



# **SALMON CREEK ESTUARY RESTORATION AND WOOD WASTE REMOVAL: LESSONS LEARNED REPORT**

**FY 2008-2011**

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**for the Salmon Recovery Funding Board**

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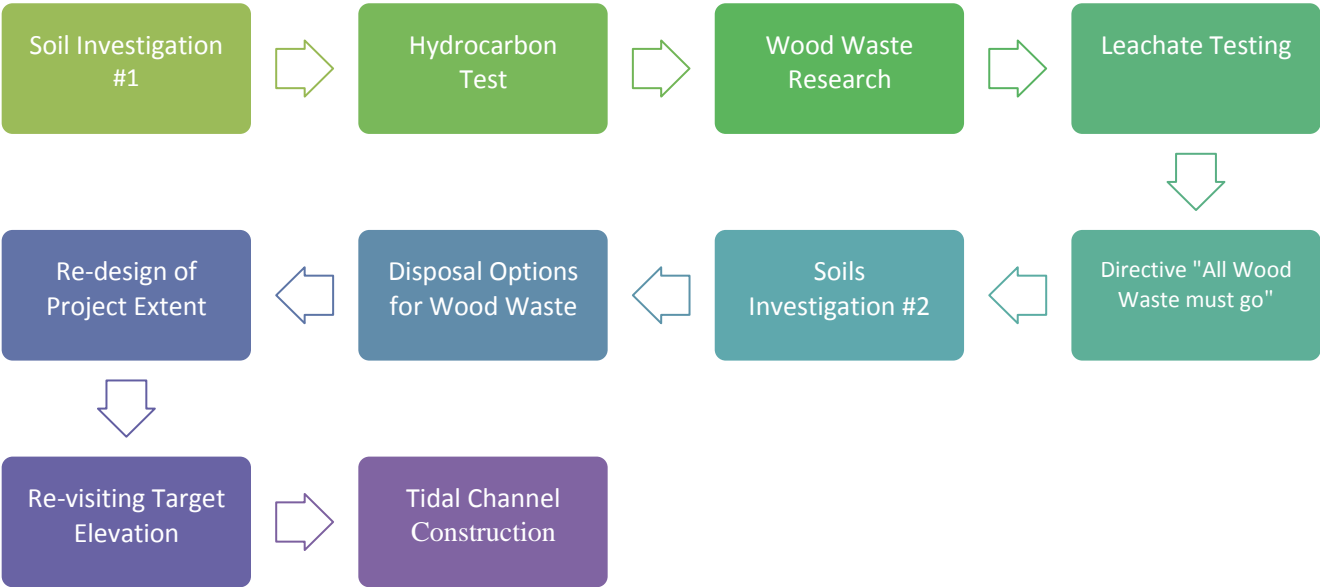
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# 1. Introduction

This report will focus on the lessons learned as related to working on a nearshore project site at the mouth of Salmon Creek in Discovery Bay, Washington where wood waste became a primary restoration consideration. The report will cover the evolution of the project following the discovery of substantial amounts of wood waste at the project site, and will document how this drove the evolution of investigations and the design. There will also be discussion of two design considerations which were substantive points of decision making for the team, these are the target elevation for the sites and whether or not to dig tidal channels or let them evolve naturally.

Extensive research was required to determine how to proceed. The community of funders and restoration practitioners had little experience and great curiosity with regard to wood waste and its leachates. Information and advice in the community, usually abundant, were scarce on these topics. Many of the papers on wood waste and leachates were found in Canadian literature where wood waste is regulated as a hazardous material due to the toxic nature of the leachates. In time, the local restoration practitioners built a significant knowledge base to guide site investigations and design.

It will become apparent in the following pages that the evolution of the design took on a new life at the point when a routine soils investigation turned up a sample with a hydrocarbon smell. The subsequent testing, which coincided with discovering research on the effects of wood waste in the aquatic environment, led to a chain reaction of events, discoveries, tests, studies and incorporation of topic experts into the design process.



Although the road was long and the costs continually increasing, the journey led the design team and restoration practitioners to implementing a project which addressed not only the restoration of lost salt marsh habitat in Discovery Bay, but also the discovery and removal of a significant toxin source in the nearshore environment.

