Fir Island Farm Estuary Restoration
Final Design and Permitting
Draft 60 Percent Design Report
Skagit County, Washington

May 16, 2014

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FIR ISLAND FARM ESTUARY RESTORATION
FINAL DESIGN AND PERMITTING
DRAFT 60 PERCENT DESIGN REPORT
SKAGIT COUNTY, WASHINGTON

1.0 INTRODUCTION

This report includes a summary of our engineering and environmental studies for the Fir Island Farm estuary restoration project (the project), and our updates to the design plans and permits in accordance with the Washington State Recreation and Conservation Office, Salmon Recovery Funding Board grant 12-1205. The purpose of this report is to provide an overview of the project's progress, and to document the project at the 60 percent design level. This intermediate, draft submittal will eventually become the final design document. Shannon & Wilson, Inc's. (S&W's) services were conducted in general accordance with the contract and scope of services stated in the Washington State Department of Fish and Wildlife (WDFW) Contract No. 10-1431, Amendment 8, dated March 24, 2014.

2.0 SITE AND PROJECT DESCRIPTION

The Fir Island Farm Estuary Restoration project is located on the WDFW Snow Goose Reserve (the Reserve) at Fir Island. The project site is comprised of 245 acres that are currently farmed with special farming provisions to meet the Reserve's snow goose management objectives. The project is located on the historic Skagit River Delta between Dry Slough and Brown Slough, with No Name Sough and Claude O. Davis Slough located near the center of the project dike removal and marsh restoration area (Figure 1).

Natural tidal exchange and historical distributary flows to the site have been eliminated and blocked by historic construction of coastal dikes along Skagit Bay, around Fir Island, and the Skagit River Delta. One-way tidegates installed through the dikes block inflow of tides and allow for drainage of interior farmlands. The combination of tidegates and dikes protects interior farm and drainage areas. The proposed project will include constructing a new 6,450-foot-long setback dike on the Reserve, expanding historical tidal channels, excavating marsh pilot channels, and breaching the existing dike along Skagit Bay. North of the new setback dike, a storage pond and tidegates will be constructed to facilitate drainage from behind the dike and the existing sloughs. If approved by WDFW and its project partners, additional tidegates and a pump station would be constructed to aid interior drainage. These actions will restore

130.9 acres of farmland to estuarine tidal marsh, while preserving up to 105 acres of the Reserve farm area for snow goose management operations (Figure 3 and Table 1).

3.0 PREVIOUS AND RECENT STUDIES

The project has developed a number of studies and reports. The following is a summary of project studies, reports and design plans to date.

3.1 Feasibility Study Overview

A feasibility study was completed for the project in 2011 (S&W, 2011). The feasibility study provides baseline studies, alternatives analysis, and a preferred restoration plan recommendation for setting back the existing dike and restoring 130 acres of tidal marsh. The feasibility study was funded through a Salmon Recovery Funding Board Grant (Project Number 09-1444N).

Baseline studies and alternatives analysis were performed for tidal hydrodynamics, interior drainage, groundwater, geomorphology, soils and wetlands, fisheries, agriculture, public use, and snow goose management.

WDFW and their Steering Committee of stakeholders developed a set of restoration and project related goals, which were compiled into guiding principles (metrics). Seven project alternatives were evaluated using the metrics developed by WDFW and their Steering Committee.

The preferred setback dike and marsh restoration alternative (Alternative 2A) includes a 6,450-foot-long setback dike and approximately 130 acres of tidal marsh restoration. These numbers will be adjusted as the project progresses through final design.

The feasibility study estimates 65,000 to 320,000 juvenile Chinook smolts will use the area annually. The project balances natural resources, agricultural, flood protection, and drainage interests; and meets snow goose management objectives. Interior drainage effects are expected to be mitigated on site. Adjacent farms and private property are protected and respected with the project being located on public lands. Public access is maintained similar to existing conditions. Site snow goose viewing opportunities will change with decreases in the snow goose farmed areas.

The feasibility study identified additional engineering study needs, including more comprehensive geotechnical, hydrogeology, hydrology, coastal hydrodynamic modeling, and coastal engineering studies. These updated studies continue to influence design decisions and are summarized in this report.

3.2 Final Engineering Studies and Design Reports

A series of final engineering studies were performed prior to initiating the 60 percent design. These studies were tailored to answer questions identified in the feasibility study and to reduce uncertainty in design parameters and criteria. The final engineering studies that have been incorporated into the 60 percent design include:

- Baseline topographic, bathymetric, structure and boundary surveys
- Geotechnical and hydrogeologic data report
- Geotechnical engineering design report
- Interior drainage engineering design report
- Coastal hydrodynamic modeling report
- Coastal engineering design report

A summary of these studies, their findings, and recommendations for final design are summarized herein.

