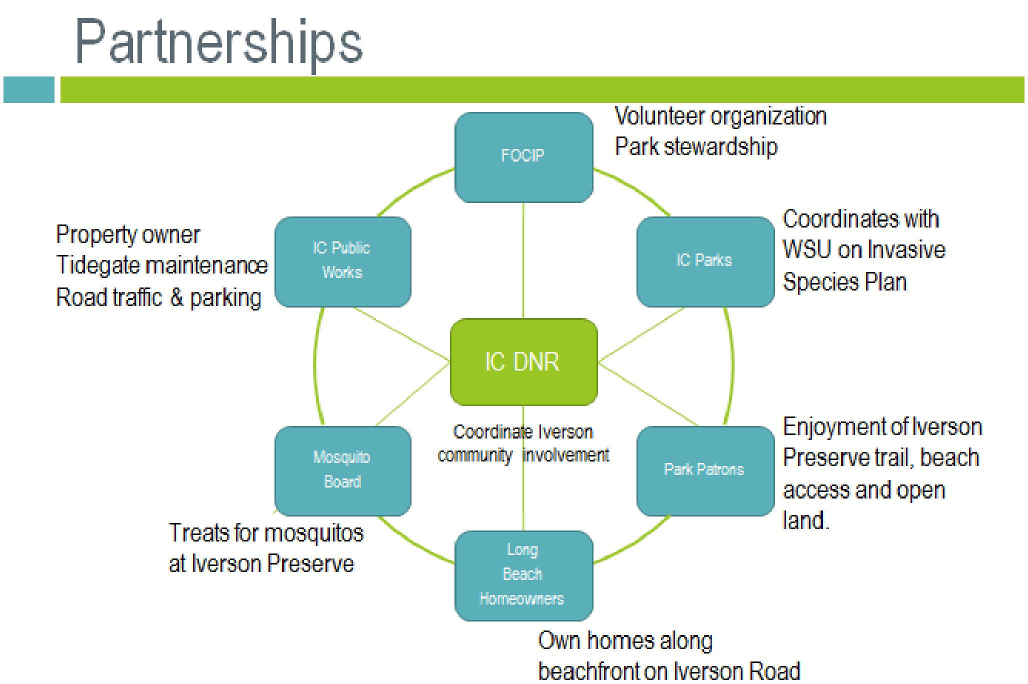
Iverson Project Summary Report

Background

Island County initiated the Iverson Stakeholder Integration Project with the main goal of working with community members to evaluate the possibilities of developing a multi-benefit project that balances the needs of community with a habitat gain for listed species at Iverson Preserve.

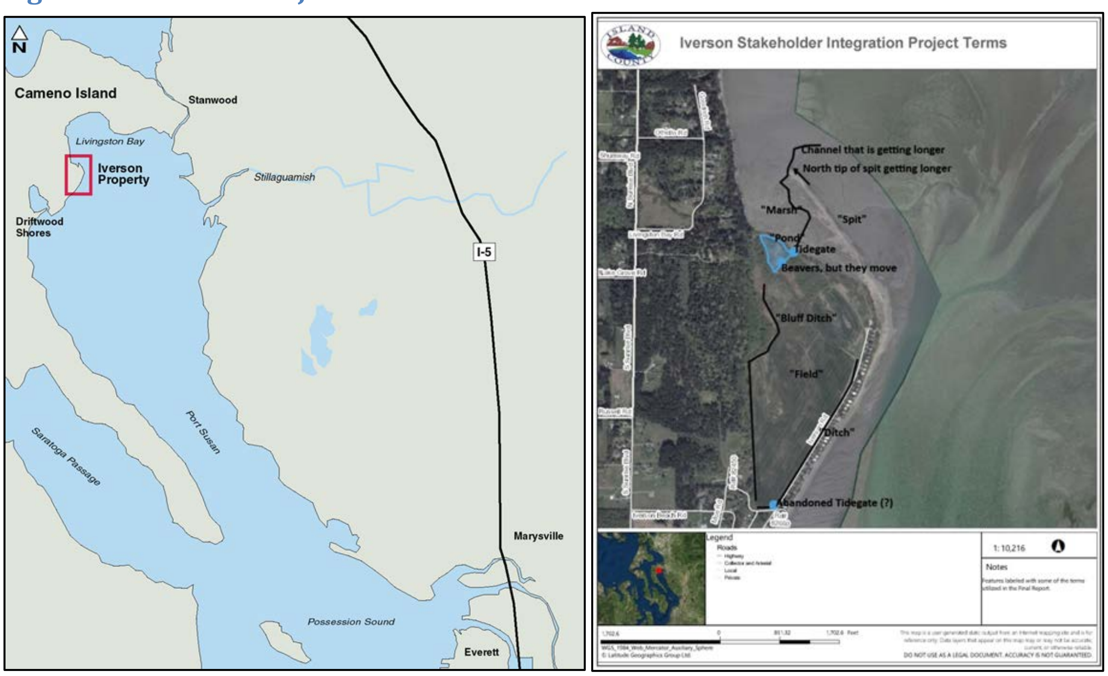
The Project had two concurrent phases, one was the data collection and synthesis of sedimentation and groundwater interactions for the Iverson Preserve and the second was the stakeholder integration phase intended to define the most successful community-approved alternative of conceptual design. The data collection and synthesis characterization was to assist with the assessments of current drainage issues and determine acceptable alternatives for restoration at this site. Island County Public Works will make the final decision on any upcoming drainage improvements at Iverson Preserve. The community-led conversation attempted to come up with creative recommendations that could be incorporated into a multi-benefit project.