### **Special Thanks**

This project evolved from a set of ideas to reality over the course of close to a decade. The driving force was a local group of cooperators called the Chumsortium. Chumsortium is made up of a core team from the Jefferson County Conservation District, Jamestown S’Klallam Tribe, Washington Department of Fish and Wildlife, North Olympic Salmon Coalition, Jefferson Land Trust, Hood Canal Coordinating Council (Lead Entity for Salmon Recovery in the region), Department of Natural Resources, Clallam County, Washington State University’s Jefferson County Extension Office and supported by many others from state and local government and other non-profits. These folks worked together, no one mandating that they do so, to develop a watershed plan for recovering lower Salmon and Snow Creeks. They then identified actions to pursue in order to acquire properties and begin implementing restoration actions for ESA listed Summer Chum Salmon in these watersheds. One of those actions was restoration of the estuary. The group established a core working group called the ‘Snow Salmon Technical Advisory Group’ or SSTAG. Meeting monthly for a number of years, this group worked collaboratively to establish the project vision, lay the groundwork and support all of the steps in the process from acquisition through design, implementation and monitoring of the Salmon Creek Estuary Wood Waste Removal Project. This project is an excellent example of the power of grassroots, community-based restoration and NOSC would like to thank the Chums, Partners, and SSTAG members who supported this project from conception through monitoring.

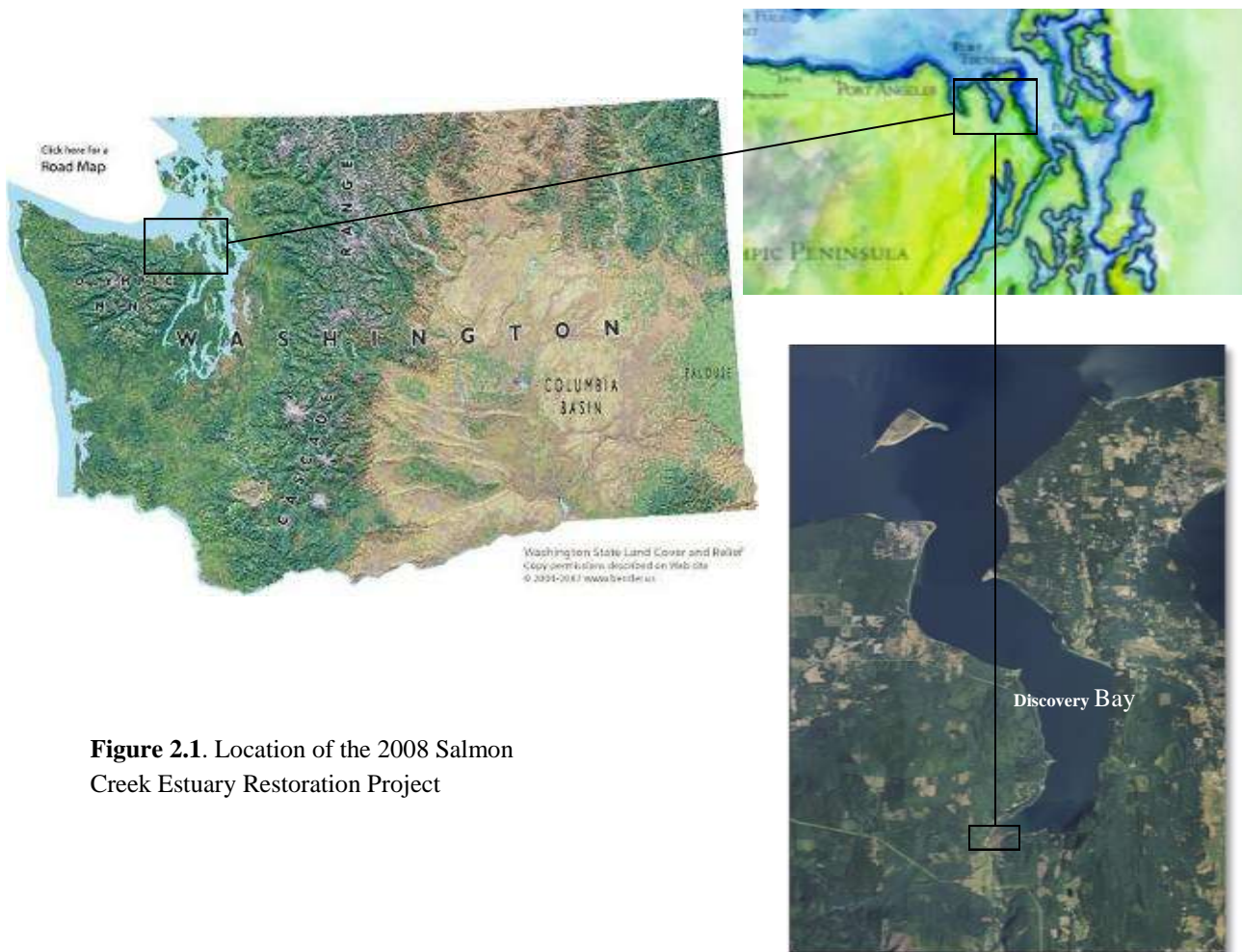
NOSC would also like to thank the Recreation and Conservation Office’s Salmon Recovery Funding Board for funding the wood waste removal and restoration portion of this project.