3.2.1 Baseline Topographic, Bathymetric, Structure, and Boundary Surveys

WDFW's Al Hammond, Professional Land Surveyor, performed surveys of the project site in the summer and fall of 2013. These surveys included topographic, bathymetric, and structure surveys of the proposed setback dike, interior drainage storage pond, and dike removal areas. WDFW completed surveys of property lines, fences, stormwater infrastructure, and utility locate marks along Fir Island Road. Surveys to date are mostly complete, with remaining needs for additional tidal marsh ground surface, exterior rock protection extents, and haul route-slough crossing bathymetry. The project survey datum are the Washington State Plane North, North American Datum 1983 (NAD83) and the North American Vertical Datum 1988 (NAVD88).

Ground surveys were only performed along the proposed dike and pond areas. Other farm areas shown in the basemaps are from 2003 Light Detection and Ranging (LiDAR) data provided by the Skagit River System Cooperative. The areas with LiDAR survey data include the proposed pilot channels and high marsh fill grading shown in the 60 percent design plans. There is a risk that the Contractor may claim that LiDAR surveys are not accurate enough for pay surveys in the area. For example, an additional 0.5 foot of grading along a 25-acre, high marsh fill grade area is approximately 20,000 cubic yards of materials. If ground elevations are substantially different or lower than the LiDAR surveys, the construction contractor may have grounds for a claim. This can be addressed through specific contract language regarding baseline topographic survey conditions and payment clauses or additional topographic surveys as

mentioned above. We recommend additional topographic survey along the tidal channel and high marsh fill grade areas to reduce the Contractor claim risk.

WDFW and Al Hammond provided mean lower low water (MLLW) to NAVD88 survey datum transformation (see equation below). This datum transformation was used by S&W to establish the design elevation for the setback dike, in conjunction with the hydrodynamic modeling study recommendations. The datum transformation, as described in the design plans, will likely be referred to by the construction contractor for establishing tidal elevations expected during construction.

$$\text{NAVD88 (feet [ft])} = \text{MLLW (ft)} - 2.14 \text{ ft}$$

3.2.1 Geotechnical and Hydrogeologic Data Report

S&W produced a draft geotechnical and hydrogeologic data report in September 2013 (S&W, 2013). The report presents the results of our 2010 and 2013 field exploration program, in situ testing, and laboratory testing for the project site. The purpose of the study was to document subsurface soil and groundwater conditions in support of future engineering efforts for the setback dike and interior drainage designs.

A total of 66 subsurface explorations were performed at the site using test pits, borings, cone penetration tests, and geoprobes. Nine groundwater monitoring wells were installed in borings and geoprobes. In situ testing included Standard Penetration Tests, pore pressure dissipation tests, and well tests. Laboratory soil testing included index and strength testing.

Subsurface cross-sections along the proposed setback dike and across the interior drainage pond were developed from the gathered information. Our geologic interpretations of the subsurface conditions were included in the cross sections and discussed in the report.

3.2.2 Geotechnical Design Report

S&W produced a draft geotechnical engineering design report in April 2014 (S&W, 2014a). The purpose of the report was to summarize our geotechnical engineering analyses, present our results and conclusions, and provide geotechnical recommendations for the design and construction of the project. Geotechnical engineering analyses included dike seepage and stability, foundation soil liquefaction, dike settlement, soil filters, and temporary access roads.

Recommendations for dike geometry, geosynthetic reinforcement, fill material and compaction, filter design, cut slopes, and earthwork installation are included in the report.

This report is currently under review by an Independent Technical Review (ITR) team, WDFW, their Steering Committee, and project partners.

3.2.3 Interior Drainage Design Report

S&W produced an interior drainage engineering design report in April 2014 (S&W, 2014b). The report included a drainage study and modeling analysis of the project and its potential effects on the interior drainage system and farm areas. The modeling utilized information from the coastal hydrodynamic modeling of the proposed project, seepage studies and numerical modeling, a surface water hydrologic runoff model, and a pond water surface elevation hydraulic model. The draft drainage design report identified potential effects on pond water surface elevations and adjacent farm critical root zones. This effect was driven primarily by the anticipated hydrodynamic tailwater effect predicted by the coastal hydrodynamic model.

In response to these findings, additional drainage studies and modeling were performed to analyze mitigation measures including seepage cutoff walls, additional gravity drainage structures (tidegates), and a pump station. The revised drainage report concludes that replacement of existing tidegates, construction of a new interior drainage storage pond, and adding an additional tidegate to the current array of two at Dry Slough is necessary to maintain interior drainage patterns. The option to install a pump station and additional tidegates from the interior drainage pond to Dry Slough, if approved would offset potential project drainage effects.

