Ecological Restoration Design ~ Civil Engineering ~ Natural Resource Management

TECHNICAL MEMORANDUM

To: Shane Latimer, Latimer Environmental, LLC.

From: John Dvorsky, Waterways Consulting, Inc.

Date: September 21, 2012

Re: Riverbend Landfill Geomorphic Analysis

Overview

The Riverbend Landfill Co. (RLC), located in Yamhill County, Oregon (Figures 1 and 2), has proposed a floodplain enhancement project on land owned by RLC that abuts the South Yamhill River (South Yamhill). To support this effort and provide design criteria and recommendations, Waterways Consulting, Inc. (Waterways) conducted an evaluation of geomorphic conditions of the South Yamhill in the vicinity of the project. The analysis included a geomorphic evaluation of the site, use of aerial photos to map changes in channel planform over time, and a general description of the form and function of the South Yamhill. This brief technical memorandum summarizes the results of the analysis and provides design approach recommendations for channel-floodplain improvements.

Geomorphic Setting

The South Yamhill is a low gradient, meandering river that drains the east side of the Oregon Coast Range. The primary geomorphic influence on the form and function of the South Yamhill are the deep, fine grained sediments deposited by the Missoula Floods during the Pleistocene (Figure 3). Much of the Yamhill Valley was periodically inundated in the backwater of the Columbia River-derived Missoula Floods, which are known to have occurred many times over the last two million years. Following the passing of each flood, reincision of the unconsolidated, fine-grained deposits resulted in a moderately incised, meandering channel planform that was quickly recolonized by riparian vegetation. As this process repeated itself over the last two million years, a mosaic of terraces, oxbows, and floodplain channels formed, overlain by thin alluvial layers deposited by the South Yamhill. Consequently, alluvial features present along the modern Yamhill River consist of landforms that were generated in response to the Missoula Floods and those that were generated directly by the South Yamhill and its tributaries.

Geomorphic Evaluation

Due to soil characteristics, the lack of a significant supply of coarse bedload, and the natural density of vegetation lining the banks, the current planform of the South Yamhill, within the project area, has not changed significantly from what it was historically. This hypothesis is supported by radiocarbon dating of a Native American archaeological site on a flood terrace within the project area that dates back to approximately 3,000 years before present[1]. This evidence suggests that the South Yamhill has not reworked these terrace deposits for at least the last 3,000 years.

To further test this hypothesis, an analysis of channel planform in the project area was conducted using historic aerial photos dating back to 1936 and extending to 2005 (Figures 4 and 5). Although 69 years of data does not definitively describe long-term changes to the form and function of the South Yamhill, it does provide an opportunity to evaluate changes to channel form during a period of rapid changes to adjacent land uses, and the watershed as a whole, and provides a sufficient amount of time to estimate rates of channel migration.

To roughly evaluate the rate of change of the local planform of the South Yamhill, five meander bends were assessed using the vegetated bank lines digitized from the georeferenced aerial photos from 1936, 1966, and 2005. The measured rates of channel migration ranged from 3.9 feet per year to 1.5 feet per year with a mean of 2.2 feet per year (see Figures 4 and 5). Although it was not analyzed quantitatively, a qualitative/observational evaluation suggested that the observed rates of bank erosion were associated with meander bend migration and/or translocation through a process of inner bend accretion and outer bend erosion, rather than wholesale widening of the channel.

The results of the analysis suggest that the planform of the South Yamhill has been fairly static over the past 69 years and rates of bank erosion are low, despite the degree of change that has occurred in the watershed. Much of the watershed has converted from natural land cover types to land uses dominated by agriculture, industrial forestry, and suburban and rural development.

The primary effect of land use changes appears to have been to the profile stability of the South Yamhill, rather than the lateral stability. The primary result of impacts to profile stability has

[1] Radiocarbon dating of the archaeological site within the project area was conducted by ICF Jones & Stokes in 2009. Although a report was prepared, the information and the location of the site can not be shared with the public to protect the documented artifacts.

been increased rates of channel incision along the mainstem of the South Yamhill. Channel incision has been observed along many mainstem river systems draining the east side of the Oregon Coast Range including the Tualatin River, Chehalem, Luckiamute, Mary's River and others. The causes of channel incision vary but are primarily the result of changes to the downstream base level (e.g. – incised mainstem rivers downstream), changes to the hydrology (e.g. – higher peak flows, increased flashiness), or direct channel modifications (e.g. – straightening, filling of floodplain channels, etc).