### **Key members of the SSTAG:**

Bob Barnard, Habitat Engineer – Washington Department of Fish and Wildlife (WDFW)  
Rebecca Benjamin succeeding Kevin Long, Project Manager – North Olympic Salmon Coalition (NOSC)  
Paula Mackrow, Executive Director, NOSC, later succeeded by Rebecca Benjamin  
Richard Brocksmith, Lead Entity Coordinator – Hood Canal Coordinating Council (HCCC)  
Sarah Spaeth, Stewardship Coordinator– Jefferson Land Trust (JLT)  
Stephanie Reith, Executive Director – JLT (later succeeded by Sarah Spaeth)  
Byron Rot, Habitat Program Manager- Jamestown S’Klallam Tribe (JSKT)  
Randy Johnson, Watershed Steward– WDFW (later of JSKT)  
Al Latham, Manager – Jefferson County Conservation District (JCCD)  
John Hansen, Engineer – WDFW

## 2. Project Background

The North Olympic Salmon Coalition conducted a large-scale restoration of 11 acres of salt marsh habitat at the mouth of Salmon Creek in 2008, with re-vegetation and monitoring work continuing in 2009, 2010 and 2011. The project area is located on Washington Department of Fish and Wildlife Property at the head of Discovery Bay in Washington State. (**Figure 1.1**). The property was purchased for the purposes of restoration and conservation. This project created and restored 11 acres of salt marsh in an area that was highly impacted by nearshore filling for a historic veneer mill and utilization of the nearshore for wood waste dumping. The area was restored to natural conditions by removing derelict buildings, wood waste and fill, constructing tidal channels, and planting native marine riparian vegetation.



**Figure 2.1.** Location of the 2008 Salmon Creek Estuary Restoration Project

## 2.1 Restoration Goals and Objectives

The goal of the Salmon Creek Estuary Restoration project was to restore estuarine and nearshore conditions and processes in the marine environment to benefit salmonid rearing and habitat for other nearshore and estuarine species. Below are the objectives for the project during the planning stage.

Objectives:

- Create approximately 11 acres of salt marsh plant communities
- Create 5,200 meters of tidal channels available to salmonids for foraging, rearing, cover and migration (1,100 meters of constructed tidal channels and 4,100 meters of additional tidal channels developing through natural processes over time)
- Increase presence of benthic and terrestrial insects that are forage for salmonids and shorebirds
- Remove five derelict buildings
- Improve diversity of native wetland vegetation
- Decrease pasture grasses and invasive vegetation
- Remove over 48,000 cubic yards of fill material, including 25,000 cubic yards of wood waste (these volumes increased as the project design developed. Final volume was 66,275 cubic yards of fill.
- Improve water quality

## 2.2 Project History and Restoration Need

In 1999 two estuarine-obligate salmonids (Hood Canal/Strait of Juan de Fuca summer chum and Puget Sound chinook) were listed as threatened under the Endangered Species Act. Salmon and Snow Creeks, located at the head of Discovery Bay, were one of the strongholds for the ESA listed Hood Canal Summer Chum. The local group called Chumsortium had been visioning, planning and implementing actions to further the recovery of summer chum salmon in Salmon and adjacent Snow creeks for several years. Many factors made implementation of the Wood Waste Removal project timely: The Jefferson Land Trust and Washington Department of Fish and Wildlife had recently accomplished the goal of acquiring land for the purposes of restoration and conservation, the Chumsortium had completed development of a Wildlife Area Management Plan for the Salmon-Snow Watershed, the Jefferson County Conservation District and WDFW had accomplished a 2500 foot stream re-meander on lower Salmon Creek, returns of Snow Creek (non-supplemented) summer chum salmon continued to be low, and the Salmon Creek summer chum broodstock program initiated in 1992 had sunset in 2003. **The Salmon Creek estuary was considered one of the highest priorities for restoration in the entire summer chum salmon ESU (HCCC Strategy, 2005).**



**Figure 2.2:** Salmon Creek estuary project aerial view during restoration (left) and after restoration (right).

The project included two sites, which are referred to as the ‘North’ and ‘South’ sites, **Figure 1.2**. The North site included an old log peeling and veneer mill. Wood waste was placed atop the historic estuary at the head of Discovery Bay mid-century during a brief history of log peeling and veneer making at the site. Ground water seeping through the wood waste ‘leached’ natural chemicals from the wood. These leachates were toxic, containing high levels of sulfur, ammonia and other chemicals. Leachates created toxic conditions for aquatic wildlife in an existing tidal channel adjacent to the wood waste pile. In order to grade the site to marsh surface elevation and improve water quality, the project required the removal of 4,700 cubic yards of sawdust and 25,000 cubic yards of other types of wood waste and gravel. Historic tidal channels filled with wood chips, were revealed and excavated when the wood waste was removed.