The original contract covering this 60 percent design report included design of replacement of the existing tidegates and design of the interior drainage storage pond only. The revised interior drainage report (S&W, 2014b) has been submitted for review by WDFW their project partners, and by the granting agencies. Upon agreement by their partners and funders, the additional tidegates and pump station will be included in the final project design. In this 60 percent design report, the additional tidegate and pump station project elements are described briefly and shown schematically in the designs as design “options.”

3.2.4 Coastal Hydrodynamic Modeling Report (Battelle, 2013)

Battelle produced a hydrodynamic modeling analysis of existing conditions, and the proposed project with and without the spur dike (Battelle, 2013). The Battelle 2013 report summarizes modeling studies for the project performed in 2011. The hydrodynamic modeling

study evaluated existing and proposed setback dike conditions. The report describes the modeling setup, simulation times, boundary conditions, and results. The results presented in the Battelle 2013 report were interpreted and decisions made regarding the spur dike, main tidal inlet width, sedimentation and erosion, and dike design as described in the following report section. In addition to the hydrodynamic modeling analysis and results, Battelle provided an analysis and estimate of maximum water level used for dike elevation design.

3.2.5 Coastal Engineering Design Report

S&W produced a coastal engineering design report (S&W, 2014c). This report interprets the coastal hydrodynamic modeling studies and provides design criteria and recommendations as summarized below:

- Documentation of the project's tidal and project survey datum transformations.
- Interpretation of Battelle's hydrodynamic modeling results and identification of dike design criteria.
- Characterization and estimates of sea level rise, erosion and sedimentation, and vegetation establishment for consideration in the interior drainage study.
- Summary of coastal dike design criteria and recommendations on dike design height and erosion protection features.
- Summary of interior drainage design criteria and recommendations as they relate to coastal processes.
- Summary of marsh restoration design criteria and recommendations as they relate to coastal processes.

4.0 PROJECT DESIGN

The project design includes a number of elements described below. The presentation of these descriptions is in a sequence likely to be adopted by the construction contractor. The design project elements include:

- Year 1 Construction
  - Temporary Erosion and Sediment Control (TESC) Measures
  - Environmental Protection Measures
  - Site Access and Haul Routes
  - Staging Area
  - Setback Dike
  - Interior Drainage

        - Storage Pond
        - Tidegates
        - Pump Station (Option)
    - Marsh Restoration Area
        - High Marsh Fill Grading
        - Pilot Tidal Channels
        - Native Seeding and Irrigation
- Year 2 Construction
    - Existing Dike Demolition

The project features are shown in the 60 percent design plans in Appendix A. The outline of anticipated technical specifications is included in Appendix B. Brief descriptions of the project design elements and outstanding design issues are summarized herein.

4.1 Temporary Erosion and Sediment Control (TESC) Measures

TESC measures will be necessary prior to starting earthwork. A National Permit Discharge Elimination System (NPDES) Section 402, General Construction Stormwater permit will need to be submitted and received prior to starting the project, including installation of TESC and Best Management Practices (BMPs). There are multiple ways to handle the NPDES 402 permit. It can be submitted by either WDFW or the Contractor. If WDFW applies for the permit in advance, they would need to reassign the permit to the Contractor after award of the contract, for the Contractor to implement.

Typical TESC and BMPs measures used for the project will include silt fences, crushed rock construction access entrances, coir logs, floating silt curtains, hydroseeding, and wet bottom basins.

Another aspect to sediment and erosion control will be the timing and sequence of the marsh pilot channel excavations, high marsh fill grading, native seed establishment, and existing dike demolition, as described in the following report sections.

4.2 Environmental Protection Measures

Environmental protection measures include special provisions to protect the environment and human health. Items we recommend in the environmental protection special provisions include discovery protocols for contaminated soils and archaeological and cultural resources. Other

environmental protection measures described in the permits section of this report include work limits and schedule limits for habitat protection.

4.3 Site Access and Haul Routes

Site access and hauling materials are a key consideration for the project. Nearly 150,000 tons of imported dike fill, 43,000 tons of riprap, and other materials are needed to construct the project. Haul vehicles, including double trailer haul trucks, will need a stable crushed rock diving surface in order to deliver materials. The large quantity of materials for the project will be delivered in a three- to four-month timeframe. Providing a haul route "loop" with separate entry and exit points would greatly improve options and flexibility for the Contractor, transport efficiency, and site safety.