Incision impacts channel function by reducing the frequency at which flows access the floodplain, thereby disconnecting the main channel from its floodplain and degrading the value of the floodplain. Incision can also result in further incision due to increases in shear stress on the bed of the channel as flow depths increase, creating a positive feedback loop that can eventually lead to bank erosion and channel widening. This process is more pronounced where the bank material is composed of sand or other coarser, unconsolidated sediments. But in all cases, channel incision has a direct impact on channel-floodplain interactions, degrades the value of the floodplain, and can eventually lead to bank erosion and channel widening.

Although land use impacts have led to moderate rates of channel incision on the South Yamhill in the recent past, it is unlikely that the channel will continue to incise. Because channel incision can have a significant impact on existing infrastructure, such as diversion structures, culverts, and bridges, efforts to arrest the incision (e.g. – grade control at bridges) occur over time to lessen the impact. The effect is a new base level for the river and a more stable channel profile. Where bank material is composed primarily of unconsolidated sediment (e.g. – sand, gravel, and cobble) or where bank vegetation has been removed, incised channel with stable bed profiles often begin to migrate laterally. In the case of the South Yamhill in the vicinity of the project, moderate incision of the channel has not led to lateral instability because the bank material is fairly consolidated and a healthy riparian corridor has been maintained along the margins of the channel.

Design Approach Recommendations

In situations where channel-floodplain interactions have been impacted by channel incision, two potential enhancement approaches can be pursued. One approach involves measures to re-aggrade the channel, thereby forcing the bed of the channel back up to where there is a more frequent hydrologic connection with the floodplain. The techniques to accomplish this vary considerably from site to site but can include channel-spanning structures, reducing the slope of the channel by forcing a more sinuous meander pattern, or other measures to increase channel roughness. A major constraint associated with this approach is the fact that increases in the elevation of the channel bed are often accompanied by increases in flood elevations. In many cases, increases in flood elevations are not tolerated due to impacts to adjacent properties and infrastructure as well as upstream effects.

An alternative approach to improving channel-floodplain interactions is to lower the elevation of the floodplain. This involves mass excavation of terrace deposits and is often accompanied by creation of lower terraces that flood more frequently, integration of floodplain wetland features, installation of habitat elements such as large wood, and a vigorous program of native revegetation. The specific approach taken at each site needs to consider the hydrology to define the proposed bench elevations, soil conditions to minimize erosion of the bench prior to vegetation establishment, upstream and downstream effects, and the potential impacts that localized changes in cross-section geometry and channel-floodplain dynamics might have on sediment transport continuity through the system. One of the primary constraints on using this approach to improve channel-floodplain dynamics is the cost associated with implementation. For the project to be effective it often requires that a large amount of material is removed from the abandoned terrace. In many cases the removed material needs to be hauled off site and a disposal site identified.

Given the conditions at the Riverbend site, forced aggradation of the South Yamhill is not a feasible option. Raising flood elevations would significantly impact adjacent and upstream farmland and common techniques used to aggrade streambeds are not practical for a river the size of the South Yamhill. Consequently, the preferred approach to improving channel-floodplain interactions is to lower adjacent terrace and floodplain elevations closer to the river elevation. To minimize potential impacts to sediment transport continuity along the South Yamhill, improvements to channel-floodplain interactions could best be achieved by mimicking a backwater/alcove landform rather than through direct benching. This approach also addresses bank erosion concerns by maintaining a buffer between the lowered floodplain/alcove and the main channel and protects existing mature riparian vegetation within that buffer.

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FIGURE 1

Project location for the Riverbend Landfill floodplain enhancement project on the South Yamhill River. The project is located south of McMinnville, Oregon.

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FIGURE 2

Existing project site conditions on the South Yamhill River. The project site is southeast of the existing landfill operation on Salmon River Highway 18.