The South Site is bordered by Salmon Creek and had historically been graded for use as pasture. The project graded the area to salt marsh elevation and a network of primary and secondary tidal channels were constructed. 30,000 cubic yards of the material were moved to an upland disposal site on the same property, 2,875 cubic yards were moved to the North Site and used as backfill, and 3,700 cubic yards were moved offsite.

## 2.3 The Planning Process

Over the course of 2005-2008 the SSTAG met monthly to assist with the design of the project. The North Olympic Salmon Coalition took the lead on the SSTAG and eventually sponsored the grants to fund the work and managed the project. Participation by staff from multiple departments of WDFW, the HCCC, JSKT, JLT and JCCD was key to the SSTAG's success in



**Figure 2.3:** Excavation of the North Site Estuary, 2008 (Photo courtesy of NOAA)

bringing a wide range of backgrounds and experience together to design a complex project. The ability of the group to share knowledge, debate merits of various approaches, disagree, agree, challenge one another and ultimately make consensus decisions was the foundation of a healthy planning process and is an outstanding example of great work taking place at the local level with a group of collaborative partners and stakeholders. The group determined the necessary

information to be gathered that would inform design, cost and constructability estimates, then reviewed the results of the studies for consideration in relevant design elements. A great deal of consideration was given to all elements of the design to ensure that project goals and objectives would be met. Foundational work to support meeting the project goals included survey, wetland delineation, vegetation survey, archaeological investigation, soil studies, geotechnical investigation, tidal elevation study, toxicity investigations, a Snow/Salmon reconnection study and a bridge capacity study for the Highway 101 Bridge. Of all these investigations, it was the first soil investigation that proved to be the most pivotal.

## 3. Soils Investigation #1

In December 2006 a preliminary soils investigation was carried out to determine the types of soils on site for evaluating design approaches to both the North and South sites, suitability for long term vegetation establishment and to investigate likelihood of industrial contaminant presence. Combinations of hand auger and backhoe holes were dug.

### 3.1 North Site Soils

It was known that a sawdust pile existed at the North Site covering approximately 20% of the 4 acres. What wasn't known until the backhoe accessed other areas of the site, seeming to be upland, was that close to 95% of the North Site contained wood waste. Areas covered with upland vegetation and seeming to be stable turned out to be nothing more than wood waste under highly saturated conditions, with upland vegetation growing on top. Unfortunately it was the weight of the backhoe that revealed the hidden wood waste swamp at the 'upland' portion of the North Site. What's a restoration project without at least one sunken backhoe incident?



**Figure3.1:** Areas thought to be upland, turned out to be pockets of wood waste saturated with ground water and unsuitable for our exploration equipment access.



#### **Lesson Learned:**

Gravel and wood waste are not suitable substrates for long term establishment of stable vegetation colonies. Salt marsh vegetation needs at least 18" of suitable soils.



Soils at the North Site turned out to be varied and much of the area, once excavated, would end in coarse, gravelly fill material, sawdust or other wood materials (bark, veneer, charred wood, wood chips). The design team deliberated the implications of sawdust and gravel as materials in which salt marsh vegetation could establish. Evaluation of the nearby Jimmycomelately (JCL) site (a similar salt marsh restoration/fill removal project) and other projects in Oregon and San Francisco, along with consultations with Estuary and Salmon Restoration Program (ESRP) and National Oceanic and Atmospheric Association (NOAA) staff, led the design team to decide that imported gravels and sawdust were not suitable substrate for long-term

plant establishment. Vegetation will recruit to these substrates, but successful long term establishment is not likely as root structures are easily uprooted in storm surges. Therefore the design directive was given: areas where the target grade elevation ended in gravel, were to be over-excavated and backfilled.

### 3.2 South Site Soils

The presence of soils suitable for long term vegetation establishment at the South Site boded well for restoration. At the target elevation, there were fine grained soils that would support salt marsh plants.