The main access route to the site is from the existing Reserve entrance, south to the parking area (West Access). The WDFW main access route is 1,300-foot-long and will be available to the Contractor during construction. Plans are to realign the southern 450 feet of the existing WDFW access road to the west along the toe of the old Brown Slough dike. The new alignment will improve access and connection to an underutilized farm area on the west side of the site. The existing WDFW access falls within the 660-foot bald eagle protection zone, and will not be suitable for full time access during key construction periods. This route alone will not provide adequate access to deliver the necessary equipment and materials.

A second, 3,500-foot-long temporary, access route will begin at the existing WDFW access road and No Name Slough crossing (see Figure 2). This access route follows along the north side of No Name Slough, then after a 100-foot radius turn crosses the Slough, and heads south along the east side of the Slough to an access ramp leading to the Claude O. Davis Slough tidegates. This 100-foot turning radius is a design minimum to allow double-trailer haul trucks to maneuver. Vehicles are not expected to need an area to turn around as the haul route continues to the outer loops for egress. The outer haul route loop will include a 2,150-foot-long temporary access constructed along the eastern margin of the site from Fir Island road approximately 2,500 feet east of the main Reserve access (East Access). This access route follows Dry Slough (West) south to the corner of the setback dike. These multiple ingress and egress routes, that will become the responsibility of the Contractor during construction, will improve Fir Island Road and site transportation flow, safety, and provide increased efficiency for the construction contractor. The East Access is temporary and will be demolished with aggregate and geotextiles used to construct the route removed upon completion of the project.

The setback dike will have a permanent, 20-foot-wide access route running along the dike landward toe from the north end of the WDFW parking lot, east to Dry Slough, then south to the Dry Slough tidegates. This permanent access will be available to the Contractor during construction as part of the haul routes, but will be refinished prior to project closeout. A second permanent access route will run along the top of the setback dike, as described below.

4.4 Staging Area

A 300-foot by 300-foot, temporary construction staging area will be available to the Contractor located east of No Name Slough and immediately north of the new interior drainage storage pond. We anticipate the Contractor will keep a project office, portable toilets, storage facilities, equipment, and material in the staging area. This staging area is located outside the bald eagle nesting zone. We recommend, if the Contractor elects to use a staging area, that a security fence be located around the area during construction for public safety and protection of the construction contractor equipment. This area will be fully reclaimed for farming upon completion of the project.

4.5 Setback Dike

A new 6,450-foot-long setback dike will be constructed for the project. The new setback dike alignment starts at the south end of the existing WDFW parking area, travels north for 1,200 feet, then runs west-east for 2,200 feet, and then north-south along the west side of Dry Slough for 3,050 feet.

The dike final design elevation is 15 with a top width of 15 feet. These design criteria were based on the Coastal Engineering Report recommendations (S&W, 2014c). The dike side slopes are 2.5 horizontal to 1.0 vertical (2.5H:1V) based on the Geotechnical Design Report (S&W, 2014a). The dike foundation includes a geotextile reinforcement to improve stability.

The geotechnical design report indicates that up to 1 foot of settlement may occur (S&W, 2014a). However, it is likely that a majority of this will occur during construction and only a minimal amount of overbuild will be needed to accommodate remaining settlement, if any. Settlement monitoring is included in the design plans to verify that primary consolidation is complete during construction and that secondary compression is minimal.

The waterward side of the dike will have a riprap erosion protection blanket; D_{50} = 24-inch at a thickness of 2 to 3 feet, and a 3- to 4-foot toe below finish grade (S&W, 2014c). The erosion

protection blanket and landward dike slopes will be covered with topsoil and seeded with native grass seed tolerant to brackish water.

An access road of crushed rock surfacing aggregate will be placed along the top of the dike crest. Dike on/off-ramps are located at the WDFW parking lot, the northeast corner, and the southeast corner near Dry Slough. Access ramps are also located on the marsh side of the proposed No Name Slough tidegates and log boom protection area.

The dike has not been designed to withstand wave overtopping or to resist soil foundation instabilities resulting from seismic-induced liquefaction.

4.6 Interior Drainage

The existing interior drainage system will be reconfigured with a new storage pond, tidegates, and options of a pump station and Dry Slough tidegates pending approval. These drainage design elements and justification for their inclusion in the project are described in detail in the Interior Drainage Design Report (S&W, 2014b).

4.6.1 Storage Pond

The interior drainage storage pond is designed to offset the reductions of interior drainage ditch and channel storage volume that will occur from setting back the dike. The new interior drainage storage pond will be 2,200 feet long, 150 feet wide, with side slopes of 3H:1V, and is located on the north side of the setback dike. The pond will depth will aim to reduce the potential for establishment of cattails (Typha) that could clog and reduce the storage pond volume.

