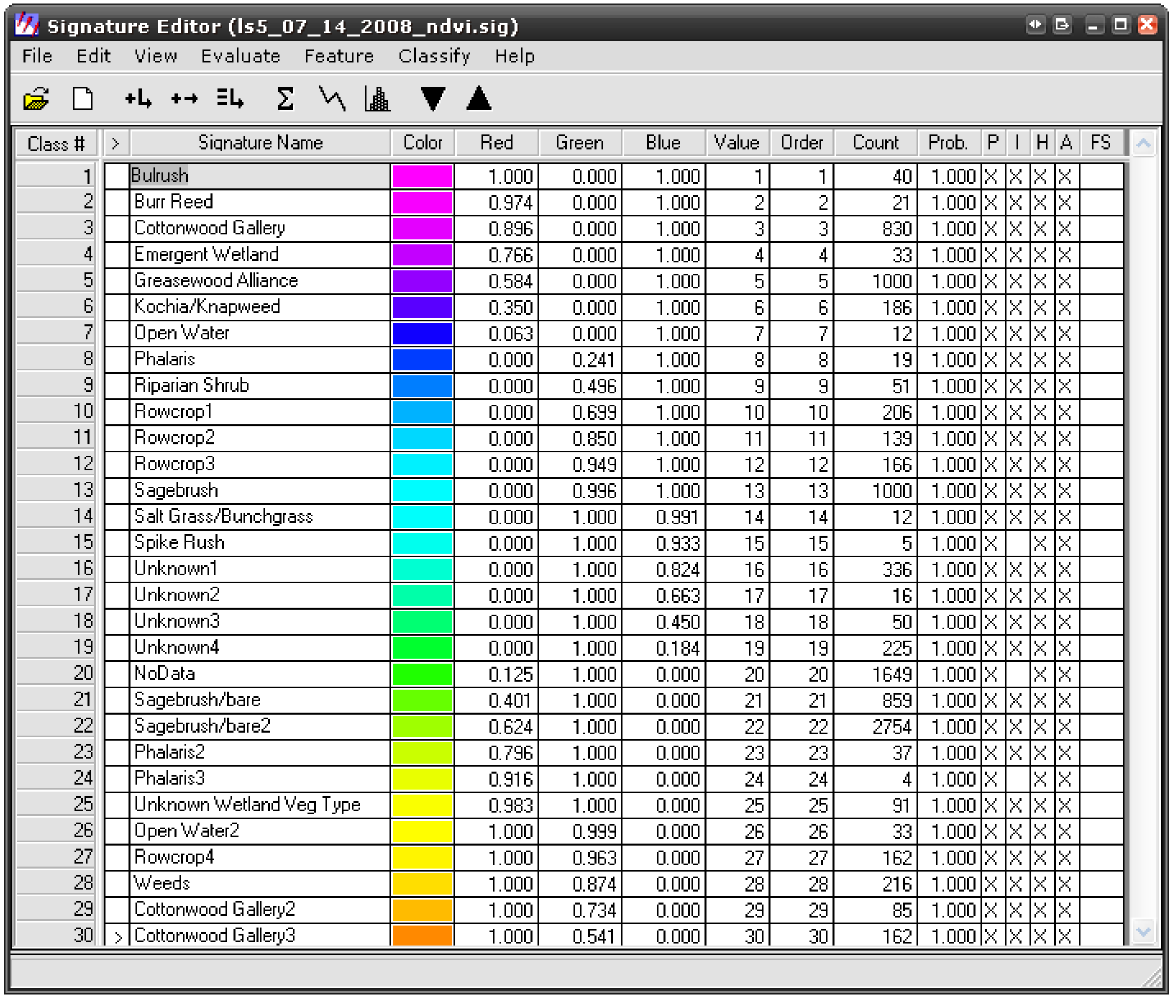



Fig. 12. Vegetation polygons in ERDAS Imagine viewer.




| Class # | > | Signature Name | Color | Red | Green | Blue | Value | Order | Count | Prob. | P | I | H | A | FS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | Bulrush | | 1.000 | 0.000 | 1.000 | 1 | 1 | 40 | 1.000 | X | X | X | X | |
| 2 | | Burr Reed | | 0.974 | 0.000 | 1.000 | 2 | 2 | 21 | 1.000 | X | X | X | X | |
| 3 | | Cottonwood Gallery | | 0.896 | 0.000 | 1.000 | 3 | 3 | 830 | 1.000 | X | X | X | X | |
| 4 | | Emergent Wetland | | 0.766 | 0.000 | 1.000 | 4 | 4 | 33 | 1.000 | X | X | X | X | |
| 5 | | Greasewood Alliance | | 0.584 | 0.000 | 1.000 | 5 | 5 | 1000 | 1.000 | X | X | X | X | |
| 6 | | Kochia/Knapweed | | 0.350 | 0.000 | 1.000 | 6 | 6 | 186 | 1.000 | X | X | X | X | |
| 7 | | Open Water | | 0.063 | 0.000 | 1.000 | 7 | 7 | 12 | 1.000 | X | X | X | X | |
| 8 | | Phalaris | | 0.000 | 0.241 | 1.000 | 8 | 8 | 19 | 1.000 | X | X | X | X | |
| 9 | | Riparian Shrub | | 0.000 | 0.496 | 1.000 | 9 | 9 | 51 | 1.000 | X | X | X | X | |
| 10 | | Rowcrop1 | | 0.000 | 0.699 | 1.000 | 10 | 10 | 206 | 1.000 | X | X | X | X | |
| 11 | | Rowcrop2 | | 0.000 | 0.850 | 1.000 | 11 | 11 | 139 | 1.000 | X | X | X | X | |
| 12 | | Rowcrop3 | | 0.000 | 0.949 | 1.000 | 12 | 12 | 166 | 1.000 | X | X | X | X | |
| 13 | | Sagebrush | | 0.000 | 0.996 | 1.000 | 13 | 13 | 1000 | 1.000 | X | X | X | X | |
| 14 | | Salt Grass/Bunchgrass | | 0.000 | 1.000 | 0.991 | 14 | 14 | 12 | 1.000 | X | X | X | X | |
| 15 | | Spike Rush | | 0.000 | 1.000 | 0.933 | 15 | 15 | 5 | 1.000 | X | | X | X | |
| 16 | | Unknown1 | | 0.000 | 1.000 | 0.824 | 16 | 16 | 336 | 1.000 | X | X | X | X | |
| 17 | | Unknown2 | | 0.000 | 1.000 | 0.663 | 17 | 17 | 16 | 1.000 | X | X | X | X | |
| 18 | | Unknown3 | | 0.000 | 1.000 | 0.450 | 18 | 18 | 50 | 1.000 | X | X | X | X | |
| 19 | | Unknown4 | | 0.000 | 1.000 | 0.184 | 19 | 19 | 225 | 1.000 | X | X | X | X | |
| 20 | | NoData | | 0.125 | 1.000 | 0.000 | 20 | 20 | 1649 | 1.000 | X | | X | X | |
| 21 | | Sagebrush/bare | | 0.401 | 1.000 | 0.000 | 21 | 21 | 859 | 1.000 | X | X | X | X | |
| 22 | | Sagebrush/bare2 | | 0.624 | 1.000 | 0.000 | 22 | 22 | 2754 | 1.000 | X | X | X | X | |
| 23 | | Phalaris2 | | 0.796 | 1.000 | 0.000 | 23 | 23 | 37 | 1.000 | X | X | X | X | |
| 24 | | Phalaris3 | | 0.916 | 1.000 | 0.000 | 24 | 24 | 4 | 1.000 | X | | X | X | |
| 25 | | Unknown Wetland Veg Type | | 0.983 | 1.000 | 0.000 | 25 | 25 | 91 | 1.000 | X | X | X | X | |
| 26 | | Open Water2 | | 1.000 | 0.999 | 0.000 | 26 | 26 | 33 | 1.000 | X | X | X | X | |
| 27 | | Rowcrop4 | | 1.000 | 0.963 | 0.000 | 27 | 27 | 162 | 1.000 | X | X | X | X | |
| 28 | | Weeds | | 1.000 | 0.874 | 0.000 | 28 | 28 | 216 | 1.000 | X | X | X | X | |
| 29 | | Cottonwood Gallery2 | | 1.000 | 0.734 | 0.000 | 29 | 29 | 85 | 1.000 | X | X | X | X | |
| 30 | > | Cottonwood Gallery3 | | 1.000 | 0.541 | 0.000 | 30 | 30 | 162 | 1.000 | X | X | X | X | |

Fig. 13. Vegetation classes and their associated spectral signature as derived from field-mapped data.