### 3.3 All Hydrocarbons are not Created Equal

Through the soils investigation at the North Site, the soil scientist detected a 'hydrocarbon' smell in one of the hand augured sites along the known sawdust pile. Four samples were collected and sent to a lab for testing. Tests results indicated that one of the samples had carbon in the 'range' of motor oil. Given the industrial use of the site, this was not unexpected and was taken to mean that 'motor oil was present'. We began considering how to proceed with further testing to determine the extent of the problem. In the meantime, the project manager began reading about wood waste and found research papers on the leachates associated with wood waste (including sawdust). The literature covered wood waste in the environment when it occurs in large amounts, in anaerobic conditions and is exposed to ground water infiltration.

#### Signs of leachates include:

- Oily sheen (which breaks into angular fragments when disturbed)
- Petroleum-like odor
- Black liquid
- Foaming
- High sulfur smell (can be nauseating at close proximity)
- White filamentous strings or mats of white bacteria coating adjacent surfaces in the aquatic environment



#### **Lesson Learned:**

When found in large quantities in a location exposed to fresh, groundwater infiltration, wood waste can produce leachates toxic to the aquatic environment, even if the wood source had no prior chemical treatment.



## Signs of Leachate Lead to Closer Examination of the Hydrocarbon Sample

At the project site, adjacent to the known sawdust pile, the project manager had observed the oily sheen, sulfur smell, white mats of bacteria and the soil scientist had observed a petroleum-like odor. The project manager called the lab to discuss possible testing for leachates and to discuss the samples that had tested positive for hydrocarbons. The lab manager indicated that



### Leachates include:

Sulfates, ammonia, phenols organic nitrogen, resin acids, Zinc, Iron, Manganese, tannins and lignins

the North Site samples were tested for a 'carbon range' but tests were not qualitative because things like leaves and sawdust can also produce results in the same range. When the lab manager learned that the samples in question came from a sawdust pile, she informed us that unless a 'silica cleanup' was done on our samples, it wasn't certain if the carbon presence was organic or

chemical. The 'silica cleanup' involves using a silica gel to absorb all water and natural fats from the sample, leaving behind any chemically produced oils (e.g. motor oil). This test was not done; therefore we had no way of knowing if we actually had motor oil or other naturally occurring hydrocarbons from the sawdust pile; and the sample had been discarded so it couldn't be re-tested.

The end result of the original soil investigation was an inconclusive hydrocarbon test, and a fairly certain presence of wood waste leachates. The leachates were draining into an existing, otherwise healthy salt marsh tidal channel adjacent to the sawdust pile site. Further investigation into the wood waste and leachates followed.



### Lesson Learned:

When hydrocarbons are suspected at a site which may also have wood waste present, inform the lab of the presence of organics and determine if a silica cleanup is needed on the sample to define the origin of hydrocarbons.

## 4. Wood Waste

*"Taking into consideration the information on sawdust leachates, their propensity to have a 'petroleum-like odor' and the likelihood that these leachates are present at our site, I do not feel it is necessary to continue with hazardous materials testing at this time. I suggest instead, that we shift our focus to testing for leachates and evaluating the proper procedures to follow for*

*determining what to do with the sawdust pile.*” - Rebecca Benjamin, project manager in a meeting with the technical team January 2007.

#### 4.1. Wood Waste Research

The project manager and habitat engineer spent countless hours researching wood waste. Many of the papers on the subject come out of Canada, where wood waste is regulated as a hazardous material by their government because of the leachates’ toxic effect on the aquatic environment. These substances are released at such a high concentrations that they are toxic to aquatic life. In Canadian studies, leachates have been shown to decrease a fish’s blood carrying capacity for oxygen and fish exposed to certain leachates died in 90 seconds, macroinvertebrates in 48 hours (Alkahem, 1993, 1994; Mazon et al., 2002). For more information about wood waste leachates please refer to Appendix A.

During our research on wood waste and leachates, there was a newspaper article on the Commencement Bay Restoration Project and the presence of sulfur loving bacteria. Joel Elliott, featured in the newspaper article, is a professor at University of Puget Sound. He had recently published a paper on sulfur-loving *Beggiatoa* bacteria growing on wood waste piles in the marine environment. After sending him photos of the white mats of bacteria in the tidal channel adjacent to the pile at our North Site, he immediately came to the site and took sample of bacteria and ran sulfide samples on the water in the channel (**Figure 4.1**). He observed white sulfur loving bacteria from the sawdust pile where it appeared as thick mats of white filaments in deep-red tannin stained water. These mats extended to the tidal channel mouth where it appeared as a thin film on the rocks. He also noted distinct absence of tunicate holes and castings in the channel which was a variation from the healthy populations of tunicates in channels not exposed to the leachate. Dr. Elliott confirmed the suspicion that indeed the site had a leachate problem, and it was substantial.