Typha species have adapted to anaerobic soil conditions by transferring atmospheric oxygen through cells in the plants' stems and into the roots, or rhizomes. Typha survives after the fall senescence because the stems remain standing and the oxygen pathway remains functional. When Typha stems are inundated for prolonged periods of time the oxygen pathway is broken and tissue degradation and plant death occur (Miklovic, 2000).

In a study at the W. K. Kellogg Biological Station in Michigan, a monoculture of broadleaf cattail (*Typha latifolia*) was observed to grow in a maximum water depth of 31 inches (Gucker, 2008). A study at the University of Arkansas, *T. latifolia* did not survive in ponding greater than 37 inches (Gucker, 2008).

Narrow-leaf cattail (*Typha angustifolia*) has been found to tolerate greater depths of inundation than *T. latifolia*. A study focused on controlling Typha found that inundation depths greater than 39 inches killed *T. angustifolia* when stands were flooded for at least one year (Grace and Wetzel, 1982). In rare instances, dense Typha root mats float to the water surface and continue growing (Miklovic, 2000).

Hybrids of *T. latifolia* and *T. angustifolia*, known as *Typha glauca*, were observed to grow densely at water depths of 39 inches in a study south of Lake Manitoba (Gucker, 2008). However, in Minnesota's Agassiz National Wildlife Refuge, areas that had experience draw down for the previous two to five years were flooded for a period of five years. After the third year of flooding, *T. glauca* died in over 24 inches of water. In the same study, T. latifolia died in all continuously flooded areas but survived in temporarily flooded areas (Gucker, 2008).

The storage pond daily low water elevation design is 3 feet. Therefore, in an effort to reduce cattail growth, the pond bottom elevation has been established at -1 foot. This allows 4 feet of year-round inundation depth, which is greater than the 39 inches recommended above.

4.6.2 Tidegates

A total of five tidegates have been analyzed at three different locations. The first pair of tidegates are two, 48-inch, side-hinge tidegates located in No Name Slough at the new setback dike crossing location. These tidegates will replace the existing tidegates in the existing dike located at Claude O. Davis Slough. Consolidated Diking District 22 (CDD22) and WDFW discussed this installation and concurred on side hinge tidegates at this location.

The second pair of tidegates are two, 48-inch, side-hinge tidegates located in the interior drainage storage pond, leading into Dry Slough. These tidegates are designed to take advantage of the fact that Dry Slough will not have the hydrodynamic tailwater effect and some drainage flow can be shunted east into Dry Slough from the No Name Slough system. CDD22 and WDFW discussed this installation and concurred on side hinge tidegates at this location. Side hinge gates will need to be slightly setback in an alcove feature to allow the gate doors to remain open when Dry Slough is flowing. This second pair of tidegates is a recommended option that if approved by WDFW and its partners, will assist in mitigating interior drainage effects.

A third location will include a single, 48-inch, top-hinge tidegate added to the existing Dry Slough tidegates at the mouth of Dry Slough. This tidegate will accommodate additional seepage into the drainage system from the tidal marsh into Dry Slough. CDD22 and WDFW discussed this installation and concurred on a top hinge tidegate at this location, similar to the

existing tidegates. Final design of this structure will need to consider construction methods and alignment to protect the existing tidegate structures.

4.6.3 Pump Station (Option)

A pump station consisting of three 3,000 gallons per minute pumps has been recommended to pump from the interior storage pond to the tidal marsh. The pump station is necessary to mitigate for the anticipated hydrodynamic tailwater effects that could raise water elevations, affecting farm field critical root zone groundwater elevations.

The pump station structure will likely include a concrete housing positioned on the landward side of the dike with an intake pipe leading into the pond. Electrical power will be provided along the east access temporary haul route in a buried electrical conduit. The electrical utility will need to be placed at a depth below farm plowing depths. Electrical control units will be placed near the top of the dike, above flood elevations.

If accepted by WDFW and their project partners, pump station designs will be developed and incorporated into the project design at the 90 percent and final design phases. More details on the pump station design will be provided at that time.

4.7 Marsh Restoration Area

The current farm areas being restored to estuarine tidal marsh have a number of planned construction components. These include high marsh fill grading, pilot tidal channel excavations, native seeding, and irrigation, as described below. Figure 2 shows the final grading plan, expected marsh, dike, and drainage configurations.

4.7.1 High Marsh Fill Grading

High marsh fill grading will occur along the northwestern and northeastern marsh restoration areas. The justifications for high marsh fill grading are to provide a broader range of topographic relief and marsh habitat types, mimicking natural marsh areas outside the existing dike (Figure 3). Additionally, the existing farm area elevations are fairly low, and there is not likely enough natural sediment supply alone to accrete a high marsh platform in the near future. The sediment supplies may be low enough, and sea level rise high enough that without additional earthwork an existing elevation marsh area could be drowned out over time.