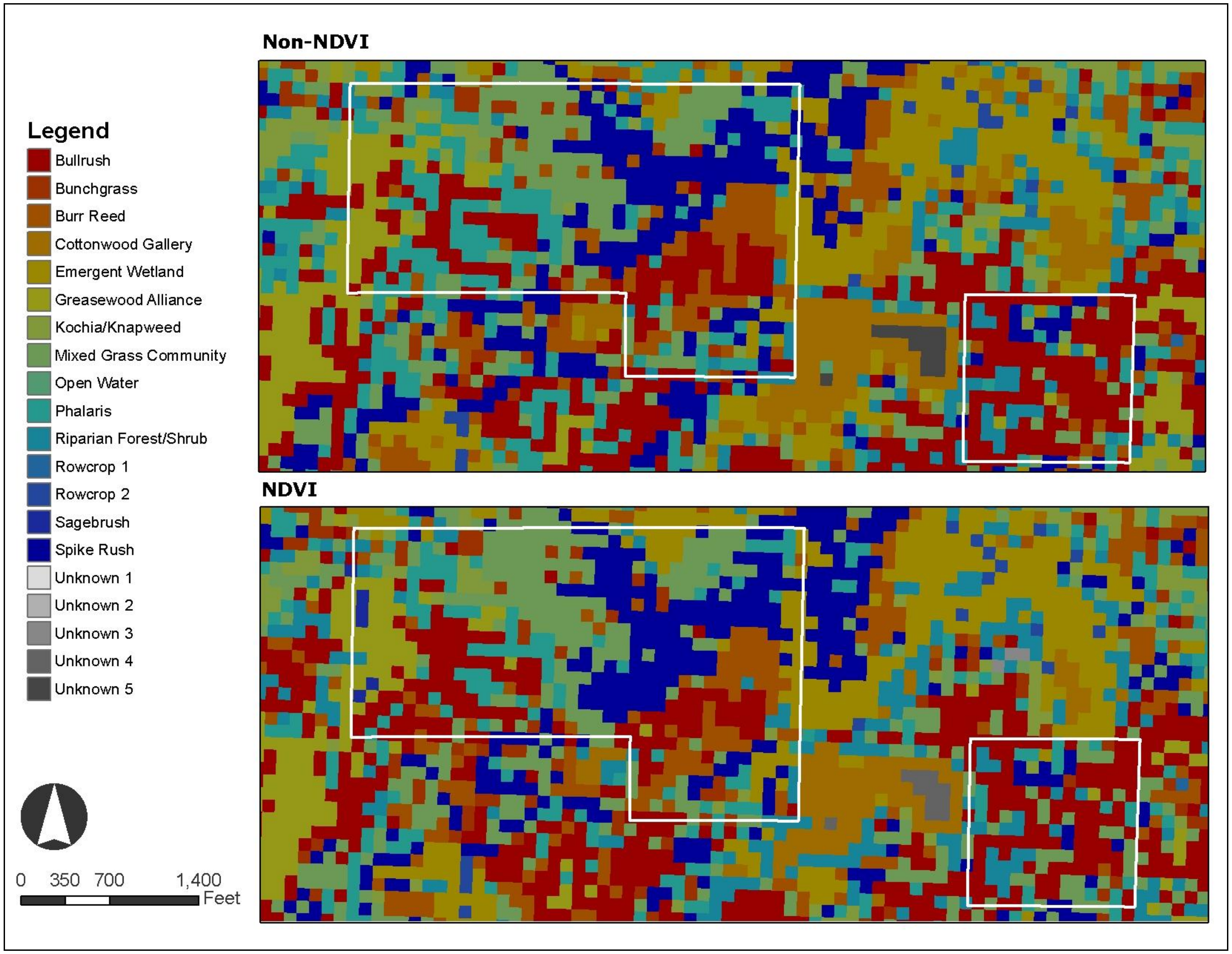



Fig. 14. Results of method using strict polygons to train the classification. Notice the presence of bulrush identified in known greasewood community at the Old Goldendale restoration site.

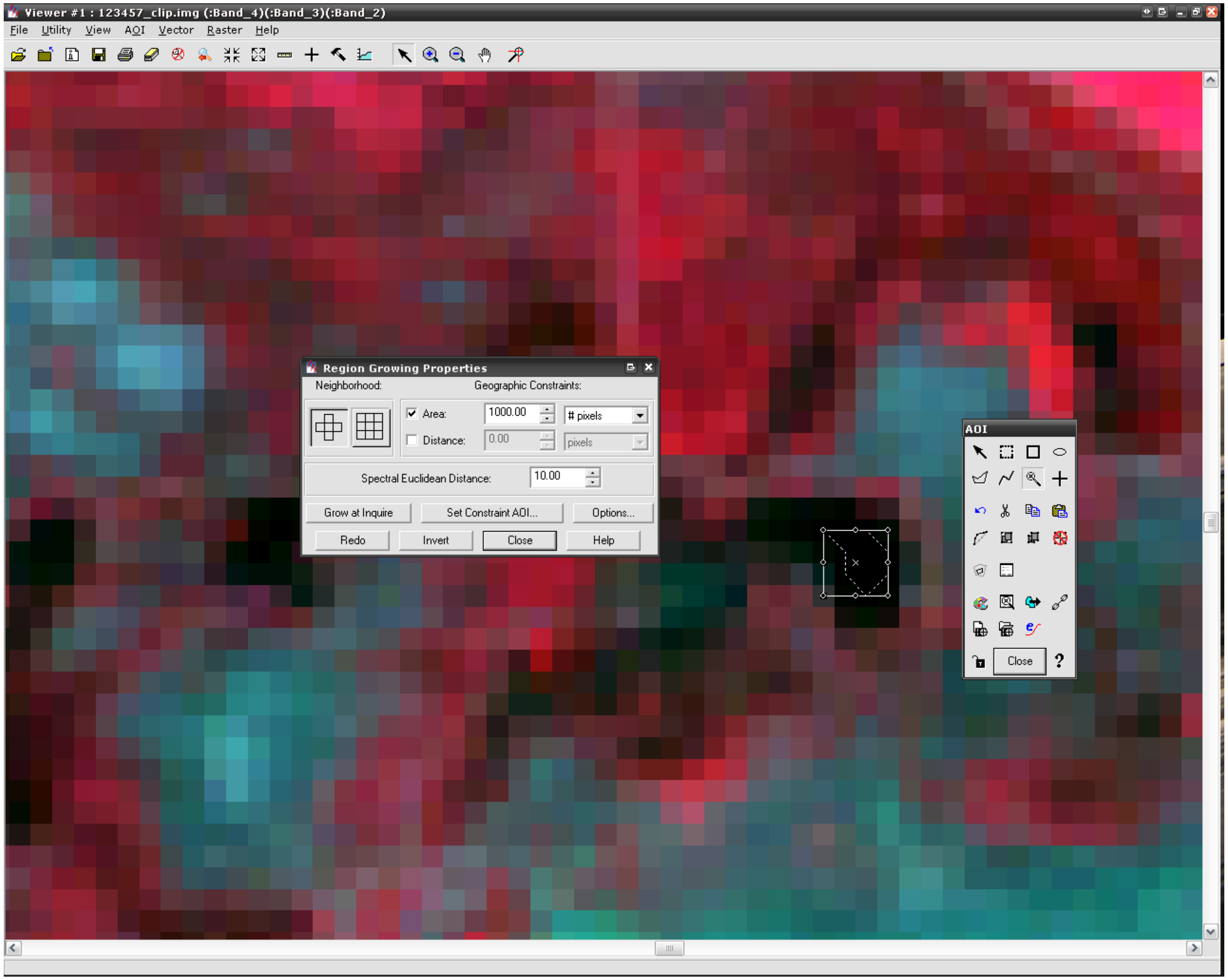
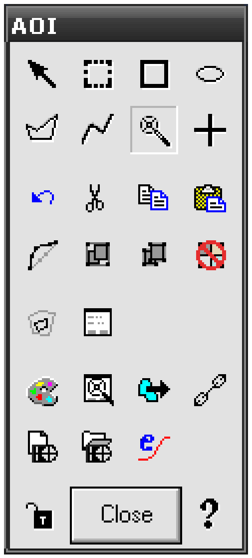
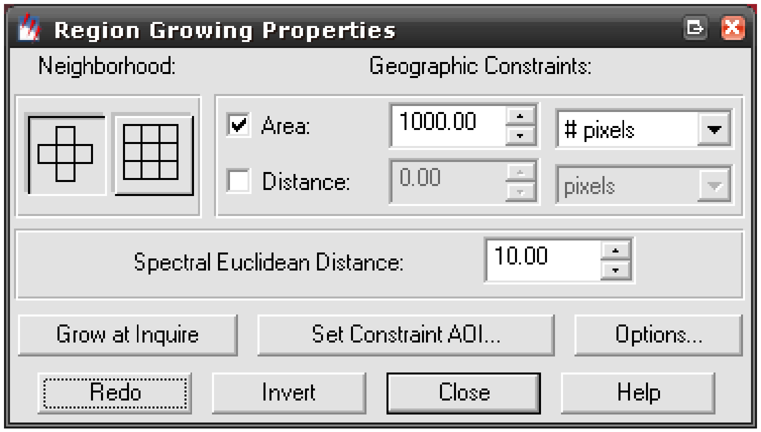



Fig. 15. The creation of AOIs using the region growing tool instead of verbatim polygons derived from 1-meter imagery.




Figs. 16-17. The AOI toolbar and the region growing properties dialog in ERDAS Imagine.