## 4.2 Leachate Testing

Simple ammonia and sulfide tests were done to get a snapshot of what might be happening on the site in terms of leachate presence and concentrations. There were many factors affecting these tests results (pH, Oxygen etc.) that were not sampled at the time, but these test results were sufficient to provide a snapshot of what we were facing. Ammonia was above the level known to be toxic to fish and sulfides were almost 5,000 times higher than the level known to be toxic to salmonids. Even at the mouth of the 375 foot channel, levels of sulfides were 2,000 times higher than the known toxic level. More extensive testing could have been done but with the sulfides at such high values in the preliminary tests, we had enough information to be certain the wood waste on site had to be eliminated.

**Table 4.1:** Results of Leachate Testing

Contaminant	Lab Results	Implications
Ammonia	.26 mg/L	.20 mg/L considered toxic to fish
Sulfides at start of tidal channel	9965 mg/L	2 mg/L considered toxic to salmonids
Sulfides midway down the tidal channel	4103 mg/L	2 mg/L considered toxic to salmonids



**Figure 4.1:** Left: White sulfur-loving bacteria in a tidal channel adjacent to the wood waste pile; Right: Joel Elliot, a professor at University of Puget Sound, collects samples of the bacteria for testing.

## 5. New Design Directive: 'All wood waste must go'

Once the determination of the presence of wood waste leachates in toxic levels was made, and with the project goal of improving habitat and ecosystem processes for juvenile salmonids utilizing estuaries and nearshore, it became evident that it was necessary to remove all wood waste from the site. All of the literature, the consultation with Joel Elliott, conversations with Canadian experts and the results of testing at the site supported this decision. Preliminary soil investigations showed that there was wood waste far beyond the footprint of the apparent sawdust pile. A more robust investigation of the wood waste was needed to answer the following:

- What is the extent and composition of wood waste and unknown soils?
- What are the disposal options, requirements, costs?
- What is the threshold of excavation (will sub soil have sulfides/ammonia to be considered)?



### Lesson Learned:

Expenditure of funds on additional studies saved the project uncountable funds in change orders that would have occurred during construction if the extent of wood waste was not defined during design.



## 6. Soil Investigation #2

A low cost approach to the second soils investigation was attempted first. The project manager, habitat engineer and NOSC intern sampled twenty one hand augur holes in and adjacent to the project footprint. In places the wood waste was too deep to effectively sample with the augurs, and in other places the origin of the organics being encountered was uncertain. It became clear that a second, professional investigation was needed. The soils were saturated and given the previous incident with the backhoe sinking in wood waste, we needed a machine that could navigate the terrain safely in order to succeed. Areas that seemed to be



**Figure 6.1:** Left: Geoprobe used to take core samples of site; Right: Resulting core sample from project site with wood waste on top.

upland (as indicated by vegetation composition) may be disguising extensive deposits of wood waste and we had two acres of vegetated, swampy, uplands to explore. It was determined that a machine called a 'Geoprobe' was the tool for the job; not only could it pull clean samples, it could access the soggy soils of the site. In addition there was a substantial area developed for the veneer operations where a lens of gravel was concealing more wood waste below. Thus, it was important that a thorough job of determining the *vertical* and *horizontal* extent of wood waste across the site would need to be completed. This information was used to inform the re-design of the project footprint, determine finish elevations and establish directives for the extent of excavation and need for over excavation and backfilling.



**Lesson Learned:**

Wood waste needed to be tested for heavy metals, pH and salinity prior to determining disposal options.

**Lesson Learned:**

Disposal of wood waste, that was not chemically treated or salt water saturated, was accomplished by identifying a beneficial re-use at a local composting facility.



## 7. Disposal Options

The design team and soil investigation consultants gave considerable and creative consideration to disposal options for the wood waste.

To determine suitability for composting within Washington State guidelines, wood waste was tested for heavy metals and pH. No heavy metals were present and only slight pH issues were identified. The pH would easily be remedied by the mixing that would undoubtedly occur during loading, hauling and disposal. Salinity was also tested, and found to be at normal levels as the sawdust pile had little to no tidal inundation and had groundwater flushing through it 9 months of the year. Additionally, new samples were taken from the site of the original 'positive' hydrocarbon test and were tested for hydrocarbons using a silica gel cleanup. The results indicated that only organic hydrocarbons were present.