The Iverson Task Force is a self-selected group of 27 members comprised of park patrons, Long Beach residents, Island County staff, Audubon/birding interest, Friends of Camano Island Parks, and the Mosquito Board. The group was formed to assess community values, vet concerns, and discuss creative, potential, multi-benefit solutions that could be possible at Iverson Preserve. The group came together for 12 meetings to gather relevant information for discussions on potential solutions for drainage and habitat improvements. The recommendations from the Iverson Stakeholder Integration Project are laid out in this report.



A portion of the Preserve consists of a relic salt marsh that has been diked and ditched for agricultural purposes and is referred to in this report as the ‘field’. The Preserve also supports an emergent salt march and estuarine channels north of the dike and is referred to in this report as the ‘marsh’. The dike at Iverson Preserve was built prior to the 1940’s and drains the field through a tide gate. Since 1999, the land behind the dike has been owned and managed by Island County Public Works, Parks Department, and managed as park land. The land form that is now Iverson Preserve and the Long Beach Community is the result of both a natural buildup of a spit as well as the accumulation of silt from Livingston Bay and erosion of the island itself. An early sketch of the area shows inlets and channels consistent with a salt marsh habitat in what is now the field. More drainage work was done in the 1980’s with tiles and the resulting land became a mix of farmland, and brackish wetlands. Island County purchased about 300 acres for the purpose of habitat conservation in 1999. Studies were commissioned in 2001 to determine the potential to recover marine saltmarsh habitat while preserving flood protection for Long Beach homeowners. Island County is interested in balancing the community’s flooding concerns and maintaining the area for the enjoyment of Preserve patrons with improving wildlife habitat, including ESA-listed species, and water quality.

Figure 1 – Iverson Project Area



Iverson Task Force Meetings’ Summaries (January-July 2017)

A series of presentations by subject matter experts were made to the Task Force in order to increase awareness and knowledge of different concepts and components that may inform conversations about the nearshore dynamics of flooding and habitat creation in the Preserve. The Task Force also took field trips to two local restoration sites to hear about projects that were developed to address flooding, drainage and habitat. The conversations and findings are summarized below.

Sedimentation - Eric Grossman, PhD, USGS

Studies in the Skagit and Stillaguamish Rivers show there is more sediment being transported from the upper watersheds and being deposited in the deltas due to changes in regional rain/snow patterns. The deltas of both rivers are growing and more sediment is moving in to the bays, including Port Susan. The Oso slide did have an impact on the amount of sediment coming out of the Stillaguamish River, but it is likely smaller than we expected.

The Task Force shared that they have noticed changes to the spit since the Oso slide. The beach has more mud (as opposed to sand) extending farther out into the intertidal area. They have observed a new grass (reddish in color; maybe pickleweed) growing in front of the houses.

Ground Water Dynamics – Doug Kelly, IC Public Health

The group learned that water levels in wells near Iverson tend to be 2-3 feet above Mean Sea Level (MSL) and the top driver of salt water intrusion is the level of water in the aquifer. When water level is high, salt water is pushed out. The numbers are low enough in this area (ft MSL) that the area is at risk for salt water intrusion. Groundwater levels below 4 feet is the level where salt water intrusion becomes a concern. The Preserve area is considered a groundwater discharge area. When the tide comes in there is saltwater influx and when the tide is out the groundwater replaces with freshwater. Groundwater recharge from precipitation also affects the low lying areas. Water level distribution is governed by how much flow is in the aquifer, how easily water flows through, and the elevation of the boundary condition. Sea level rise will change the boundary (aquifer system shifts upward). This will not result in a collapse in the system, the aquifer will respond with a shift.

On-site Septic Systems Discussion – Kathleen Parvin & Heather Kortuem, IC Public Health

The Task Force heard about on-site septic systems and additional secondary treatment, including sand filters. Drain fields are compromised when the groundwater level rises and reduces the depth of dry, permeable soil in the drain field. It was discussed that the 30 feet between drain fields and the ditch at Iverson provides enough separation that the water in the ditch it isn't a concern for drain field functions or surface water contamination. The road bed is quite solid for a significant depth and likely acts as a barrier to horizontal water movement from drain fields to the ditch.