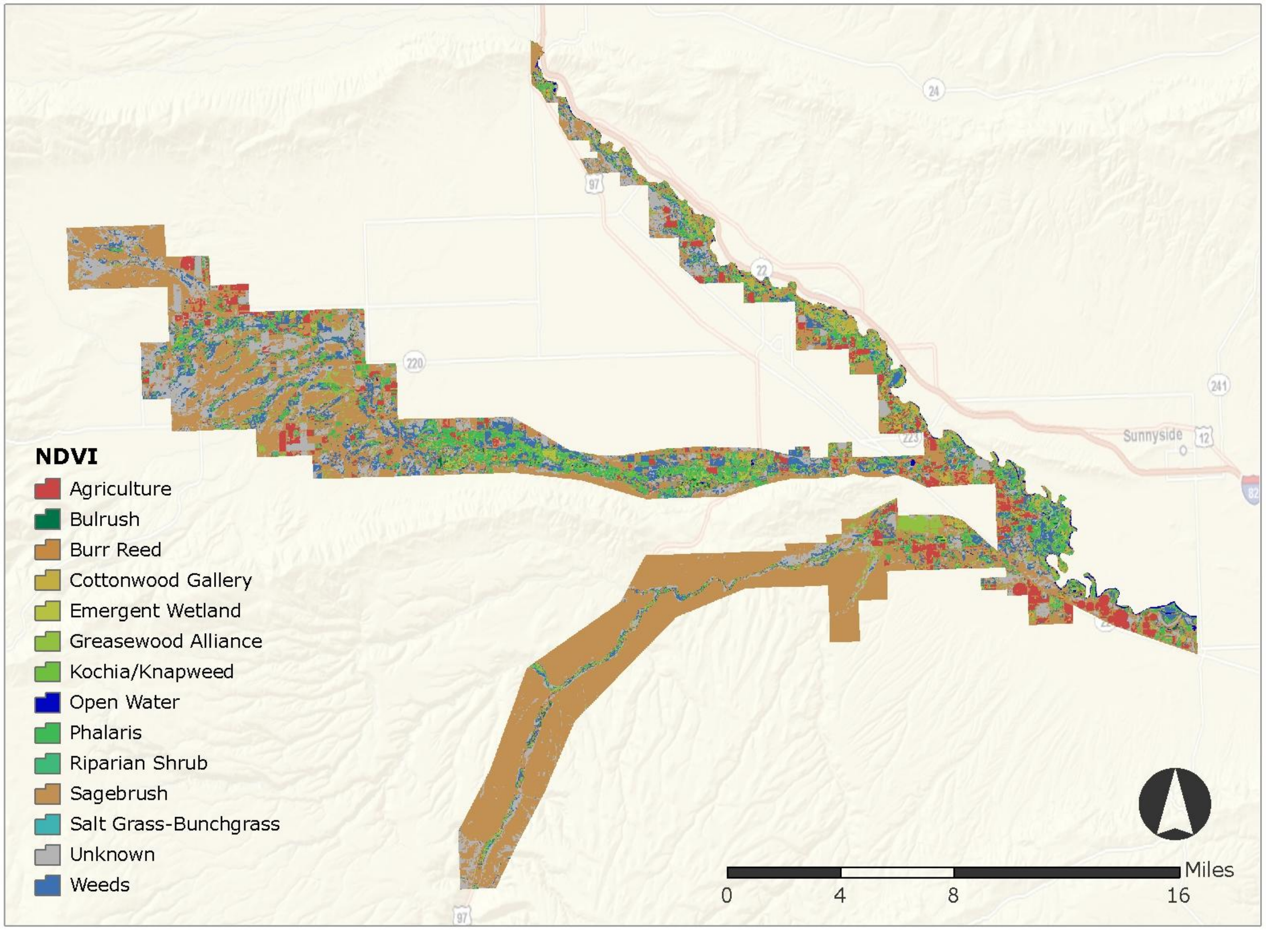



Fig. 18. NDVI classification of Landsat imagery for the Yakama Nation Wetlands and Riparian Restoration Project annexation corridor .

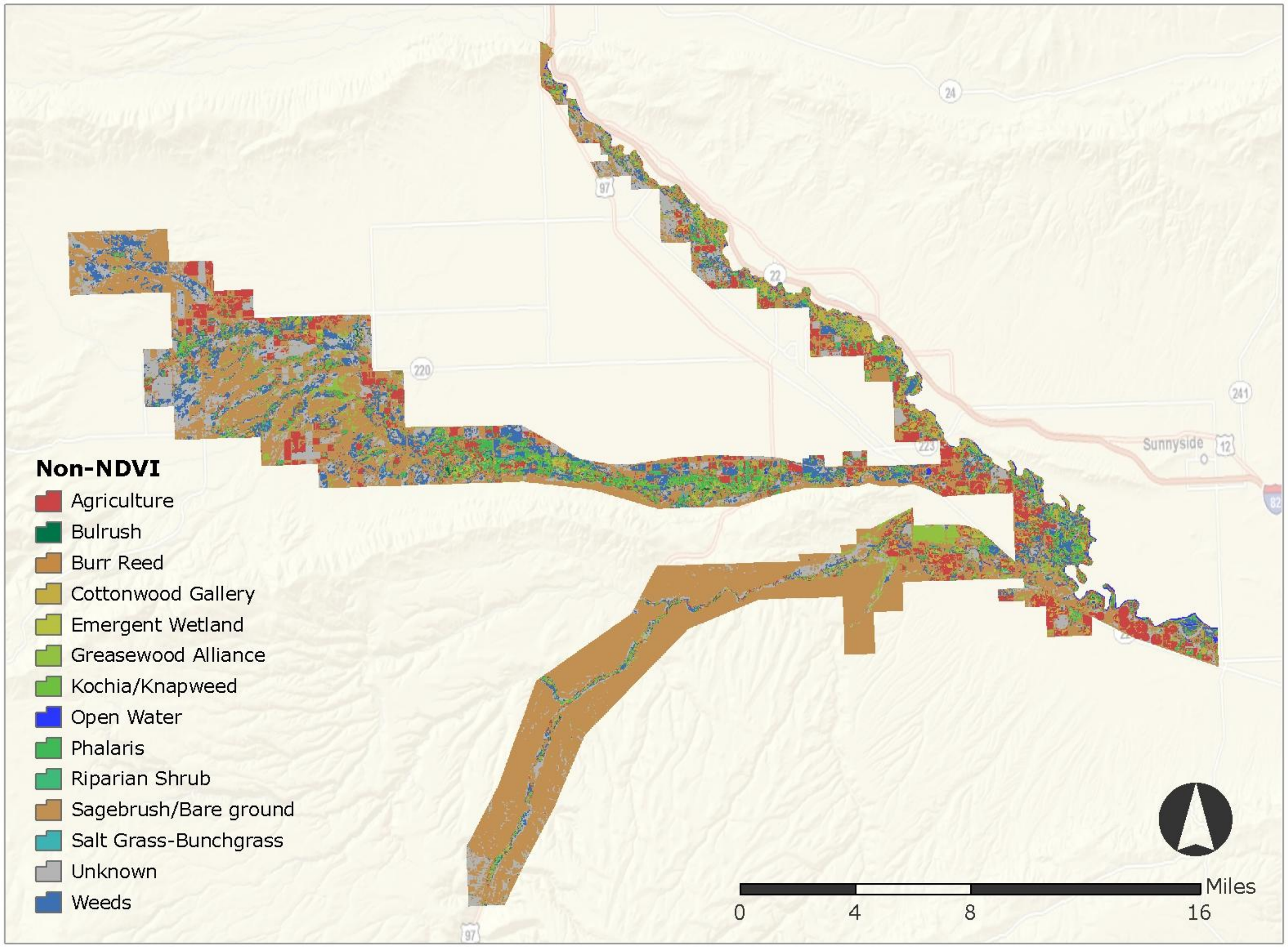



Fig. 19. Non-NDVI Classification of Landsat imagery for the Yakama Nation Wetlands and Riparian Restoration Project annexation corridor .