In addition to the variety in marsh habitat types, high marsh fill grading will provide dike stability benefits. The fill grading will use existing slightly clayey silts and silty sands resulting

from the interior drainage storage pond excavations. The fill grades will be built up to 3 feet deep and will be graded south into the new marsh as much as 1,000 to 2,000 feet away from the toe of the setback dike. These fill areas will reduce seepage through and underneath the dike into the interior drainage system. The slope of fill grading will also shed water from the setback dike and reduce ponding along its toe.

4.7.2 Pilot Tidal Channels

Pilot tidal channel construction is designed to jump start tidal channel development, deliver flow, sediment, nutrients, and fish at a wider range of tidal elevations into the marsh, while limiting the amount of erosion and sedimentation that would otherwise occur. The pilot channel layout was developed in the 2011 Fir Island Farm Feasibility Study (S&W, 2011). The number, location, and sizes of channels use empirical models described by Hood in the marsh island modeling method (2007). Pilot tidal channel excavation material will be spread adjacent to the newly excavated channel, and seeded with native seed.

4.7.3 Seeding and Irrigation Strategy

A seeding and irrigation strategy has been developed to reduce erosion and sedimentation across the site, facilitate low and high marsh vegetation communities establishment, and provide interim winter forage opportunities for snow geese. Six seed mixes have been developed for setback dike, the side slopes of the storage pond, and much of the restoration area, as described in Table 2.

All seeded areas will by hydroseeded in mid- to late-September during Year 1 with a long-fiber wood mulch added as a natural tackifier and for moisture retention. A slow-release granular fertilizer will be added only to the hydroseed applied to the setback dike side slopes.

The high marsh seed mix strategy divides that area within the restored marsh above an elevation of 7 feet into four zones. Different strategies will be used within each zone to allow WDFW or others to monitor the effectiveness of native high marsh vegetation establishment. These four zones are summarized as follows:

- Zone 1: Apply a winter wheat cover crop together with commercially available herbaceous cover (e.g., Creeping bentgrass and Inland saltgrass) observed within the existing bayfront high marsh habitats. This seed mix would allow winter forage for snow geese and provide erosion and sediment control using commercially available seed for species documented in the area.

- Zone 2: Apply a winter wheat cover crop for snow goose forage together with a collected native high marsh seed mix procured from the existing bayfront high marsh. This seed mix would allow winter forage for snow geese while jump-starting the establishment of high marsh habitat with genetically appropriate seed.
- Zone 3: Apply a winter wheat cover crop would to provide snow goose forage habitat and root structure for erosion and sediment control. High marsh establishment within this zone would occur only from native colonization.
- Zone 4: Do not seed this zone. Rely on native colonization solely to provide cover. This zone corresponds to the high marsh fill areas created using the cuttings from the existing dike removal. Therefore, these high marsh soils would only be exposed during Year 2 as the dike removal was occurring.

The low marsh seed mix strategy divides those areas within the restored marsh below an elevation of 7 feet into two zones to allow for future monitoring of low marsh establishment. The two zones are summarized as follows:

- Zone 5: Apply a winter wheat cover crop together with commercially available herbaceous cover (e.g., Creeping bentgrass, hardstem bulrush, and alkali bulrush) known to occur in low marsh habitats within Skagit Bay.
- Zone 6: Apply a winter wheat cover crop to provide snow goose forage habitat and root structure for erosion and sediment control. Low marsh establishment would occur only from native colonization.

A temporary irrigation system will be installed to irrigate the low marsh habitat in Year 1 using brackish water from the interior drainages within a 1,000-foot radius of the proposed tidal channel that will be constructed the following year during the dike breach. In this area, tidal velocities and sheer stresses are expected to be at their greatest during the tidal cycles following restoration. Therefore, irrigation is proposed so that seeded areas within this low marsh area have an opportunity to better establish during the year prior to the dike removal to reduce erosion and sedimentation from these low marsh areas. The use of brackish water is intended to expose low marsh habitat within the irrigation zone to water quality conditions similar to post-restoration conditions. The temporary irrigation system will be calibrated to provide 2 inches per week between March 15 and October 15. It will operate following seed application in Year 1 up and during Year 2 until one week prior to the setback dike removal.

4.8 Existing Dike Demolition

In the first year, setback dike, interior drainage system, high marsh fill grading, and pilot tidal channels will be constructed, and planting and seeding activities will be completed and allowed

to establish. In the second year of construction, after the vegetation has been allowed a season to thoroughly root, the Contractor will demolish the existing dike.

The dike demolition plan uses existing dike materials to fill interior drainage ditches running along the landward toe. The ditch fill zones are located outside the anticipated erosion zones (to the far east and far west) identified in the Coastal Engineering Report (S&W, 2014c).