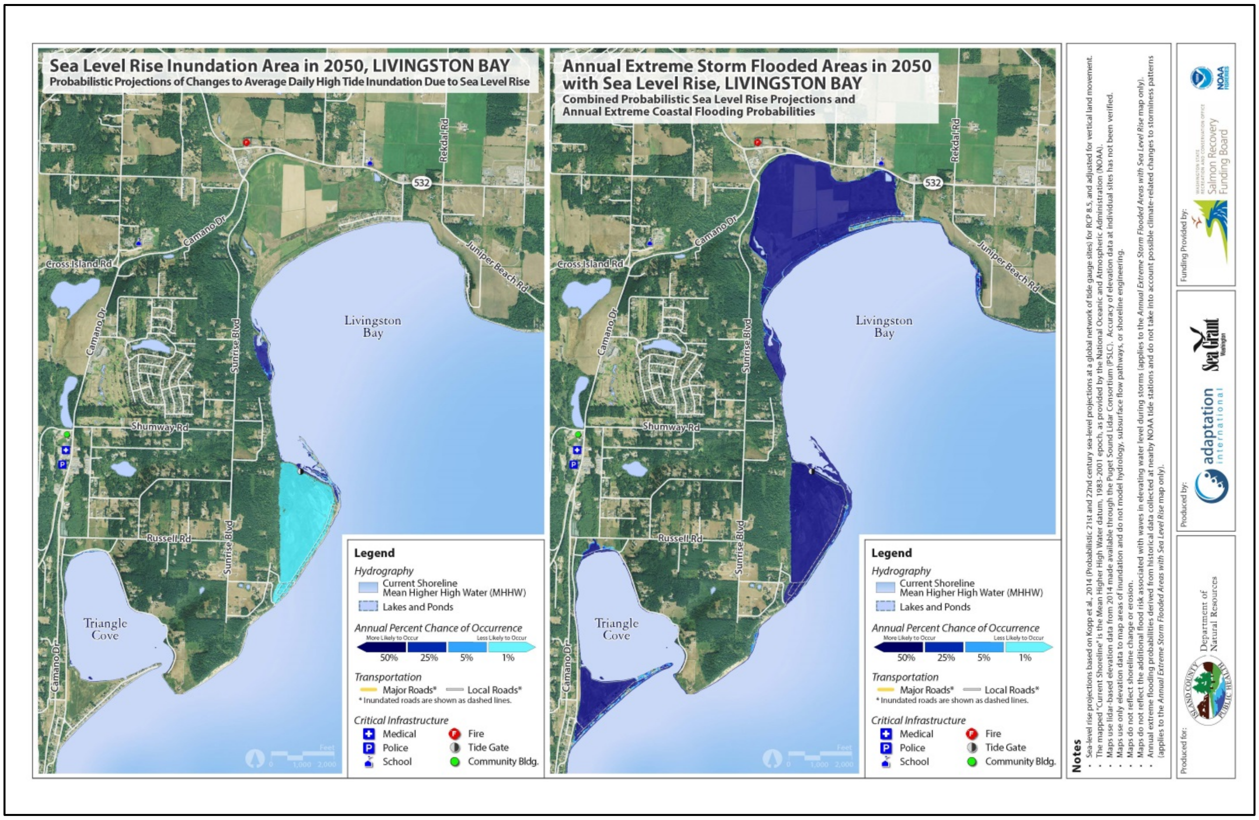
Jefferson County has a community system which is an example of a successful project where a community worked together to solve individual on-site septic issues with an off-site community treatment system. Juniper Beach (on Camano Island) investigated off-site community treatment options but the plan was never implemented. Some communities are using common drain fields. Each house has their own septic tank and sand filter system that is connected to a common distribution system that pumps to an off-site community drain field. Any solutions that involve a community partnership will take time and may need the help of outside facilitation and design. It is better to start discussions prior to an emergency due to the complexity of the discussions.

Sea Level Rise and Coastal Flood Risk Assessment – Ian Miller, PhD, UW Sea Grant

Probability models for sea level rise and storm surge were created to assess potential restoration and ecosystem recovery projects. The Sea Level Rise maps created for Island County are elevation based and mapped both changes to average sea level and annual extreme water level for predicted sea level rise scenarios. Modifications, not reflected by LIDAR data, are not included (i.e. tide gates or drainage channels). These maps show patterns of coastal flooding over time and should be comparable to the FEMA flood maps. Extreme events, coastal flooding, high tides, storm surge, waves, erosion, groundwater (salt water intrusion), bluff erosion, and critical habitat are variables which are not factored into the maps.

Homeowners can look at this issue as a community; 15 parcels on the Dungeness River Delta did a collective community-led project to evaluate options for sea level rise adaptation. Ian shared that in Connecticut, residents are lifting their homes to be able stay longer in their homes on the shoreline. Special purpose districts can be created to raise money to do projects for the people who are affected.

Figure 2 – Livingston Bay Sea Level Rise Projections for 2050



Marsh Habitat & Functions Management Considerations – C.K. Eidem, Ducks Unlimited

Ducks Unlimited (DU) balances restoration potential with wetland aging (succession) and subsidence (sinking freshwater marsh) to provide bird habitat. At some point it becomes unfeasible to farm areas theses freshwater marshes which are experiencing subsidence. Iverson Task Force discussed that Iverson Preserve is fighting nature on several fronts and would ideally like to figure out a management plan for this site that takes into consideration all these barriers (increased water from rain, sedimentation, sea level rise, subsidence). Sedimentation models can be used to inform potential, feasible strategies about what can be done to manage this area into the future

Crop and Agriculture land is important to migratory birds as a food source. Estuaries are also important because they provide different types of food sources and alternate timing to crops. Over 120 species of birds have been seen at Iverson: including shorebirds, mallards, gadwall, widgeon, herons, geese, eagles, harriers and swans.