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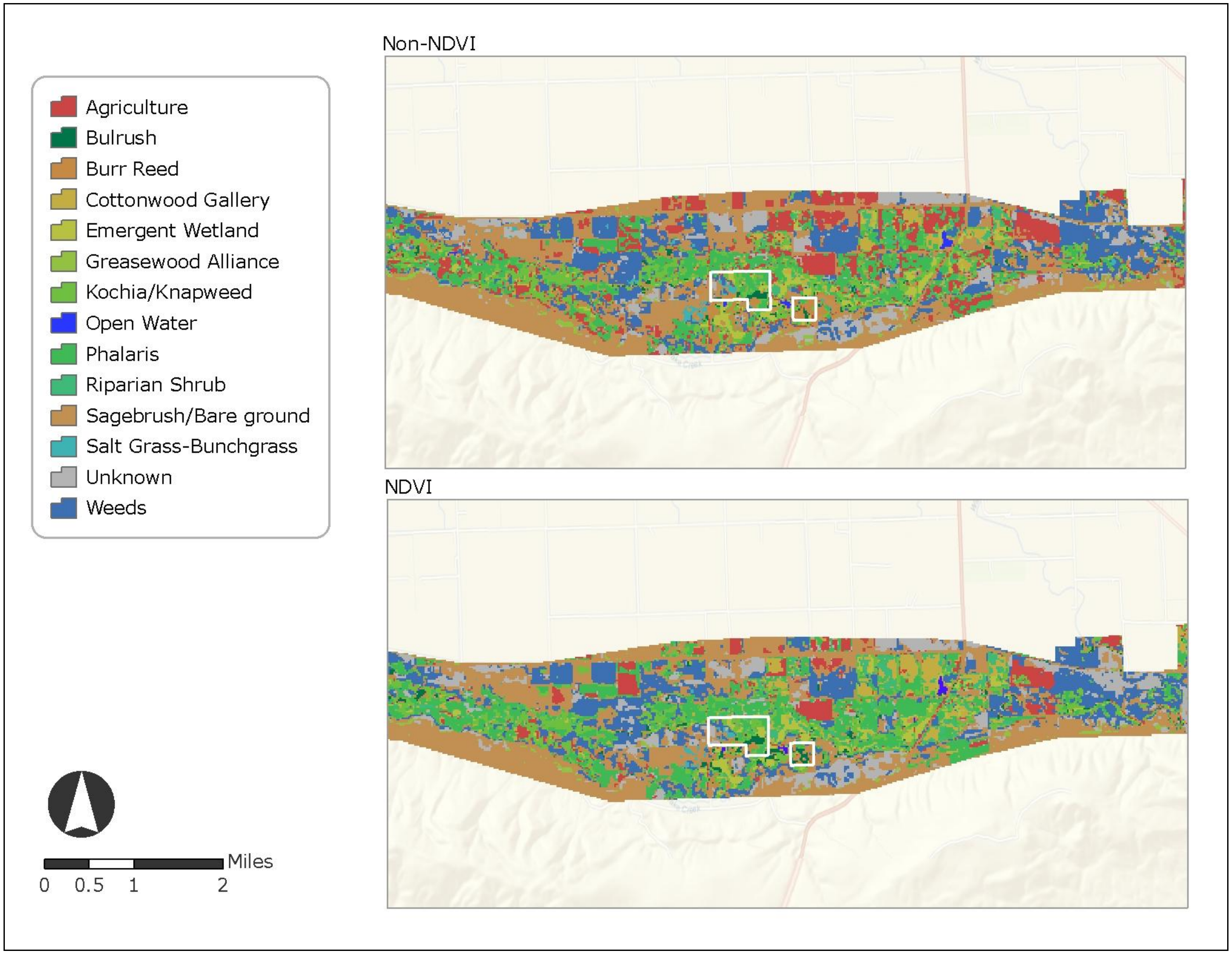



Fig. 20. Larger scale comparison of NDVI and Non-NDVI classification results.

Table 1. Vegetation Communities, Old Goldendale Restoration Site, 2008

| Vegetation Community | Number | Minimum Size ($m^2$) | Maximum Size ($m^2$)_ | Mean Size ($m^2$) | Total Area ($m^2$) | Percent of Site |
|---|---|---|---|---|---|---|
| Bulrush | 18 | 337 | 47308 | 4411.7 | 79410 | 10.3 |
| Bulrush-Cattail | 3 | 409 | 1365 | 1000.3 | 3001 | 0.4 |
| Bur-reed | 10 | 410 | 11524 | 3031.2 | 30312 | 3.9 |
| Broadleaf Cattail | 1 | 344 | 344 | 344.0 | 344 | 0.1 |
| Cockleburr | 5 | 297 | 2216 | 972.2 | 4861 | 0.6 |
| Greasewood | 1 | 2704 | 2704 | 2704.0 | 2704 | 0.3 |
| Mixed Grass | 12 | 38 | 11403 | 2558.0 | 30696 | 4.0 |
| Pepperweed | 6 | 214 | 2628 | 1036.5 | 6219 | 0.8 |
| Reed Canary Grass (Phalaris) | 25 | 94 | 90413 | 8754.4 | 218859 | 28.3 |
| Phalaris-Bulrush | 2 | 458 | 1543 | 1000.5 | 2001 | 0.3 |
| Phalaris-Bur-reed | 1 | 707 | 707 | 707.0 | 707 | 0.1 |
| Salt Grass-Bunchgrass | 30 | 26 | 83323 | 9713.8 | 291414 | 37.6 |
| Spike Rush | 5 | 698 | 7317 | 2835.6 | 14178 | 1.8 |
| Spike Rush-Bur-reed | 1 | 3914 | 3914 | 3914.0 | 3914 | 0.5 |
| Spike Rush-Salt Grass-Phalaris | 1 | 3105 | 3105 | 3105.0 | 3105 | 0.4 |
| Unclassified | 4 | 575 | 9584 | 3249.0 | 12996 | 1.7 |
| Weeds | 7 | 174 | 40889 | 8571.0 | 59997 | 7.8 |
| Wild Rose | 5 | 62 | 1133 | 572.8 | 2864 | 0.4 |
| Willow | 6 | 71 | 1554 | 889.5 | 5337 | 0.7 |

**Table 2. Description of Principal Vegetation Communities, Old Goldendale Restoration Site**

**<u>Reed Canary Grass Community (*Phalaris arundinacea*).</u>**

Reed canary grass has firmly established itself over the majority of the Old Goldendale site (Table 1 and Figs. 4 and 6). Communities are dispersed throughout the entirety of the project, representing the dominant ground cover on over 28% of the site. The communities extend from the north central section of the project eastward and southerly, surrounding isolated softstem bulrush (tule) and bur-reed/sedge communities. Reed canary grass constitutes the dominant vegetation pattern within the projects boundaries. Reed canary grass colonies form a thick blanket of ground cover, limiting the capacity of native grass species to establish colonization. Although invasive, reed canary grass provides beneficial ground cover on shorelines, stream banks, wetlands and in areas with exposed moist soils, providing a buffer against erosive processes. Reed canary grass finds great success in disturbance and is often first to colonize after fire events or flooding, as it can survive in knee deep water by sending adventitious roots to the water's surface. Reed canary grass is one of the first grasses to sprout in the spring and provides cover and a marginal nutritional source for fauna, based on its poor palatability and presence of alkaloids.

**<u>Softstem Bulrush Community (*Scirpus tabernaemontani*)</u>**

Within the Old Goldendale Site, softstem bulrush communities have established themselves on approximately 10% of the site, primarily in the mid southeastern section of parcel A (Table 1 and Figs. 4-5). A dense and nearly impenetrable stand of softstem bulrush and its litter from previous years blankets low areas where trace evidence of seasonal inundation wetland conditions are present. A perennial species native to Washington, softstem bulrush grows in moist soils, deep or shallow wetland waters, muddy or marshy areas surrounding pools or streams, or on wetland prairies where it can tolerant alkali soil conditions. Growing from 1 to 3 meters tall, the stems are dark green to brown in color with seed heads clustering at the tip of the stem. Flower color is reddish brown and form overlapping scales. Softstem bulrush provides important cover for fish, muskrats, otters, raccoons and waterfowl. The seed heads provide an important food source for ducks, shore birds and marsh birds while the stems and below ground portion of the plant provide a staple food source for geese. The dense cover provides nesting habitat and cover. The growing season is from June to September. Historically, softstem bulrush was and is continued to be used by Native Americans for weaving and as a food source. The plants roots can also be harvested and eaten, while the stalks may be used to create intricate, floor mats, bags and baskets. The leaves can also be used in the construction of twine.

**Salt grass (*Distichlis spicata*), Bunchgrass (*Pseudoroegneria spictata*), Greasewood (*Sarcobatus vermiculatus*) Community**.

Found in patches throughout the project, generally surrounded by reed canary grass communities, salt grass/bunchgrass communities represent the remnants of native vegetation, occupying approximately 37% of the site (Table 1 and Fig. 4). Blue bunch wheatgrass (*Pseudoroegneria spictata)*, wild rye (*Elymus cinereus)*, and steppe bluegrass (*Poa secunda*), with an occasional greasewood shrub, form the traditional bunchgrass community. Providing good cover and food sources for native fauna, bunchgrass communities also are exceptionally suited for cattle grazing in the arid west. Favoring arid, semi alkali soil types, salt grass/bunchgrass communities are well suited to basaltic loam soils.

**Mixed Grass Communities**.

Mixed grass communities are made up of both native and invasive grass species, and occupy approximately 4% of the Old Goldendale site (Table 1 and Fig. 4). Native grass communities include Blue bunch wheatgrass (*Pseudoroegneria spictata*), salt grass (*Distichlis spicata*), wild rye, *Elymus cinereus*, squirreltail (*Elymus elymoides***)**, bottlebrush and steppe bluegrass, *Poa secunda*. Reed canary grass (*Phalaris arundinacea*) and cheatgrass (*Bromus tectorum*) are the most notable of invasive grass species found on the Old Goldendale project. Grass communities provide excellent grazing conditions for native fauna including elk, and deer, and domesticated animals such as sheep and cattle. Sod forming grasses such as canary grass form and spread through a thick rhizome matt, while the traditional bunchgrasses such as blue bunch wheatgrass form colonizing mounds.

**Common Bur-reed Community (*Sparganium eurycarpum*)**,

Bur-reed is the dominant sedge community within the Old Goldendale site, occupying approximately 3.9% of the area (Table 1 and Fig. 4). Found throughout the mid eastern portion of parcel A, and the central portion of parcel B, common bur-reed is a perennial sedge that uses hearty rhizomes to survive through the winter months. Bur-reed is found in marshes, along the margins of lakes, streams, ponds, and in areas of moist soils. Bur-reeds have long flat, emergent, V shaped leaves that look like a compressed triangle. The plants grow from 1 to 1.5 meters tall. The leaves sprout from a shallow rhizome base. Seeds are spherical shaped with protruding spikes after growing to maturity. Bur-reed colonies help provide soil stability by anchoring sediments and providing a buffer to water action. The fruit is eaten by several waterfowl, while the stalks are grazed by muskrats and deer. Bur-reed communities provide cover and nesting habitat for waterfowl and shorebirds.