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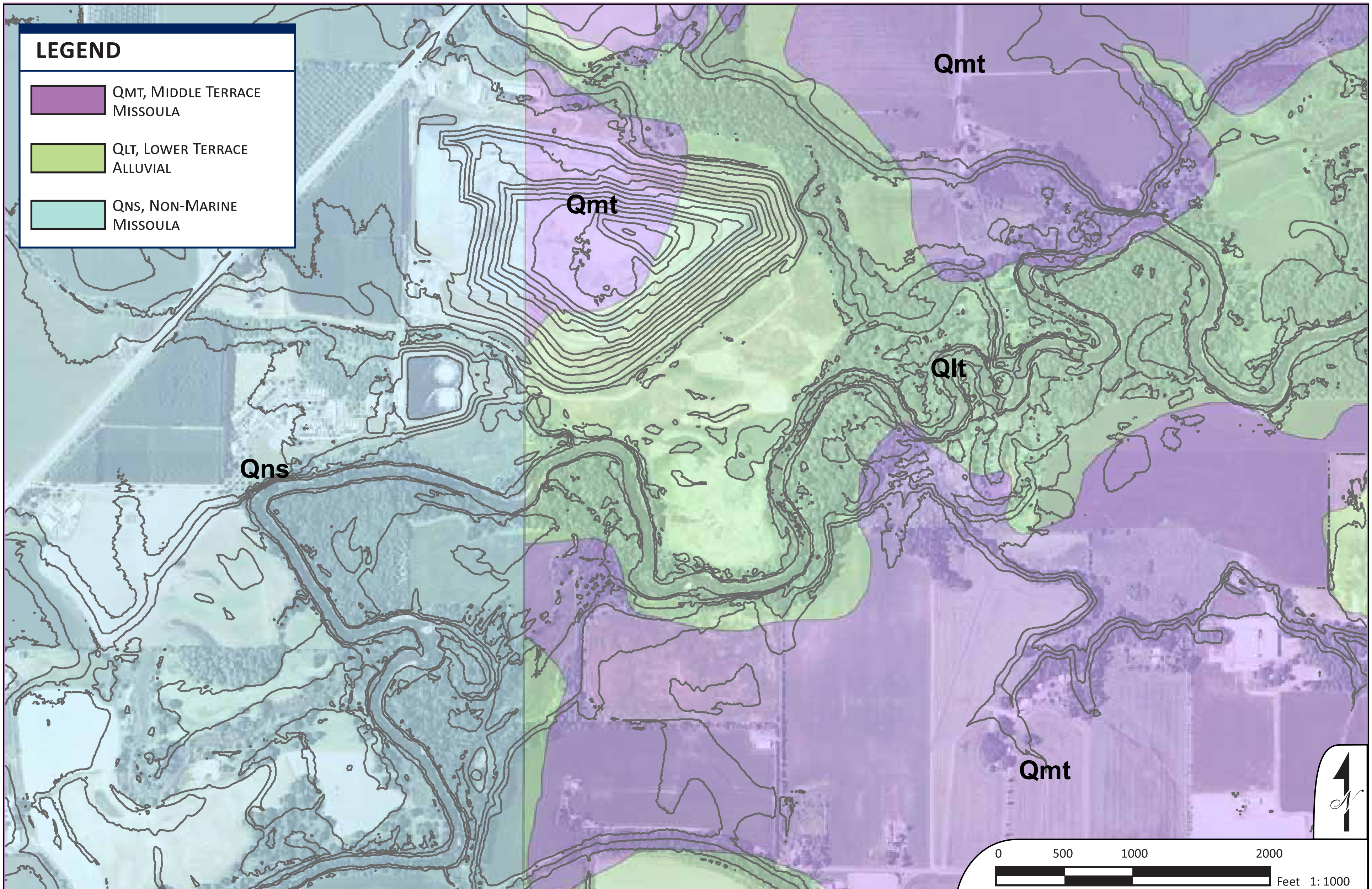

FIGURE 1

Geologic map in project vicinity with 10-foot contour lines, and aerial in background.
Geology map source: DOGAMI, 2012; Original source is from two mapping products.