The expense to dredge the old ditches in the Preserve to keep the field dry may be cost prohibitive. Ducks Unlimited (DU) manages wetlands/croplands by controlling the timing of when the field floods to target species migration. They flood the wetland, allowing standing water, to support avian species migration path and farm/grow crops the remainder of the year. This flooding/draining pattern also succession reset and helps build the soil and marsh level over time and encourages native plants recruitment.

When Iverson Preserved was diked off, it prevented the mechanism that enables the natural maintenance of marsh land processes. There is no salt water flooding with tide changes to kill off vegetation species and support the natural sediment flux. The result is subsidence in the Preserve.

The group discussed a beneficial crop that could be grown at Iverson that would be good for birds and did not have known allergy issues. The crop would also have to be profitable for a lessee to grow. Corn and Swiss chard have been grown in the past. DU clubs do grow crops on wetlands and then harvest part for profit and leave some standing for ducks.

DU uses gravity to maintain drainage whenever possible and often lets managed sites go back to saltwater (cheaper to maintain, easier to permit, better for birds). They try not to use pumps due to maintenance and expense. Island County has used pumps previously but couldn't keep up with the amount of water because there is so much drainage that comes off from upland into the recharge area.

Fisher Slough and Fir Island - Restoration as a Drainage and Flood Reduction Tool

The Iverson Task Force took field trips to two local restoration sites to hear about projects that were developed to address flooding, drainage and habitat to inform conversations about the nearshore dynamics of flooding and evaluate potential alternative options.

The Nature Conservancy managed the Fisher Slough restoration project. It created new set back dikes, inundated a previously farmed field for freshwater habitat and installed self-regulating tide gates between the wetland and the south fork of the Skagit River. There were flood control measures installed to direct flood waters from the stream system into the irrigation water system. The irrigation ditches (parallel to the road) are a separate system from the natural water body and are used for flood relief storage. The neighboring farmed fields had drain tiles and wells installed to extend the growing season. The wells are used to monitor the effectiveness of the drainage system. If predicted water levels are exceeded (fields are wetter), there is an adaptive management plan in place to lower the water level. It was noted that the field next to the dikes was starting to grow crops, as opposed to the wet field on the other side that was not part of the overall project and still had issues with ponding.

Fir Island is managed by the Department of Fish and Wildlife. The restoration project included the installation of new setback dikes, a runoff retention pond for the neighboring field and a pump system to drain the pond into the estuary, as necessary. The old dikes were breached in the fall of 2016. This system is more similar to Iverson in its proximity to the bay and tidal water. The Task Force members were impressed by the pumps, the magnitude of the water being managed and the technology. After the pump was turned on, the resulting volume and velocity of water coming out was moving sediment effectively out of the channel. The scouring from the pumped water was doing the same job that manual dredging was doing previously.

Data Collection and Synthesis for the Iverson Preserve

To further the knowledge of the historical and current conditions potentially driving the changes being observed at the Preserve, Coastal Geologic Services (CGS) was contracted to assess sedimentation patterns and groundwater behavior at the Iverson Spit Preserve (Iverson Preserve and Livingston Bay: Sedimentation, Groundwater Data Collection and Synthesis , 2017). CGS worked with Skillings Connolly and the USGS to:

- Characterize sedimentation patterns to evaluate the effects on current drainage from the field, ditches, and natural tidal channels to Livingston Bay and, to the best extent possible, predict future effects on drainage.
- Characterize the groundwater behavior and response to tides to determine the extent of tidal forcing.

Sediment coring was used to help quantify the character and rate of sedimentation within the marsh, the tidal flats, and east end of the spit. Grain size analysis and dating of the core samples was completed to describe the character and age of various sediment deposits. Additional analysis into historical shoreline and bathymetric change was used to characterize conditions at the Preserve.

Groundwater behavior was analyzed by Skillings Connolly. Hydrodynamics and sediment flux were analyzed by Dr. Eric Grossman, USGS.

Shore Change and Sedimentation, Coastal Geologic Services

CGS used several analyses to determine the historical rates and likely future trend of sedimentation in and around the Preserve. The following analyses were used:

- Knowledge of drift cell mapping and littoral drift processes (previous studies by CGS)
- GPS mapping of current MHW along the spit
- LiDAR analyses – historical spit and channel lengths
- Bathymetry analyses– historical elevation changes eastward of the spit
- Surface sediment samples – 14 sites, to 10 cm depth, grain size analysis
- Sediment core sampling – 4 sites, to 9 foot depth, grain size analysis and dating (PB-210 and radiocarbon)

The shore change shows that sedimentation rates around the spit are increasing (Table 1), areas of the marsh are subsiding and the channel between the tide gate and Livingston Bay is getting longer at a faster rate recently than it has historically. As a result, the drainage from the marsh and the field has become more impeded over time. Historical maps (1886, 1958, 1990, 2014 and 2016) were compared to see the differences in the shoreline area. Primarily, the indentation a third of the way up the spit has been filled in and straightened out and the north tip of the spit has grown in length further to the north. The channel through the marsh out of the field has changed direction and length. The spit grew 100 feet between 1958 and 2014. The channel was 1700 feet longer in 2014 than in 1958. The accretion rate tripled between 1954 and2014 from 16.3 feet/year 6.3 feet/year. Bathymetry changes along the beach and at the lower intertidal to shallow subtidal elevation show an elevation loss but the bay farther out (east) has gotten shallower as the main channel from the top of the bay south has moved westward towards the spit and homes.