**<u>Reed Canary Grass (*Phalaris arundinacea*), Softstem bulrush (*Scirpus tabernaemontani*) Community</u>**.

Reed canary grass and softstem bulrush communities are found in the mid eastern portion of parcel A, of the Old Goldendale site (Table 1 and Fig. 4). As reed canary grass communities encounter softstem bulrush communities, a transitional community is formed comprised of a dominant canary grass community and a secondary softstem bulrush community. Reed canary grass, though invasive, provides good ground cover for fauna, while also helping to provide soil cover and stability. The nutritional value of canary grass is low for fauna, but because of its early growing season provides a good early season food source. Softstem bulrush provides important cover for fish, muskrats, otters, raccoons and waterfowl. The seed heads provide an important food source for ducks, shore birds and marsh birds while the stems and below ground portion of the plant provide a staple food source for geese. Further, softstem bulrush provides nesting habitat for birds and cover for local fauna.

**<u>Reed Canary Grass (*Phalaris arundinacea*), Softstem bulrush (*Scirpus tabernaemontani*), Broadleaf Cattail (*Typha latifolia*) Community</u>**.

Reed canary grass, softstem bulrush, and cattail communities are found in marshlands, stream banks, standing water, and in riparian corridors (Table 1 and Fig. 4). Reed canary grass colonies form a thick blanket of ground cover, limiting the capacity of other, native grass species to colonize. Although invasive, reed canary grass provides beneficial ground cover on shorelines, stream banks, wetlands and in areas with exposed moist soils, providing a buffer against erosive processes. Reed canary grass finds great success in disturbance and is often first to colonize after fire events or flooding. A shoreline plant, reed canary grass can survive in knee deep water by sending adventitous roots to the water's surface. Reed canary grass is also one of the first grasses to sprout in the spring, and provides cover and a marginal nutritional source for fauna, based on its poor palatability and its presence of alkaloids. A perennial species native to Washington, softstem bulrush grows in moist soils, deep or shallow wetland waters, muddy or marshy areas surrounding pools or streams, or on wetland prairies where it can tolerant alkali soil conditions. Growing from 1 to 3 meters tall, the stems are dark green to brown in color with seed heads clustering at the tip of the stem. Flower color is reddish brown and form overlapping scales. Softstem bulrush provides important cover for fish, muskrats, otters, raccoons and waterfowl. Broadleaf cattail, like softstem bulrush, provides important habitat for fish, muskrats, otters, raccoons, waterfowl and other fauna. Broadleaf cattail grows in shallow, standing or slow moving waters, moist grounds, pools, ponds and along roadside ditches. Broadleaf cattails provide natural cover and nesting habitat for marshland animals. Among the more important characteristics of broadleaf cattails is their natural ability to filter water, making them a key vegetation species to consider when monitoring or mitigating wetland habitats.

**<u>Softstem bulrush (*Scirpus tabernaemontani*) Cattail (*Typha latifolia*) Community</u>**.

Softstem bulrush and broadleaf cattails are found in wetlands, along stream corridors, roadside ditches, in moist soil conditions, and in moist prairies (Table 1 and Fig. 4). A perennial species native to Washington, softstem bulrush grows in moist soils, deep or shallow wetland waters, muddy or marshy areas surrounding pools or streams, or on wetland prairies where it can tolerant alkali soil conditions. Growing from 1 to 3 meters tall, the stems are dark green to brown in color with seed heads clustering at the tip of the stem. Flower color is reddish brown and form overlapping scales. Softstem bulrush provides important cover for fish, muskrats, otters, raccoons and waterfowl. The seed heads provide an important food source for ducks, shore birds and marsh birds while the stems and below ground portion of the plant provide a staple food source for geese. The dense cover provides nesting habitat and cover. The growing season is from June to September. Historically, softstem bulrush was and is continued to be used by Native Americans for weaving and as a food source. The plants roots can also be harvested and eaten, while the stalks may be used to create intricate, floor mats, bags and baskets. The leaves can also be used in the construction of twine. Broadleaf cattail, like softstem bulrush, provides important habitat for fish, muskrats, otters, raccoons, waterfowl and other fauna. Broadleaf cattail grows in shallow, standing or slow moving waters, moist grounds, pools, ponds and along roadside ditches. Broadleaf cattails provide natural cover and nesting habitat for marshland animals. Among the more important characteristics of cattails is their natural ability to filter water, making them a key vegetation species to consider when monitoring or mitigating wetland habitats.

**<u>Greasewood Community (*Sarcobatus vermiculatus*)</u>**

Greasewood is a native shrub to Washington, usually found in arid, alkali conditions. Within the Old Goldendale site, several greasewood alliances have established in the western portion of parcel A and throughout the entirety of parcel B (Table 1 and Fig. 4). Greasewood is well adapted to alkali soil conditions, tolerating excessive soil salts that draw water out of other plants through osmosis. Greasewood can be identified from other shrubs by its deep green appearance and its numerous small linear, needle like leaves. Greasewood can grow to be several feet tall, providing cover for rabbits and other small terrestrial rodents. In the Old Goldendale site, greasewood communities are indicative of parched basaltic soils with a high probably of alkali conditions. Few, if any, other types of vegetation are found within the greasewood dominated community.

**<u>Blue bunch wheatgrass (*Pseudoroegneria spictata*), Salt Grass (*Distichlis spicata*), Greasewood (*Sarcobatus vermiculatus*) Community</u>**.

Natural shrub steppe communities are still found on the Old Goldendale site. These communities are represented by blue bunch wheatgrass mounds, intermixed with salt grass and greasewood shrubs. Blue bunch wheatgrass provides an excellent source of food for native and non native fauna of the region, while salt grass and other basin grasses provide sustainability to the grasslands. Greasewood plants are indicative of slightly alkali soil types and are often sparsely scattered throughout the grass communities.  Other grasses that might be found in this community are wild rye (*Elymus cinereus*) and steppe bluegrass (*Poa secunda*).  These grasses provide excellent cover for nesting birds, as well as a stable diet for grazing animals.

**Spiny Cocklebur (*Xanthium spinosum*) Community**

Spiny cocklebur is found throughout the Old Goldendale site, from the north eastern portions of parcel A, in low lying sloughs, to the dense thickets found in the northern portion of parcel B.  This low-lying annual grows up to three feet tall, with vibrant green leaves that have a three lobed shape.  In the spring, cocklebur grows round spiny soft green seed nodes.  The fruit matures in the fall and in late winter when the fruit becomes oval shaped and takes on tiny hook spines that facilitate the movement of the plant.  The burrs easily connect themselves to animals, allowing them to be carried great distances.  Native to Chile, spiny cocklebur is an invasive species introduced from South American livestock to the United States.  Well adapted to a multitude of environments, spiny cocklebur easily out competes native species for both space and resources.  Cultivation, mowing, slashing and burning are all implemented controls against spiny cocklebur in the United States.

**Thistle Community**.

Thistles are noxious weeds that have been brought from Asia, Europe, and South America.  Characterized by leaves that have sharp prickles on their leaves, thistles have adapted to protect themselves from herbivores animals.  Canadian thistle, Scotch thistle, teasel and Russian thistle have all established intermixed communities on the Old Goldendale site.  These communities are a major management concern as they out compete native plant species for space and resources.  Thistles are included in Washington States Weed Control Program.

Table 3. The lookup table for the reclassified images in ArcGIS.

| VALUE | CLASS |
|---:|---|
| 1 | Bulrush |
| 2 | Burr Reed |
| 3 | Cottonwood Gallery |
| 4 | Emergent Wetland |
| 5 | Greasewood Alliance |
| 6 | Kochia/Knapweed |
| 7 | Open Water |
| 8 | Phalaris |
| 9 | Riparian Shrub |
| 10 | Agriculture |
| 11 | Sagebrush |
| 12 | Salt Grass-Bunchgrass |
| 13 | Spike Rush |
| 15 | Unknown |
| 16 | Weeds |

*Table 4*. Statistical summary of vegetation classification for Yakama Nation Riparian Restoration Corridors using the NDVI and Non-NDVI methods.

| VALUE | NDVI Cell Count | Non-NDVI Cell Count | Difference | CLASS |
|---|---|---|---|---|
| 1 | 2760 | 1747 | - 1013 | Bulrush |
| 2 | 2595 | 4019 | + 1424 | Bur-reed |
| 3 | 16456 | 14258 | - 2198 | Cottonwood Gallery |
| 4 | 6768 | 6079 | - 689 | Emergent Wetland |
| 5 | 8962 | 12960 | + 3998 | Greasewood |
| 6 | 21272 | 18911 | - 2361 | Kochia/Knapweed |
| 7 | 2607 | 3197 | + 590 | Open Water |
| 8 | 26874 | 19266 | - 7608 | Phalaris |
| 9 | 9189 | 6890 | - 2299 | Riparian Shrub |
| 10 | 33743 | 55606 | + 21863 | Agriculture |
| 11 | 236346 | 235372 | - 974 | Sagebrush/Bare ground |
| 12 | 479 | 1064 | + 585 | Salt Grass-Bunchgrass |
| 15 | 70774 | 60291 | -10483 | Unknown |
| 16 | 49534 | 48699 | - 835 | Weeds |