Taking the test results into account, the best idea for disposal turned out to be hauling the wood waste to a local farmer who intended to incorporate the material into his commercial composting operation, as well as use it for winter bedding in his cattle operation. Close to twenty-five thousand cubic yards of sawdust were hauled to this local farm.

For more information on the spectrum of disposal options considered, see the [Landfill Investigation Report for the Estuary Restoration Project](#) prepared for NOSC by Kennedy/Jenks consultants (2007).

## 8. General Design Considerations

The project design team started with an assumption that the target elevation for the sites would be Mean Higher High Water (MHHW) which correlates to a high salt marsh vegetation complex, the climax community for the estuary. This elevation minimized excavation and therefore cost. Designs evolve however, and as team members researched, asked questions, studied, inquired and deliberated, the benefits of targeting Mean High Water (MHW) over MHHW became apparent.

Implications of excavation to Mean High Water instead of Mean Higher High Water:

- allows deposition of a foot of natural materials over time
- provides naturally recruited sediment for long term establishment of stable salt marsh vegetation communities
- Increases likelihood of natural channel formation due to increased tidal prism
- increased construction costs

Prior to discovery of the leachate problem, the design team considered multiple questions about the substrates found at the target elevations:

- Is sawdust a suitable substrate for growing salt marsh vegetation?
- Is gravel a suitable substrate for growing salt marsh vegetation?
- Is there literature on colonization of coarse substrates and sawdust?
- If so, what types of marsh vegetation can we expect on each substrate and will that vegetation meet habitat goals?
- Can we excavate tidal channels in sawdust & gravel and expect them to function?
- Will tidal channels form naturally in sawdust & gravel over time?

To answer the above questions, the team consulted various literature sources and received substantially useful input from ESRP's Paul Cereghino and University of Washington's Si Simenstad. The answers to the above questions led the design team to define the following directive: Gravel and sawdust are not suitable substrates for vegetation or tidal channels in the long term. Therefore, where excavation to the target elevation ends in sawdust or wood waste, excavation of that material should be continued below grade until it is completely removed and

any depression shall be backfilled with suitable material. When excavation ends in gravel or other imported fill, there will be an over excavation and backfill of 18”.

## 9. Tidal Channels- To Dig or Not to Dig?

Should we dig tidal channels or not? Our design team was all over the map on this question at the outset of the process. Some were resolved not to dig but rather expected tidal channels to form over time with the increased tidal prism created by targeting a lower elevation. Others insisted channels must be dug to provide immediate benefit. Others felt we should not excavate channels at the time of construction; rather, we should give the site a year to settle in and then assess likelihood of tidal channel success. There were concerns about the project constructability on the wet, soft surface, thus the substrate was assessed at the time of construction and based on the results the tidal channels may or may not be constructed. We even considered an experimental approach: digging channels on one site and not on the other. In the end, the reasoning for providing immediate, usable habitat for out-migrating juveniles prevailed. Tidal channels were included in the plans. Sinuosity, width and depth ratios were based on the adjacent marsh, and specifications were written to include digging of main and tributary channels. The tidal prism created by constructing to MHW has been conducive to rapid development of new tributary channels.

Tidal channel evolution and development in the three years following project completion has been remarkable. Development of lower order channels has been extensive, and fish utilization of the constructed channels is substantial. It appears construction of higher order tidal channels created a fine balance of immediate habitat benefits and opportunity for natural development of lower order channels.



### **Lesson Learned:**

Digging channels proved not to be a construction issue, the contractor employed effective water management techniques on the site and excavator operators succeeded at digging the fine details of sinuosity and depth depicted on the plans.



**Figure 9.1:** Tidal channel construction at Salmon Creek Estuary.

# 10. Riparian Plantings and Planting Maintenance

After project completion, upwards of 3,000 trees, shrubs and live stakes were planted along the riparian buffer of both project sites within the first two years. The north site soil was sandy and dry, so tree species that could withstand salt spray, sun exposure and dry conditions were chosen. On the south site there were several micro-climates to consider since some areas were wet and others were dry with a clay substrate. Plantings took place with the help of volunteers and Washington Conservation Corps crew members. NOSC staff was on site during these plantings to ensure that proper planting techniques were utilized. Overall, the survival of the plants is high to date. There was one exception where cedar was put in a sunny/dry location which led to pockets of cedar mortality.

