Section 5: Project Description

1. **Project Objectives:**

   Project will retrofit an existing restoration site for enhanced native plant productivity, enhanced water quality associated with roadside runoff and to achieve GHG reductions. The following objectives have been developed:

   - Enhance native plant growth in coastal freshwater wetland.
   - Enhance water quality in relation to roadside run-off in coastal freshwater wetland.
   - Provide enhanced wetland habitat for vertebrate species.
   - Provide long term carbon sequestration and reduction of other greenhouse gases in coastal freshwater wetland.

2. ***Background and Conceptual Models*:**

   Biochar, a specialized form of charcoal useful as a soil amendment, is also a capable of mitigating climate change. Biochar is typically plowed or tilled into the soil to increase agricultural crop yields and conserve nutrients and water. Because of biochar's applicability for improving crop production, in part due to increased mycelium activity, it is believed that the addition of biochar to a coastal wetland restoration site will enhance the establishment of native wetland plants. However, this incorporation of biochar for soil productivity will also result in long term carbon sequestration as well a potential reduction in nitrous oxide (N_2O) (Rondon, M. et. al., 2009).

   Biochar is created through the process of "pyrolysis" utilizing agricultural and agro-forestry waste products as the biomass feedstock. With pyrolysis the feedstock is heated in the absence of oxygen resulting in an output of nearly pure carbon. In undergoing pyrolysis a percentage of the biomass feedstock is effectively prevented from decaying and returning CO_2 to the atmosphere.

The International Biochar Initiative (IBI) states that "one of the most critical characteristics of biochar as a climate change mitigation technology is its long-term stability in soil," concluding that *biochar can hold carbon in the soil for hundreds and even thousands of years*. (Source: IBI at http://www.biochar-international.org/protocol). Both Bill McCibbin (Founder 350.Org) and James Lovelock (originator of the Gaia theory) promote the use of biochar as a means of reversing anthropogenic induced climate change.

The IBI states that biochar also increases soil microbial life (i.e. mycelium networks), resulting in even further carbon storage in soil. In addition to storing carbon "biochar also improves soil fertility, stimulating plant growth, which then consumes more CO_2 in a feedback effect; and because biochar retains nitrogen, emissions of *nitrous oxide may be reduced*". Additionally, incorporating biochar will reduce bulk density of soil (dense silty clay soils are present at the coastal wetland site); reducing bulk density will lead to increased plant productivity.

Biochar can also effectively treat storm water runoff. In a 2014 report on stormwater BMP's, the Pacific Northwest Pollution Prevention Resource Center (PPRC), concluded that the emerging technology of biochar filtration is demonstrating efficacy in pollutant removal from contaminated stormwater, especially for dissolved metals and stating "Biochar's incredible porosity and surface area give it a high capacity to adsorb a wide variety of contaminants from water. Recent laboratory testing conducted in the PNW and worldwide shows that biochar can effectively reduce contaminants including: heavy metals like lead, copper, zinc, cadmium, cobalt, and nickel; organics such as gasoline compounds and other volatile organics, polychlorinated biphenyls (PCB), polyaromatic hydrocarbons (PAH), and some herbicides, pesticides and pharmaceuticals; nutrients such as phosphorus and ammonia, and totals suspended solids (TSS)."

Biochar "socks" can be utilized to capture heavy metals associated with storm water off roadways. Socks are essentially tubes of pervious material containing biochar blended with sand. The sand adds weight to prevent the socks from moving around and also insure that runoff water maintains sufficient contact time with the biochar.

Project will utilize applications of biochar soil for increased soil (plant) productivity, improved storm water quality off roadway, and for sequestration of carbon.

Project will also install native plants, additional to those already on-site.

Additionally, project will install large woody debris throughout habitat to provide habitat diversity and other ecosystem function to site, as well as install four raptor perching sites and bat boxes to provide habitat diversity to wetland site.

3. ***Detailed project description, including all tasks to be performed:***

Perform baseline monitoring to obtain data on soil organic carbon and nitrogen levels.

Within test plots, incorporate 5% biochar into top 6" of soil profile through rototilling (application rate = 40 CY (cubic yards) per acre), during the fall.

Monitor soil profile for soil carbon and nitrogen levels in treatment/non-treatment plots for 4 years post project implementation.

Deploy biochar for stormwater treatment utilizing 8-inch diameter socks, during the fall. Attach socks to roadway prism fill slope approximately 12" from top of slope to facilitate treatment of runoff.

Perform water quality monitoring relative to storm water runoff from roadway at both treatment and non-treatment sites. Perform storm water sampling in treatment/non-treatment plots for total 4 years.

Install large woody debris throughout site, as available during non-rainy period.

Install bat boxes and raptor perches, during non-rainy season.

Install native wetland plants, during the fall. Monitor plants for survival and vigor for three years post project implementation.