# NAWCA GRANT
# Lower Yakima Wetlands Protection/Restoration II
# Annual Report

June 2008 – June 2009

Tracy Hames, Yakama Nation Wildlife
Rocky Ross, Washington Department of Fish and Wildlife

Toppenish Creek restored wetland feeder channel – Old Goldendale Road Wildlife Area
Historic house in the background

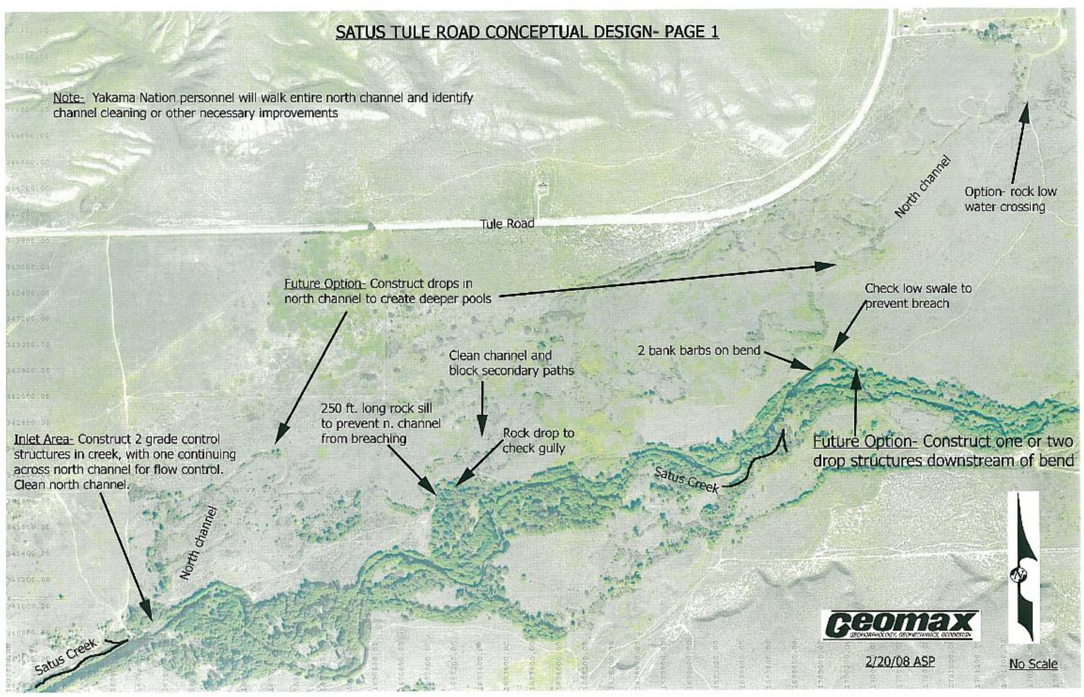
This report summarizes the activities which have taken place from June 2008 through June 2009 on the Lower Yakima Wetlands Protection/Restoration II Project funded through the North American Wetlands Conservation Act (NAWCA).

## Lower Satus Wildlife Area (Yakama Nation)

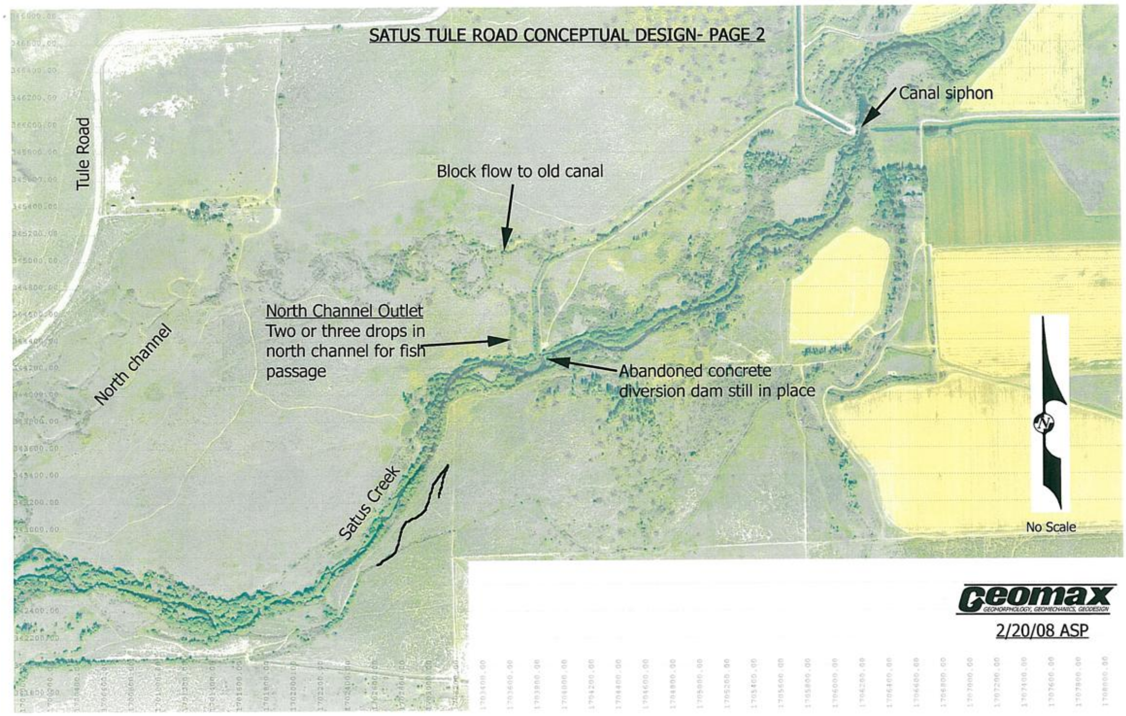
**Satus Creek restoration – NAWCA Funded** This project will begin in July 2009. Implementation will involve the construction of large rock grade control structures in Satus Creek. The structures will allow hydrologic reconnection to a side channel/wetland area that has been disconnected for decades.

**Grass Planting – Match** In 2007 145 acres were seeded to native grasses on this property. Another 100 acres were seeded in the fall of 2008.

**Russian Olive Removal – Match** Over 1,000 acres of Russian olive trees were removed from wetland areas on this property and the Satus Wildlife Area. Control of re-growth is occurring annually.




Upper portion of Lower Satus Wildlife Area restoration.




Lower portion of Lower Satus Wildlife Area restoration project.

## Satus Wildlife Area (Yakama Nation)

**Russian Olive Removal – Match** This activity has been completed in 2005-2006. Over 1,000 acres of Russian olive plants were removed from the wetland areas of the Satus and Lower Satus Wildlife Areas, piled and burned. Control of regrowth is occurring annually.

**Native grass seeding – Match** Preparation work has been ongoing. Weed issues on this site will prevent seeding from occurring here for several years. The acreage attributed to this activity will occur at the Lower Satus Wildlife Area grass planting.

## Sunnyside Wildlife Area Headquarters Unit (Washington Dept Fish & Wildlife)

This report summarizes the activities and cost share information for that portion of the grant, which took place on lands owned by the Washington Department of Fish & Wildlife. The time period in which these activities took place was January 2008 to May 2009.