Surface change between 2001 to 2014 (Figure 4) over the broad, non-vegetated areas reveals that the majority of the area north of the dike and south of the spit accreted, with considerable areas experiencing 0.5 – 1.0 FT of elevation gain. Elevation gain exceeded 1 foot in several small areas north of the dike, with more accretion in the more protected eastern area. Some adjustments near the tip of the spit are apparent in the surface comparison, with progradation of the waterward side of the north end of the spit and some lowering of the landward side of the north end of the spit, likely due to shifting of the drainage channels and erosion due to scour along the margin of this channel during ebbing tides .

Two long profiles were cut through the 2001 and 2014 LiDAR data sets, and are shown in large-format (Figure 5). Examination of both profiles A and B graphically display how much lower the northern portion of the field is as compared to the tide flats north of the dike, with general elevation differences in the neighborhood of 1.5 – 2.0 FT. These areas were likely the same elevation when the dike was first installed, and the result of long-term isolation and settling of the field area is apparent.

Sediment sampling was taken with surface grab samples (12 along the outside of the beach, and 2 in the lagoon) and sediment cores (1 farther away towards the bay from the spit, 1 at the tip of the spit, 2 by the tide gate and 1 in the field). Sediment is finer grained and muddier towards the north along the east side of the spit compared to midway along the spit, in front of the homes, where the beach has more gravel and sand. Big gravel is not getting to the tip and around the spit because there is not enough wave energy. Only pea gravel is found at the tip of the spit. The sediment cores showed a trend towards finer sediments in the top of the core indicating reduction of wave and current energy over time.

Aging of the sediment cores was attempted using PB-210 and radiocarbon markers. The PB-210 analyses were unable to be performed for the core sample from the marsh and from the lower intertidal area due to lack of PB-210 levels above background. This is likely because of the disturbance by agricultural practices in the marsh (core 1) and the movement of the intertidal channel (core 4). Compaction measurements from the field were used to convert the compacted soil measurements to feet below ground surface (FT BGS).

The rates in the field (Core 3), have risen slightly in recent past (0.06 inches /year for 2003-2016) but have averaged 0.03 inches/year starting in approximately 1937 (PB-210) and 0.05 inches/year from 1100 before that (radiocarbon). LiDAR shows areas of the field nearer to the tide gate are lowering (subsiding).

The sedimentation rates in the marsh, north of the dike and tide gate (core 2) are faster. There was rapid sedimentation in 1962 that caused a short-time spike in sedimentations rates. But that area averaged a consistently accelerating sedimentation rate since approximately 1925, with rate of 0.03 increasing to 0.10 inches/year (2001-2016). Between 1100 and 1925, sedimentation occurred at 0.06 inches/year, about half of recent rates.

Figure 3 - Changes in elevation in Iverson field and marsh. Red is getting lower, blue is rising