The second aspect of the dike demolition is to dredge and excavate materials from the main tidal channel inlet area, near the existing Claude O. Davis tidegates. Fairly significant erosion is anticipated in the inlet area during dredging activity. Dredge spoil material is planned to be placed over the landward ditch fill on the eastern half of the existing dike removal (Station 26+00 to 39+00) to begin grading the proposed bow-shaped form in the area.

Once the ditch fill and main tidal inlet excavations are complete, the existing dike demolition plan calls for spreading the remaining existing dike material above elevation 9, over the ditch fill areas and into the new restored marsh areas. The western existing dike cut material volume will be limited by the area to remain for the Hit and Miss Gun Club (Station 16+00 to 19+00.) The eastern existing dike cut material volume is anticipated to be much larger and as such will be used to complete the previously mentioned bow shaped form (Station 26+00 to 39+00.) Excavation and hauling of this spread material will be short distances and final dike demolitions will be limited to low tide periods.

5.0 PERMITS

5.1 Summary of Permits

The following is a summary of project permits and their current status.

- Field Exploration Permits
  - State Environmental Policy Act (SEPA) Exemption (WDFW). Complete.
  - Shoreline Management Act Exemption (Skagit County). Complete.
  - National Historic Preservation, Section 106 Area of Potential Effect Approval (Washington State Department of Archaeology and Historic Preservation). Complete.
- Setback Dike Construction Permits
  - SEPA Checklist (WDFW). Complete.

- Shoreline Substantial Development Permit (Skagit County). Public notice complete.
- Special Use Permit (Skagit County). Public notice complete. A public hearing is to be scheduled after the County receives the 60 percent plans and summary of project changes.
- Fill and Grading, Floodplain Development Permit (Skagit County). Application not yet submitted.
- Clean Water Act (CWA), Section 404 (U.S. Army Corps of Engineers [Corps]). Application submitted and under review. Project assumed use of a Nationwide Permit 27 (NWP 27) – Aquatic Habitat Restoration, Establishment, and Enhancement Activities. However, the Corps has recently adopted an interpretation for setback dike projects that would preclude this project from being allowed under NWP 27. Coordination is ongoing.
- Clean Water Act (CWA), Section 401 (Washington State Department of Ecology [Ecology]). Application submitted. Under NWP 27, Individual 401 review is required for projects that involve the placement of fill in tidal waters, such as this. The Section 401 Water Quality Certification process will be identified following the Corps' determination as to whether this project qualifies under NWP 27. If the Corps elects to require an individual permit, it could impact the project schedule and additional budget needed.
- Section 10, River and Harbors Act (Corps). Submitted and under review.
- Endangered Species Act Section 7 Consultation. Programmatic Biological Assessment, Limit 8 form used with Specific Project Information Form.
- National Historic Preservation, Section 106 (Corps). Consultation ongoing.
- National Pollution Discharge Elimination System Permit (NPDES) (Ecology). The Notice of Intent and Stormwater Pollution Prevention Plan have not yet been prepared or submitted.

5.2 Work Windows

The following work windows apply to the project:

- Bald Eagle Work Zone Open – August 16 to December 31
- Marine In Water Work Window – July 16 to October 14

For the Fir Island project, this includes the bald eagle work zone along the western edge of the project radiating 660 feet in all directions from the existing bald eagle nest. Construction activities must remain outside the bald eagle work zone until after August 1, each year. The apparent marine fish in-water work windows are July 16 (based on Bull Trout requirements)

through October 14 (based on Pacific Sand Lance requirements) (Corps, 2012). WDFW will issue an Hydraulic Project Approval that will also have in-water work window provisions.

6.0 OPINION OF PROBABLE COST

A cost estimate, developed for the 60 percent project design has been provided separate from this report. WDFW may or may not elect to release the engineer's opinion of probable cost. A Bid Sheet has been included in Appendix C, which contains quantities without cost.

Design elements that have changed since the 30 percent submittal, and their associated quantity updates have altered the project cost. This 60 percent design submittal includes added costs for the pump station, spur dike, interior drainage pond geometry, geotextile foundation reinforcement, haul route lengths, and changes to the tidal inlet dimensions. This submittal includes cost reductions for the elimination of floodgate and clay cutoffs, as well as the reduction of dike removal and rock protection quantities. The contingency for this submittal has also been reduced from 35 percent to 20 percent.