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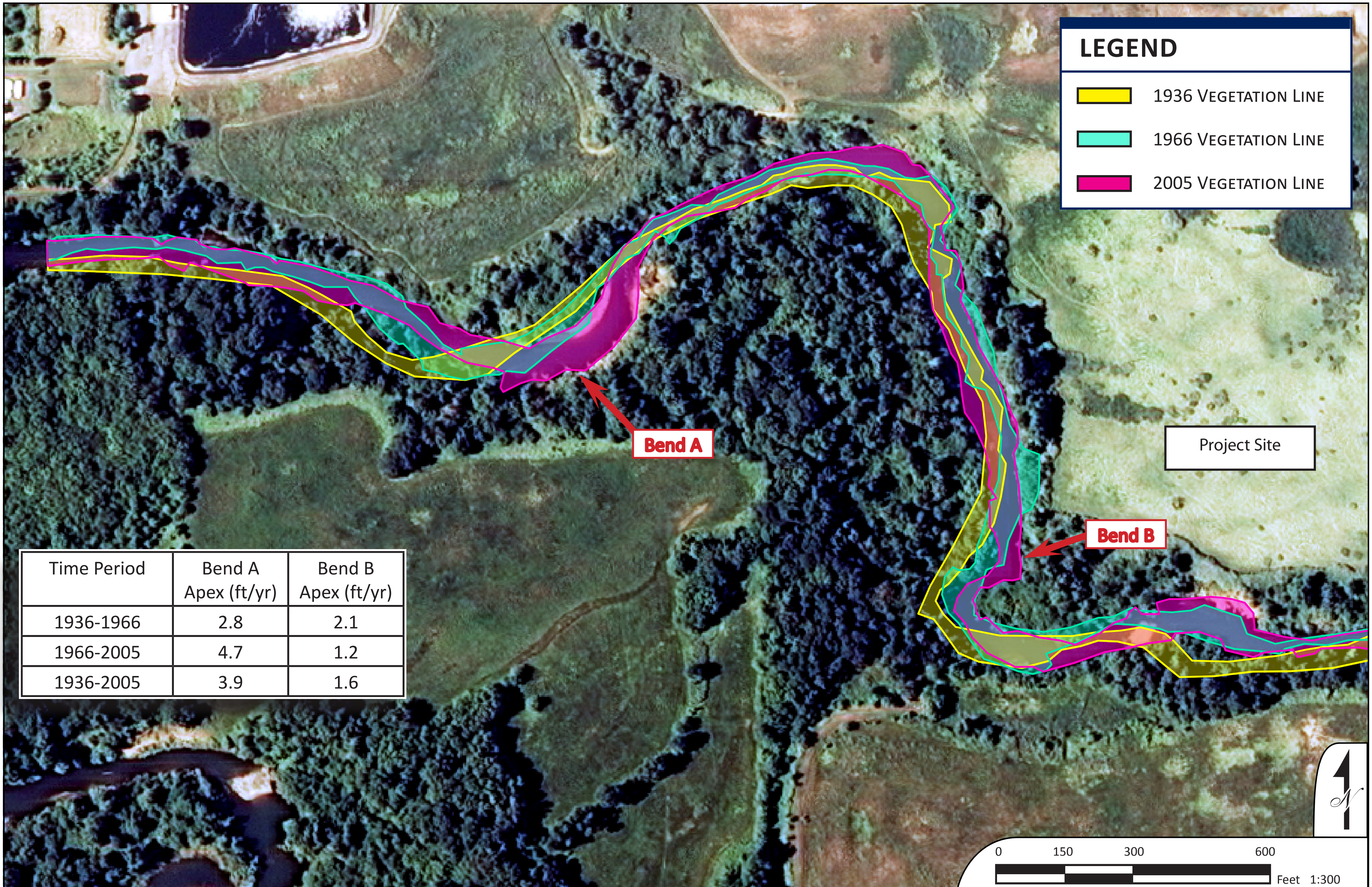

Time Period	Bend A Apex (ft/yr)	Bend B Apex (ft/yr)
1936-1966	2.8	2.1
1966-2005	4.7	1.2
1936-2005	3.9	1.6

FIGURE 4
Map depicting movement in vegetation line on the S. Yamhill River over time from historic aerial photograph analysis, shown overlaid on 2005 aerial with table of movement rates (ft/yr) at outside bends.