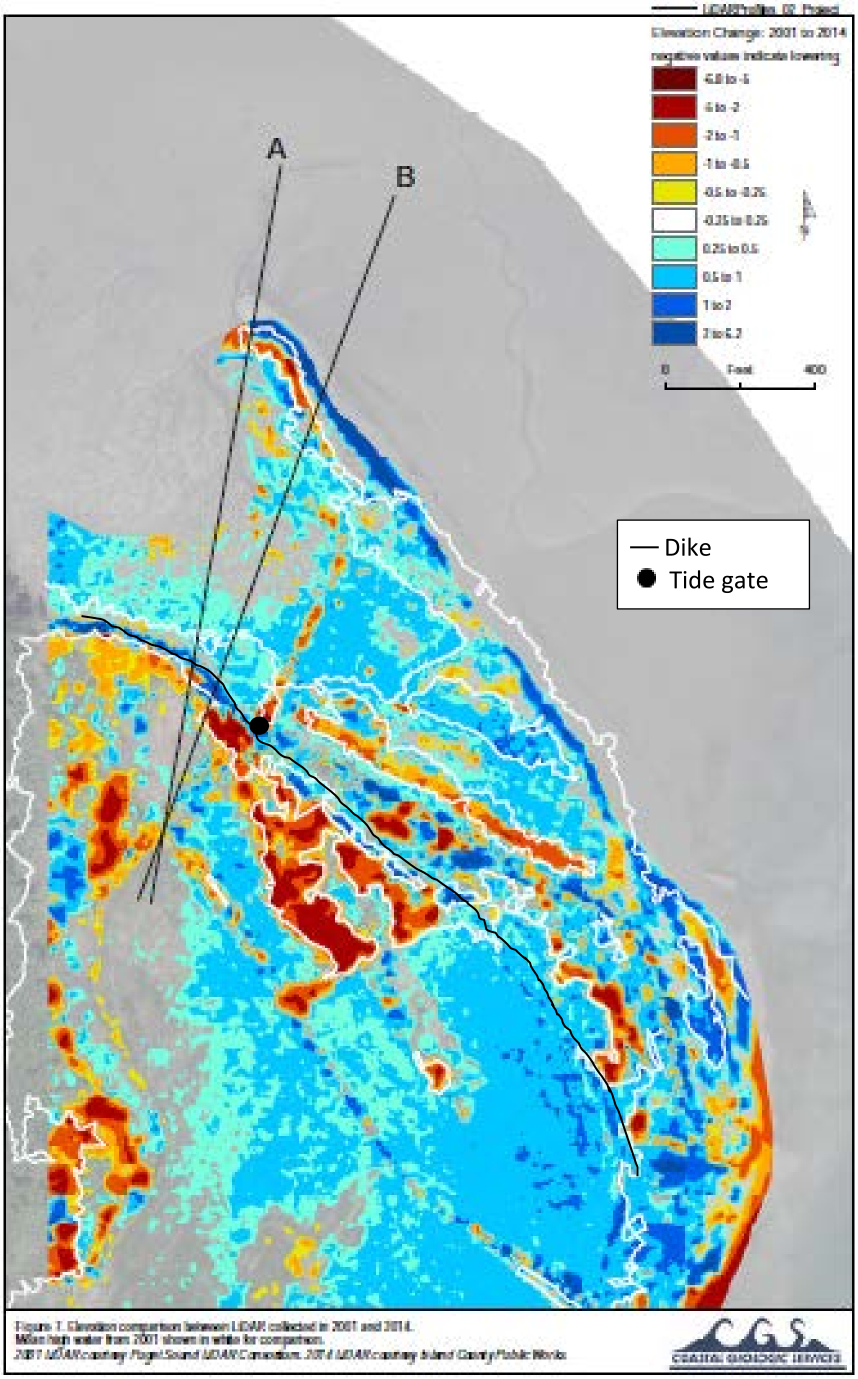


Figure 4- Elevational cross sections for the Iverson field and marsh.

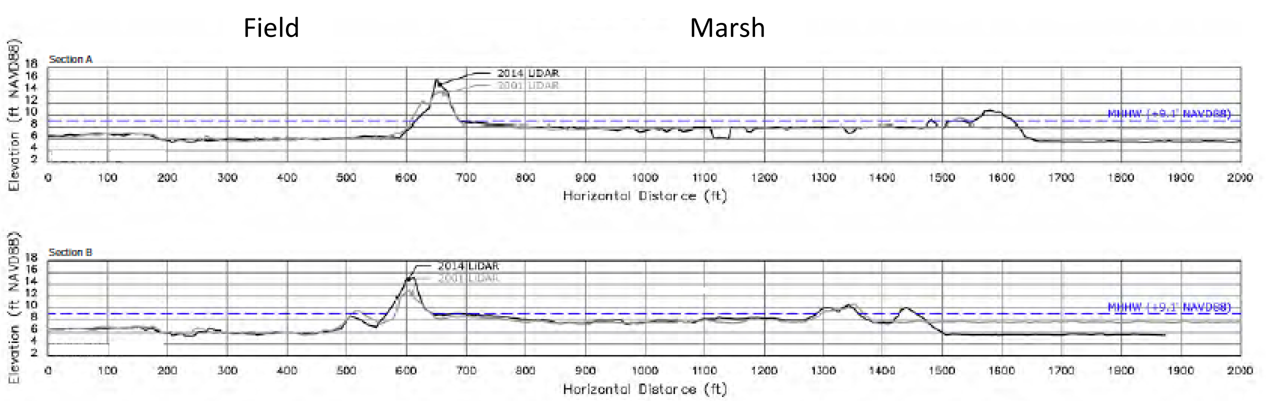


Figure 8. Cross Sections of LIDAR topography.
2001 LIDAR courtesy Puget Sound LIDAR Consortium, 2014 LIDAR courtesy Island County Public Works.
Iverson Preserve Sedimentation and Groundwater Data Collection and Synthesis

COASTAL GEOLOGIC SERVICES

Table 1: Summary of Rates of Change for Sedimentation

Measurement	Rates	Rates	Rates
Spit channel length increase	34.1 ft/yr (1990-2016)	5.3 ft/yr (1958 – 1990)	35.4 ft/yr (1941 – 1958)
Sedimentation rate in unvegetated area infront of tide gate	0.04 – 0.08 ft/yr	0.5 – 1.0 ft between 2001-2014	
Livingston Bay eastward of south houses sedimentation rate (1962-2014)	Drop of 8.39 ft	Further east rise of 6.9 ft	
Livingston Bay eastward of north houses sedimentation rate (1962 – 2014)	Rise of 4ft		
Historical sedimentation rates in the field (PB-210) (1962 – 2016)	0.03-0.06 in/yr		
Historical sedimentation rates in the field (radiocarbon) (1100-1962)	0.05 in/yr		
Historical sedimentation rates in the marsh (PB-210) (1962 – 2016)	0.03-0.10 in/yr		
Historical sedimentation rates in the marsh (radiocarbon) (1100-1962)	0.06 in/yr		