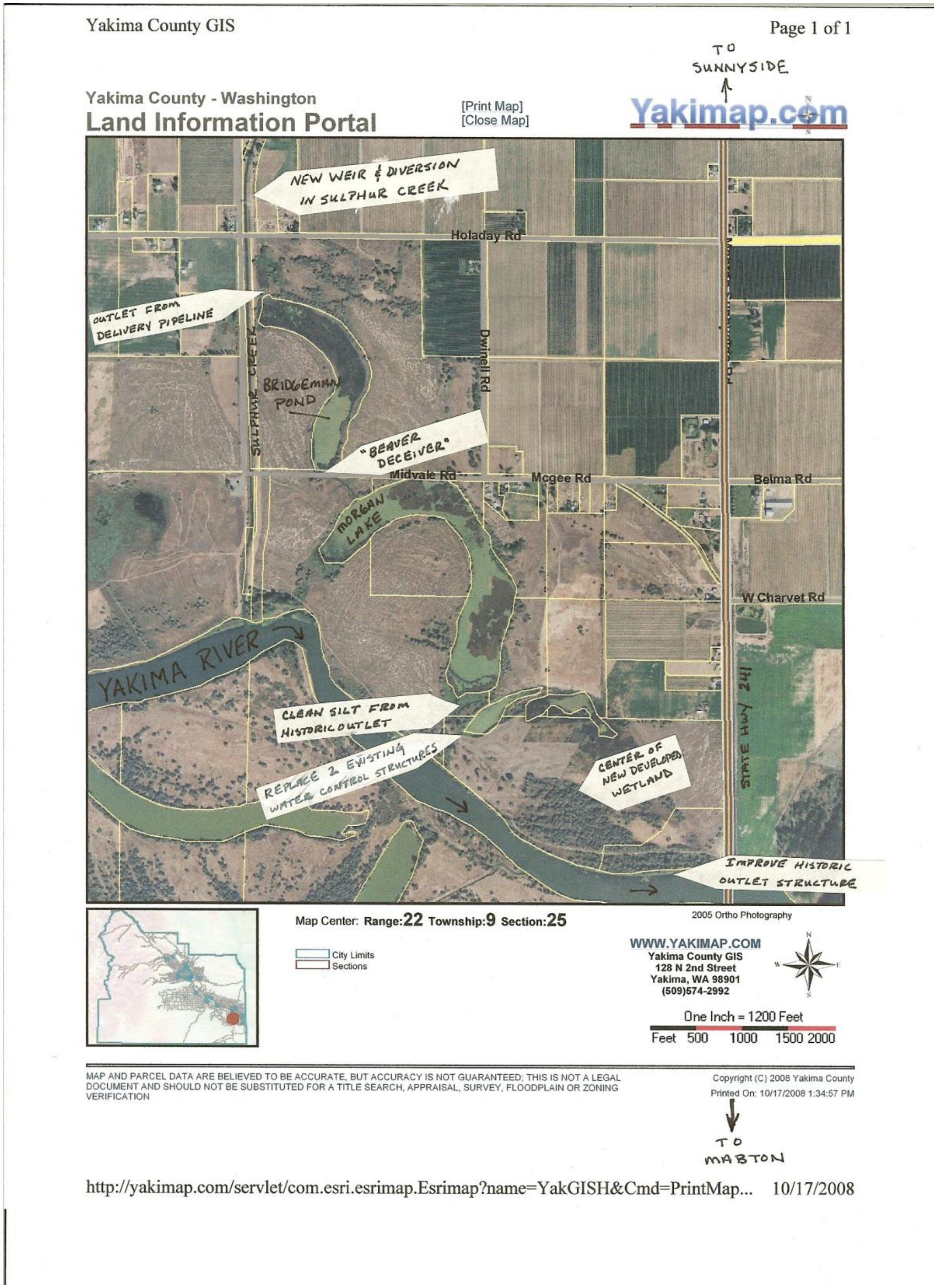
**All wetland restoration activities on the Byron Unit, originally planned under this NAWCA grant have been completed except a minor improvement to one of the water control structures. The original contractor and Sunnyside Wildlife Area staff will share that work, and it will be completed in the later summer of 2009.**

The focus for 2009 has been on the second phase of the grant; to improve wetland habitat on state lands by using water from the Sulphur Creek Wasteway. The entire infrastructure is in place on this project except some of the beaver deceivers. Those will be installed before the new wetland is filled.

Wildlife Area staff shared some of the construction work with a private contractor to bring the project to fruition. In addition, they performed the first year of follow up treatment on 35 acres of Russian olives, which were removed and burned. Because we share our dozer with another state wildlife area, we did not have full access to it so the olives were not re-piled and burned a second time. That work is currently ongoing.

The new wetland unit was sprayed for olive sprouts by ground, and noxious weeds were sprayed by air while the site was still dry. We are tentatively planning to delay the flooding of the new wetland until a substantial soil removal project can be completed.

As work was progressing under the grant, two opportunities developed that would both enhance the habitat values of the project. The first was reported last year. The Sunnyside Valley and Roza Irrigation Districts were going to build a weir in the lower end of Sulphur Creek Wasteway. This would effectively raise the level of the water to the point where it could be diverted into a wetland system on state land. We quickly coordinated a land use & water agreement with the districts, which allowed a diversion structure to be installed during construction of the weir. The pipeline was just completed in May of this year and it will carry up to 5 cfs into existing and newly constructed wetlands. The following photo gives an overview of the entire project perspective.




Overall view of the second phase of the NAWCA project on WDFW property.

The second opportunity arose when the Sunnyside Valley Irrigation District inquired about fill material. A tentative agreement is being developed that will allow SVID to "borrow" up to 80,000 cubic yards of fill material from the footprint of the new wetland. This will allow us to flood many more acres with sheet water and create a much more beneficial moist soil management area than was previously conceived. The SVID is not prepared to remove the fill material right now, so we will keep the area dry until they can get this work accomplished in 2010.

One of the unanticipated tasks necessary to complete the Sulphur Creek NAWCA component was the construction of a haul road into the construction site. The existing road was too close to the river and a vertical cut bank for safe transport of equipment and materials. Wildlife Area staff used project equipment to build this road.

**This is the lower end of Bridgeman Pond, where the culvert crosses under McGee Road, and into Morgan Lake. Beaver activity was high, in spite of passive flow.**

New beaver deceiver in place

**This historic delivery ditch, leading from Morgan Lake, was cleaned to its original elevation and a new water control structure was installed (foreground)**

Increased flow through the new control structure, at the upper end of the Johnson wetland

**Looking east, from the upper end of the new Johnson wetland, prior to filling with water. The site will be excavated to a controlled depth in 2010, and then watered up to create the moist soil management unit.**

City of Grandview—Water Treatment Facility - Match

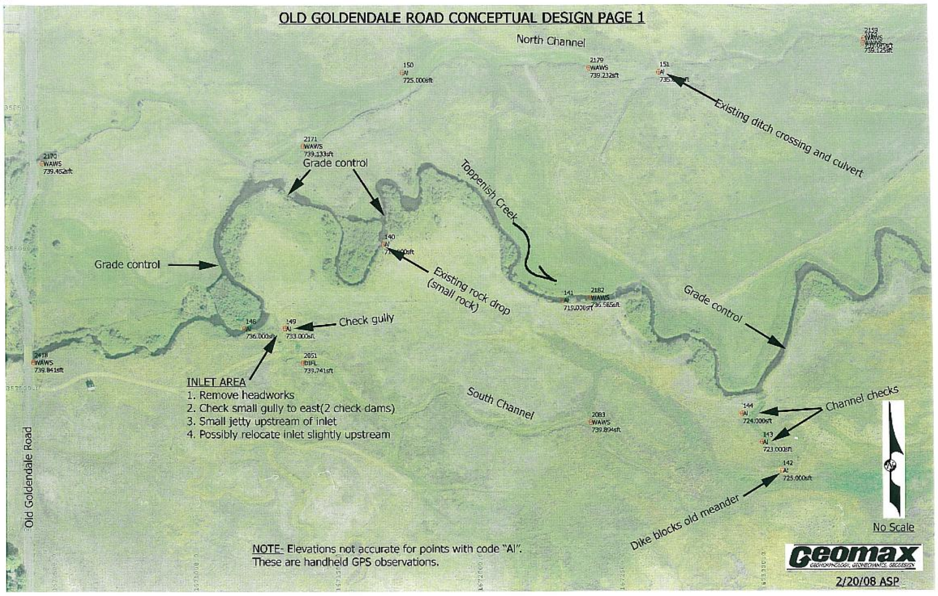
The City of Grandview (COG) operates a water treatment facility adjacent to the north boundary of the Byron Unit. Typically, between February and April, the facility releases effluent into a myriad of small swales, creating nearly 100 permanent and ephemeral ponds on 1,778 acres of COG and Department of Fish & Wildlife lands. The COG released 27 million gallons of water into these ponds in 2008. All pond basins were filled to capacity, creating approximately 121 acres of open, shallow water habitat.

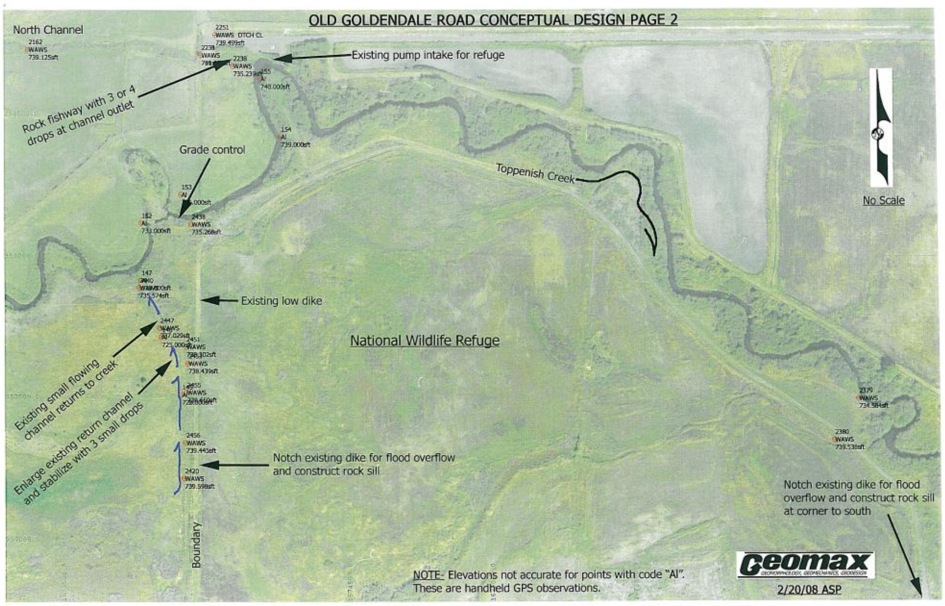
**One of many ephemeral ponds filled by the City of Grandview's Water Treatment Facility**

## Old Goldendale Wildlife Area (Yakama Nation, Toppenish NWR)

### Wetland Reconnection – Grant and Match

Implementation of this hydrologic reconnection project will occured in August and September 2008. Large rock structures were placed in Toppenish Creek to lift the grade of the creek to pre-incision conditions. This allows the restoration of wetland and side channel hydrology to the wildlife areas. Channels were constructed to allow flow and fish passage through the wetland area. Spillways allow floodwaters to pass through the area. Water control structures allow for vegetation management.