All of the plants were tubed, to protect from rodents and weed whacker maintenance to remove reed canary grass and Canada thistle. Licensed sprayers with the Washington Conservation Corps crew sprayed circle around the plants to kill the competing reed canary grass. Although While NOSC is reluctant to spray, in sites where canary grass prevails spraying has demonstrated itself to be the



**Figure 10.1:** Plant growth in one season

only reasonable way to establish trees. We say reasonable because multiple visits with a weed whacker to many acres of canary grass is also an effective manner of plant establishment, but tight project budgets do not allow for this level of labor investment. In areas where reed canary grass was not an issue, planting sites were maintained solely with weed whackers and mowers.

One issue that was encountered during plantings was the concern of neighboring landowner’s views after planting trees on a raised mound created from the fill removed from excavation. The landowner consulted with NOSC staff and the decision was made to remove the trees. The trees were stressed from the original transplant, and wouldn’t have survived a mid-summer

move so they were turned into mulch to place around other plantings in drier locations. The mound was then replanted with native shrubs after the landowners were consulted about the species selection.



**Lesson Learned:**

Always consult surrounding landowners prior to planting to ensure that they understand the planting plan and agreement is reached on species to be planted when a view-shed is involved.



## 11. Post-Project

In the third year after construction, it came to our attention that the shellfish growers interests in the bay adjacent to the restoration site was not directly considered during design and targeted outreach to this stakeholder was overlooked. Although there was a public SEPA process run by WDFW and publicly advertised outreach meetings were held in the local community, not everyone who had a stake weighed in during design. As a result, in 2011 a local shellfish grower expressed concerns about sedimentation of their shellfish beds and pointed to the restoration project as the cause. The fundamental issue however, is that of the critical importance of considering off-site impacts of the project during the design phase, and the need to incorporate any necessary studies, design elements and outreach into the process early on.

In order to address concerns at the post-project stage, when they were brought to the project sponsors attention, the project manager went back to the habitat engineer and requested an assessment of the off-site impacts of the project in terms of sediment mobilization in Discovery

Bay. That report looked at the volume of water being retained and released by the two project sites, and evaluated the erosive forces of that water and the possibility of it substantially affecting the mobilization of sediment in the mud flats of the Bay. This type of analysis should



**Lesson Learned:**

An off-site impacts analysis should be done at the outset of the project and those who could be affected should be engaged as active stakeholders in the planning of the project.



be done at the outset of the project, and those who may be affected, should be brought in as stakeholders early in the process (Barnard, 2011).

## 12. Conclusion

The mechanics of this design appeared straightforward at the outset of the design process. The desired outcomes, necessary studies and design elements were clear. The project benefited from the participation of two design team members in particular, Byron Rot of the Jamestown S’Klallam Tribe and Randy Johnson (then) of Washington Department of Fish and Wildlife. Both had been intimately involved with the nearby Jimmycomelately Project which was implemented three years prior to the Salmon Estuary Project. Many of the JCL lessons learned were applied to the Salmon Estuary Project; this propelled the process forward and reduced the learning curve for the design team. Unfortunately, the learning curve for the team increased dramatically when the wood waste leachate issue was discovered.

This turning point in the project led to necessarily applying more effort, research, money, and further design components to ensure success. In the end, a local community of restoration practitioners and funders has formed a deeper understanding of the effects of wood waste on the environment and the ways in which a project may need to address new criteria when wood waste is present.

From the earliest days of project conception to mid design, the sawdust “pile” was considered for removal (it covered about 20% of the North Site). Early on, there was little recognition of the possible extent and breadth of the sawdust pile’s effect on the ecosystems where it existed and no conception of the idea that wood waste may exist sub surface over the entire site. Resources for information were few and far between. Through this project and a few others which were developing at the same time (Commencement Bay, Thatcher Bay, Port Gamble), awareness of the effects of wood waste on the nearshore environment has been rising in Puget Sound. Department of Ecology may be starting to look at leachates more closely and multiple restoration practitioners are gaining experience with the issue. Funders throughout the project development were open to learning about the problems caused by wood waste, and were extremely supportive in providing adequate funding to deal with the increased costs required to remove the wood waste.

Nearshore wood waste may be a new frontier in the restoration and nearshore environments when it comes to targets for restoration actions. It is a contaminant that is often hidden; the effects are working quietly below the surface, often away from view. And they are having profound effects on aquatic life. Through further education and building awareness amongst

governments, restoration communities and funding communities, it is likely that more nearshore projects will contain components of wood waste removal. This project and this report are one more in the growing number of resources available in the evolution of our understanding and approach to dealing with this piece of the environmental puzzle and we hope that our lessons learned will reduce the learning curve for others embarking on similar projects in the future.



## Appendix A. References and Project Related Reports

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