Groundwater, Skillings Connolly

Below are the conclusions of the report produced by Skillings Connolly, who studied groundwater within the field:

Groundwater levels for Iverson Preserve are shown to fluctuate with seasonal and tidal influence. The inland monitoring wells were found to have a smaller fluctuation in high and low differences compared to the marine shoreline portion, which showed tidally influenced water levels. At no time during the study period did groundwater reach the existing ground levels.

Surface flooding, in the form of extensive ponding was observed during the monitoring period. However, groundwater levels did not exceed the surface elevation. It was determined that shallow ponding was a result of precipitation rather than high groundwater levels. Surface ponding was determined to be due to reduced infiltration rates associated with agricultural use of Iverson Preserve. The high clay content observed, combined with soil compaction associated with agricultural use has reduced the infiltration rate within the Preserve, creating surface ponding.

With respect to the western boundary, slope conditions did not influence groundwater levels due to heavy/dense vegetation and the conveyance ditch at the toe of slope. Soil conditions vary from west to east within the project boundary. The western extent exhibited a thick layer of clay. Sand predominated through the soil matrix in the eastern extent. Groundwater will move freely through less dense materials thus leading to the assumption that higher levels of pressure, influenced by daily tidal fluctuations from Iverson Bay, affect groundwater levels at the MW-4 location the most. Evaluation of surface water data indicates that the ditch network throughout the study area likely receives hydrology from high groundwater levels. During the wet season and winter high tides, groundwater remains relatively shallow, being restricted by hydrostatic pressure caused by close proximity to marine waters. During the dry season and lower high tides, groundwater collected within the ditch network is discharged via a single culvert that conveys flows through the protective dike. During high tide, a tide gate on the culvert restricts flows, impounding surface water within the ditch system and maintaining higher groundwater levels. Because the average tidal elevation is higher in winter, the tide gate remains closed for longer periods of time, further restricting the existing drainage system. At the very beginning of the study, the tide gate was obstructed, which would have allowed tidal flushing within the ditch system. However, the obstruction was cleared within a few weeks of well installation.

Based on soil type and the slow response time seen in groundwater fluctuations, it can be concluded that while tidal fluctuations have an impact on groundwater levels, it does not appear that the groundwater elevation responds as quickly as observed during tidal fluctuations. The use of a tide gate on the discharge culvert likely limits the level of high groundwater within the study area by limiting tidal inundation. The size of the culvert and tide gate also likely limit the volume of surface water discharged from the study area during low tide, based on hydraulic sizing.

Hydrodynamics/Sediment Flux, USGS

Below are the conclusions of the hydrodynamics/sediment flux evaluated by USGS for the Preserve:

Sediment flux into the marsh is causing aggradation, causing reduced drainage. Calm settings like Iverson are the principal deposition centers for sediment out of nearby river systems (Stillaguamish River and material from the Oso landslide). Elevated marine water levels are correlated with reduced drainage out of the field.

Topographic measurements west to east across the lagoon and channel and spit were collected. Velocimeters were used to collect velocities in the channel. Measurements showed slightly higher velocities during flood stage tides. Winter storms contribute lower salinity and cooler water to the subject area (more river water). Approximately 3,500 tons of salt water flux into the lagoon between early September and mid-October (48 days), which is less than 0.14% of the Stillaguamish annual load. Over half of this was delivered in mid-October with increased river discharge and rain events.

Suspended sediment load calculations could be overestimated because of the location of the sampling meter (being in the channel) and also because of temporary influences of the Oso landslide. Measurements of total sediment flux need to include delivery of coarser sediment (sands) that overtop spits in storms. The drainage from the field is likely affected by tidal flat aggradation in the marsh, reduced hydraulic gradient and increased tidal channel length.

It is not yet clear if the tide gate is muting the high tide or amount of water flushing. The lengthening of the spit makes it more difficult to move sediment from the field through the tide gate. If the tide gate is restricting flow it is likely that only fine-grained material is being exchanged back and forth. Without flow from the field going out, there would be less scouring of the channel and it would fill in with sediment. The current trend is increased sedimentation. It is unknown if the channel would fill in all the way, but the marsh would grow and plants would fill in as sedimentation deposition increases. If the tide gate was closed off, you would see increased sedimentation. Conversely, if you were to move the tide gate back, you would get more flushing through the channel.

Iverson Task Force Recommendations

Using preliminary results from the studies detailed above, the Task Force had two brainstorming sessions to discuss general thoughts and possible solutions for drainage and habitat improvements at the Preserve. A map of the Iverson Preserve was used to write down ideas and sketch out potential solutions. Jim Johannessen with Coastal Geologic Services provided feedback on some of these ideas from an engineering perspective.