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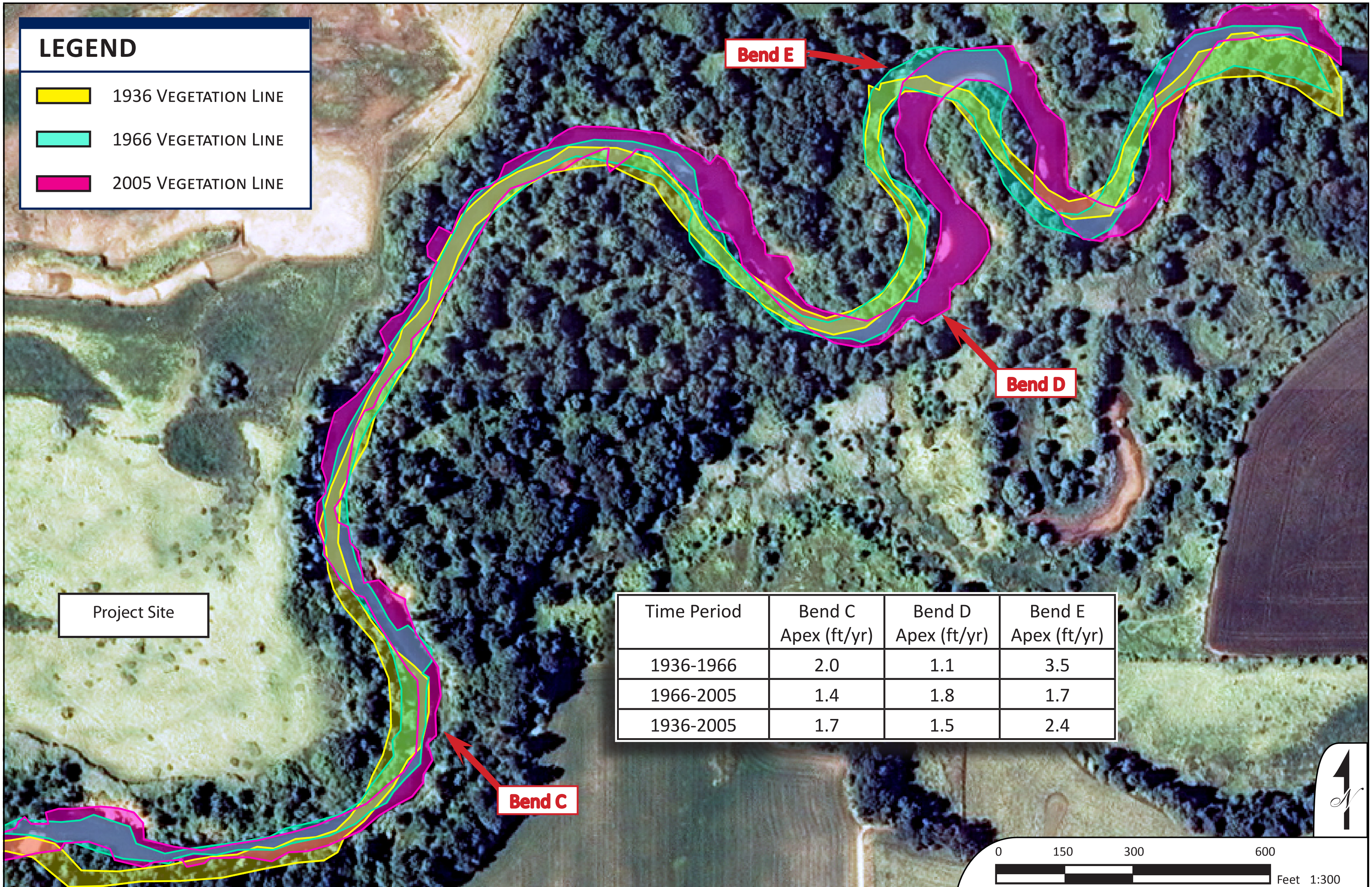

Time Period	Bend C Apex (ft/yr)	Bend D Apex (ft/yr)	Bend E Apex (ft/yr)
1936-1966	2.0	1.1	3.5
1966-2005	1.4	1.8	1.7
1936-2005	1.7	1.5	2.4

FIGURE 5

Map depicting movement in vegetation line on the S. Yamhill River over time from historic aerial photograph analysis, shown overlaid on 2005 aerial with table of movement rates (ft/yr) at outside bends.

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