OLD GOLDENDALE ROAD CONCEPTUAL DESIGN PAGE 1
North Channel
Existing ditch crossing and culvert
Grade control
Toppenish Creek
Grade control
Existing rock drop (small rock)
Check gully
Grade control
INLET AREA
1. Remove headworks
2. Check small gully to east(2 check dams)
3. Small jetty upstream of inlet
4. Possibly relocate inlet slightly upstream
South Channel
Channel checks
Dike blocks old meander
Old Goldendale Road
No Scale
NOTE- Elevations not accurate for points with code "AI".
These are handheld GPS observations.
Geomax
2/20/08 ASP


OLD GOLDENDALE ROAD CONCEPTUAL DESIGN PAGE 2
North Channel
Existing pump intake for refuge
Rock fishway with 3 or 4 drops at channel outlet
Grade control
Toppenish Creek
No Scale
Existing low dike
National Wildlife Refuge
Existing small flowing channel returns to creek
Enlarge existing return channel and stabilize with 3 small drops
Notch existing dike for flood overflow and construct rock sill
Notch existing dike for flood overflow and construct rock sill at corner to south
Boundary
NOTE- Elevations not accurate for points with code "AI".
These are handheld GPS observations.
Geomax
2/20/08 ASP


Grade Control Structure in Toppenish Creek


Spillways at lower portion of restored wetland.


Water Control Structures soon after installation


Control Structures operating at high water to pass fish

Partially-flooded restored wetland

## *Cost Share from select NAWCA Partners June 2008 – June 2009*

Not all costs are presented in detail. Cost breakout details will be included in the final report at the end of the project.

## Yakama Nation

Russian Olive removal Amount not fully determined

## Washington Department of Fish and Wildlife

The following table summarizes some of the cost share work that has been accomplished by the WDFW wildlife area staff on this second phase of the NAWCA grant.

| Job | Staff/Equipment | Hours Worked | Hourly Rate | Total Cost Share |
|---|---|---|---|---|
| Beaver Deceiver | Medina | 5 | 18.81 | $ 94.05 |
| | Sak | 5 | 26.30 | 131.50 |

| | | | | |
|---|---|---|---|---|
| | | | | |
| Channel Construction | Medina | 25 | 18.81 | 470.25 |
| | Sak | 18 | 26.30 | 473.40 |
| | | | | |
| Vegetation Management | Medina | 43 | 18.81 | 808.83 |
| | Sak | 32 | 26.30 | 841.60 |
| | | | | |
| Misc. Finish Earthwork | Sak | 12 | 26.20 | 315.60 |
| Build Access Road | Medina | 14 | 18.81 | 263.34 |
| | Sak | 25 | 26.20 | 657.50 |
| | | | | |
| Transport Culverts | Medina | 5 | 18.81 | 94.05 |
| | Sak | 5 | 26.20 | 131.50 |
| | | | | |
| Herbicide Application | Medina | 100+ | 18.81 | 1,881.00 |
| | Sak | 60 | 26.20 | 1,572.00 |
| | | | | |
| Contract Admin. | Ross | 47 | 34.15 | 1,605.05 |
| | | | | |
| | | Subtotal | Labor | 9,339.67 |
| | | | | |
| | | | | |
| | | | | |
| Use of State Equipment | | Hours Operated | Hourly Rate | Total Cost Share |
| | | | | |
| ASV Crawler Backhoe | | 29 | 32 | 928.00 |
| | | | | |
| Std. Backhoe | | 11 | 32 | 352.00 |
| | | | | |
| Dozer | | 48 | 75 | 3,600.00 |
| | | | | |
| Wheel Tractor | | 4 | 30 | 120.00 |
| | | | | |
| Water Truck | | 10 | 30 | 300.00 |

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | Subtotal | Equipment | $5,300.00 |
| | | | | |
| Goods & Services | | | | |
| | | | | |
| Aerial Weed Control | 1 job | | | $ 500.00 |
| | | | | |
| Gravel for haul road | 299 tons | $10.30/ton | | 3,079.14 |
| | | | | |
| Herbicide for olive & noxious weed control | 155.78 gal | $50/gal | | 7,709.02 |
| | | Subtotal | G & S | $11,288.16 |
| | | | | |
| | | ***Grand Total*** | | **$25,927.83** |
| | | | | |

## City of Grandview

**City of Grandview Water Treatment Facility**

Service debt on pumping infrastructure 2008 — $67,000

Electrical costs for pumping water — $10,000

## Other Partners

### Ducks Unlimited

Indirect Cost donation — $72,359

**Pheasants Forever**

Grass planting — $8,590

### Washington Waterfowl Association

Volunteer restoration and monitoring — $5,000

### Yakima Valley Audubon Society

| | |
|---|---|
| Volunteer monitoring | $17,000 |

### Central Washington University

| | |
|---|---|
| Hydrologic monitoring | $9,000 |

### Yakima Basin Environmental Education

| | |
|---|---|
| Volunteer time | Not quantified by report date |

***2008 Grand Total for all partners - Non-Federal Match $214,876***

# USFWS Toppenish NWR
# In-Kind Share Contribution Report
# for
# Goldendale Road NAWCA Restoration Project
# WA-172-6
# 2008 activities

| | | |
|---|---|---|
| Project Contributor: | USFWS, Mid-Columbia River NWR Complex | |
| Project Area: | South Channel, East/West Swales | |
| Start/end date: | 7/14/08 – 8/22/08 | |
| Equipment used: | 690E JD Excavator (machine/fuel/operator) | @ $195.50/hr |
| | 7710 JD Tractor/Meri crusher implement | |
| | (machine/fuel) | @ $35.00/hr |
| | (operator) | @ $40.00/hr |
| | 7200 JD Tractor/15’ mower implement | |
| | (machine/fuel) | @ $35.00/hr |
| | (operator) | @ $40.00/hr |
| | 416 Cat Backhoe | @ $97.75/hr |
| | Dump truck #1, 2, 3 ea (truck/fuel/driver) | @ $123.00/hr |
| | Laserplane laser level | |

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## *Summary of Costs for In-Kind Share Contribution*

### Mobilization Costs

| | | |
|---|---|---|
| 1. 690E JD Excavator from/to Burbank WA | = | $1,437.50 |
| 2. Dump truck #1 (15cubic yard) from/to Burbank WA | = | $482.00 |
| 3. Dump truck #2 (15cubic yard) from/to Burbank WA | = | $482.00 |
| 4. Dump truck #3 (15cubic yard) from/to Burbank WA | = | $482.00 |
| 5. 7710 JD Tractor with Mericrusher from/to Irrigon OR | = | $1,240.00 |
| 6. 416 Cat Backhoe from/to Toppenish WA | = | $0.00 |

### Excavation Costs - East Swale

| | | | |
|---|---|---|---|
| *5 August 2008* | | | |
| Tractor/mower/mericrusher | 8hr x ($35.00 + $40.00) | = | $600.00 |
| *6 August 2008* | | | |
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| *7 August 2008* | | | |
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |

| | | | |
|---|---|---|---|
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |

*8 August 2008*

| | | | |
|---|---|---|---|
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |

*9 August 2008*

| | | | |
|---|---|---|---|
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |

*12 August 2008*

| | | | |
|---|---|---|---|
| Excavator | 3hr x $195.50/hr | = | $586.50 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $???/hr | | |

*13 August 2008*

| | | | |
|---|---|---|---|
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |

## Excavation Costs - West Swale

*14 August 2008*

| | | | |
|---|---|---|---|
| Tractor/mower/mericrusher | 8hr x ($35.00 + $40.00) | = | $600.00 |
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |

*15 August 2008*

| | | | |
|---|---|---|---|
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |

*18 August 2008*

| | | | |
|---|---|---|---|
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |

| | | | |
|---|---|---|---|
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |
| *19 August 2008* | | | |
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |
| *20 August 2008* | | | |
| Excavator | 8hr x $195.50/hr | = | $1,564.00 |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |
| *21 August 2008* | | | |
| Backhoe/loader | 8hr x $97.75/hr | = | $782.00 |
| Dump#1 | 8hr x $123.00/hr | = | $984.00 |
| Dump#2 | 8hr x $123.00/hr | = | $984.00 |
| Dump#3 | 8hr x $123.00/hr | = | $984.00 |

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| | |
|---|---|
| Sub-total for Mobilization | $4,123.50 |
| Sub-total for Excavator | $14,662.50 |
| Sub-total for Backhoe/loader | $9,384.00 |
| Sub-total for Tractor and implement | $1,200.00 |
| Sub-total for Dump Trucks 1, 2, 3 (@ 50% of value) | $16,236.00 |
| Sub-total for Water Control Structures (see attached) | $7,435.76 |

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**GRAND TOTAL Federal Cost-Share $50,041.76**