<u>Overall impressions:</u>

- Assumptions about the drainage from the marsh becoming slower and less effective have been confirmed by the CGS data.
- The spit has extended so the outfall must travel further to drain into Port Susan. CGS has found that there is significant increase in sedimentation since 1954.

- The existing channel may break through the south end of the spit (known as a “channel avulsion”), which these types of systems have been known to do, and exit into a deeper part of Port Susan closer to the homes on the spit. This would effectively shorten the channel and may improve drainage efficiency. It would also, however, alter the existing tidal circulation and existing habitat in the marsh.
- The difference in the sand texture is drastic. It used to be that you didn’t sink when you walked out to the spit; now you sink in mud very quickly
- The tidal channel and ditches needs the flow behind the tide gate to allow flushing.

Tide gates:

- A new tide gate through the Iverson Preserve to Port Susan from parking lot (west to east) may be a good drainage solution. This would shorten the distance the field water has to travel and will be discharged to deeper water.
- Create new outfalls across County easements below the spit and pump the field water to the area in front of the houses.
- Use the old tide gate (~pre 1980s) on south tip (probably hadn’t worked since 1950s) to drain out water to the south.
- Remove material from the front of the beach and put it back into the marsh.

Ditches, beavers and mosquitos:

- The purpose of the ditch was to get the water out when flooded. Since it is no longer working, it could be filled to remove the mosquito problem.
- Jay Lawrence shared droned photography of the Iverson marsh flooded fields and beaver dam from Friday, May 18th, 2017.
- The beaver dam causes more flooding in the fields causing more mosquitos. Usually, in an ecosystem, you would have fish feeding on mosquito larvae. The fish are being blocked from entering the marsh area. Engineering the area to be a more natural habitat would take care of the mosquitos.
- One of the ideas for getting rid of beavers was to increase the tidal influence. There are tidal tolerant beavers; therefore, increasing tidal activity will likely not repel them.
- Making the pond deeper would improve habitat (for fish) and may help improve field drainage.
- Create a channel along the bluff toe to intercept water from upland areas and drain it out before it gets farther east. The ditch at the base of the bluff should be fixed to help the drainage.
- Half of the road is blocked by a berm. The field ditch along the road is filled with the water from the field, not overwash from the Bay. Ditches need to be cleaned out.
- If you can build some ditches and re-shrub the field, you would improve the drainage and prevent invasive species from growing.
- Cover the “front ditch” (along the road) and have drainage flow the direction of the park; educate the residents to not throw grass clippings into the ditch.

Funding opportunities:

- There is general support for maintaining flow in the marsh, and having a back-up system that flows out near the parking lot.
- Island County Conservation Futures Maintenance and Operations funds could be used for some of the pieces but this type of project could be very expensive. It is unlikely that Salmon Recovery Funding Board funding would pay for these changes unless the tide gate is opened to increase salmon habitat. Ducks Unlimited would only be interested in funding this if there was increased hunting capacity. National Oceanic and Atmospheric Administration has funding for community resiliency for protecting properties from coastal flood risk.
- There are mosquito control grants that could help pay for the mosquito control part of the project.
- The National Coastal Resilience Fund is a national program with a regional focus and targets specific circumstances, needs and priorities. This fund aims to benefit coastal communities by reducing the impact of coastal flooding and associated threats to property and key assets, such as hospitals and emergency routes; benefit coastal communities by improving water quality and recreational opportunities; and benefit fish and wildlife by enhancing the ecological integrity and functionality of coastal and inland ecosystems. This funding source may be a good fit for the Iverson Preserve area.

Conclusions

Considering the community concerns and interest in surface water improvements, it seems that there are some viable alternatives for incorporating drainage improvements/modifications at Iverson Preserve. Depending on the conceptual design, there may also be significant habitat improvements at this site. The project report, Iverson Preserve and Livingston Bay: Sedimentation, Groundwater Data Collection and Synthesis (Coastal Geologic Services 2017), includes the following recommendations for determining management options for balancing drainage improvements with potential habitat improvements at this site:

- Evaluate, in more detail different scenarios for management including:
  - replacement of the tide gate with a larger gate
  - dike setback to reduce the volume of impounded water to drain allow for sedimentation in a broader area, and facilitate habitat enhancement
  - projections of future conditions
- Perform conceptual design work using current and new data, hydraulic modeling, and planning level cost estimates for different alternatives.
- Qualitatively (and potentially quantitatively) evaluate likely nearshore habitat benefits of conceptual alternatives outlined immediately above.
- Evaluate the feasibility of adapting the road access, tide gate, and drainage network for projected sea level rise and site evolution.

Recommended next steps for the Iverson Preserve are to utilize the Iverson Preserve and Livingston Bay: Sedimentation, Groundwater Data Collection and Synthesis report and the Iverson Stakeholder

Integration summary to develop 2-3 conceptual designs, including information on permitting restrictions and cost-benefit analysis for each scenario. The Iverson Task Force and the Iverson community may be utilized to vet the conceptual designs to help select a preferred alternative to ensure a community supported and multi-benefit project is selected as the preferred alternative. Depending on the preferred alternative, funding sources may be available for project design, permitting and implementation.