4. ***Timeline:***

June–July 2015: Order materials. (Note: Obtaining plant material for site will incl. one year lead time for local collection of source plant material and propagation).

Sept–Oct 2015: Perform baseline monitoring for soil carbon and nitrogen.

Sept–Oct 2015: Incorporate biochar into soil for GHG reduction and increased plant productivity. Install biochar socks for stormwater treatment.

Nov–Dec 2015: Perform Yr 1 water quality sampling of storm water at roadway adjacent to project wetland, at both treated and untreated locations.

Sept–Nov 2015: Install raptor perches, bat boxes and woody debris.

Sept–Dec 2016: Perform YR 1 monitoring of soil carbon and nitrogen.

Nov 2016: Install native plants.

Nov–Dec 2015-2019: Perform YR 2 through YR 4 storm water sampling

June–July 2017: Perform YR 1 plant productivity monitoring.

Sept–Dec 2017-2019: Perform YR 2 through YR 4 (final report) monitoring of soil carbon and nitrogen.

Nov–Dec 2016-2019: Perform YR 2 through YR 4 (final report) storm water sampling.

June–July 2018-19: Perform YR 2 through YR 3 (final report) plant monitoring.

5. ***Deliverables:***

Soil Carbon and Nitrogen Monitoring Reports, Baseline Report due Jan 2016, then Yr 1-4 – due annually each year Jan 2017 through Jan 2020.

Storm Water Monitoring Reports Yr 1-4 – due annually each year Feb 2016 through Feb 2019.

Plant Productivity Montoring Reports Yr 1-3 – due annually each year Oct 2017 through Oct 2019.

6. ***Expected quantitative results (project summary):***

In their 2009 report, *Use of Biochar from the Pyrolysis of Waste Organic Matter as a Soil Amendment*, Washington State University researchers found that biochar represents an offset of about 2.93MT of CO_2 per MT of biochar applied to soil. (MT=metric ton=1000kg or 2200 lb). This project will deploy approximately 6 tons of biochar which would therefore equate to 17.58 MT of CO2 offset.

While Rondon et. al. found that the application of biochar can also result in reduced methane (CH_4) soil emissions, conditions at the proposed restoration site are unlikely to facilitate the production CH_4 as the site is only seasonally saturated; for this project measurements of CH_4 are unwarranted.

7. ***Protocols:***

Project will utilize a random plot study design; dividing a three-acre portion of the four-acre wetland site into 16 to 32 equal boxes and randomly assigning treatment. Along SR 255, approximately 5 20’ socks will be installed on roadway fill slope at various distances from top of slope. Location of the treatment sites will be chosen randomly, however each treated site will be paired with an equal distance of untreated area, for a total of 5 paired sites.

1. Humboldt State University students will sample soils and quantify soil carbon and nitrogen, prior to treatment to create baseline data. Monitoring will continue for 5 years post project implementation.

2. Soils will be sampled to a depth of 100 cm; soil profiles will be described and soil carbon

samples will be extracted from each horizon.

3. 20 soil profiles with 4 horizons per soil profile will be sampled for carbon content (80 total soil samples).

4. Soil carbon and nitrogen content will be determined using the Loss on Ignition method; lab analysis will be performed at the Humboldt State University Soils Lab.

5. Humboldt State University students will sample storm water at both treatment and non-treatment sites at the beginning of two to four storms events per year and collect water samples from the edge of road. Two samples of storm water will be taken from each treatment site; one from the upslope (inflow) and one from the downslope (outflow); two samples will then be taken at equal slope elevations at the paired untreated site for a total sample set of 20 samples. Sampling protocol will follow the State Water Resources Control Board, Surface Water Ambient Monitoring Program (SWAMP) guidelines; samples will be sent to a lab for analysis of copper, lead, zinc, heavy metals, hydrocarbons and phosphorous.

6. Plants will be sampled for survival rates and vigor, during the growing season, for four years post project implementation; plant survival and vigor metrics will be recorded for comparison between treatment and control plots.

7. Because the site is in former tidal marsh, the net loss of soil carbon will be calculated using reference soil carbon data from the City of Arcata's salt marsh soil carbon datasets. A trajectory will then be established estimating when the bichar treated site may match the natural tidal marsh carbon sequestration rate.

8. ***Literature Cited:***

Rondon, M. et.al., 2009, http://www.biochar-international.org/node/924

International Biochar Initiative http://www.biochar-international.org/protocol

PPRC, 2014 http://pprc.org/wp-content/uploads/2014/08/Emerging-Stormwater-BMPs_Biochar-as-Filtration-Media_2014.pdf

Washington State University, 2009, *Use of Biochar from the Pyrolysis of Waste Organic Matter as a Soil Amendment*.

SWAMP Guidelines http://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.shtml