The project cost estimates include 9.5 percent Washington State and Skagit County sales taxes and a 15 percent cost contingency. Specific design contingency items that need further discussion for final design and construction contract documents include:

- Pay surveys and as-built surveys
- Section 402 – NPDES construction stormwater general permit
- Asphalt repair on Fir Island Road
- No Name Slough, WDFW Fir Island Farm access road culvert replacement
- Extra dike select borrow fill quantities
- Unanticipated cultural resources or contaminated soils discovery
- Dewatering or levee breach related contingencies

7.0 PROJECT SCHEDULE

The project schedule targets a summer 2015 construction start for Year 1 and Year 2 construction completion in 2016. Key project schedule milestones are summarized as follows:

- 90 Percent Design Plans – August 29, 2014
- ITR of 90 Percent Design – September 29, 2014
- Final Design – October 31, 2014
- ITR Backcheck on Final Design – November 14, 2014
- Permits Complete – January 26, 2015
- Construction Contract Advertise – January 26, 2015

- Construction Contract Award – March 15, 2015
- Construction Contract Submittal Review/Acceptance – May 29, 2015
- Construction Field Start – June 1, 2015
- Construction Complete – December, 2016

8.0 STAKEHOLDERS AND LANDOWNERS COORDINATION

WDFW has involved their Steering Committee and project partners in a series of engineering study, design, and review meetings. Each major phase of study and design has been presented for review and comment by the Steering Committee and CDD22. A tracking spreadsheet of the Steering Committee and CDD22 comments and responses is provided in Appendix D. There are ongoing comments, responses, and discussions regarding study findings and design details, but thus far none have been considered major enough to stop or significantly alter the project. In addition to the copy of the comment/response table, a summary of agreed to design elements is located in Appendix E. We recommend that a letter of support from CDD22 also be provided in Appendix E for submittal of the 60 percent design for funding agency review.

9.0 ADAPTIVE MANAGEMENT AND MONITORING

The project involves development of an adaptive management and monitoring plan. WDFW and their team have assembled a draft plan that will be made available on the project website in June 2014. Currently, WDFW and the project team are collecting baseline data to support long-term monitoring efforts. WDFW will continue to provide notice on baseline monitoring and revisions to the adaptive management and monitoring plan as the project progresses.

10.0 INDEPENDENT TECHNICAL REVIEW (ITR)

S&W retained a third party ITR team comprised of Moffat and Nichol and Golder, Inc. The ITR process involved a review of the study reports and designs by the ITR team, who provided comments to the design team. Then meetings were held to discuss and review the comments. Modifications and corrections were made in response to the ITR comments. ITR comment-response tables are included in Appendix F. To date, no major comments have been identified that would indicate significant revisions or alterations are necessary for the project.

11.0 LIMITATIONS

This design report was prepared for the exclusive use of WDFW and other members of the Design Team for specific application to the design of the project. The intent of the report is to provide a summary of design document to WDFW so that they may communicate with their project partners, stakeholders, and granting agencies.

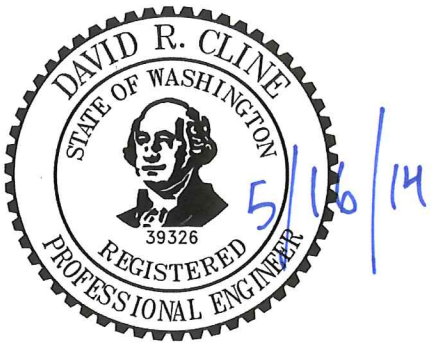
Within the limitations of the scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either expressed or implied. The findings of this report in no way guarantee that any agency or its staff will reach the same conclusions as S&W. Refer to Appendix G for Important Information About Your Geotechnical/Environmental Report.

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist, and further assume that the explorations and soil properties are representative of the subsurface conditions throughout the Fir Island Farm project site; that is, the subsurface conditions throughout the project extents and effected areas are not significantly different from those disclosed by the explorations. Unanticipated soil conditions are commonly encountered and cannot fully be determined merely by taking soil samples from a limited number of soil borings. Such unexpected conditions frequently require that additional expenditures be made to attain properly constructed projects. Therefore, some contingency funding is recommended to accommodate such potential extra costs. Our conclusions and recommendations are based on our understanding of the project as described in this report and the site conditions as interpreted from the explorations.

If, during final design and construction, subsurface, drainage, tidal or site conditions are different from those encountered in the field explorations and engineering studies are observed or appear to be present, we should be advised at once so that we could review these conditions and reconsider our recommendations where necessary. If there is substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the applicability of the conclusions and recommendations concerning the changed conditions or the time lapse.

Facts and conditions referenced in this report may change over time. Facts and conditions set forth here are applicable as described only at the time this report was written. We believe that the conclusions stated here are factual, but no guarantee is made or implied.

SHANNON & WILSON, INC.



David R. Cline, P.E., C.F.M.
Senior Associate

CMH:DRC/drc

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Shannon & Wilson, Inc. (S&W), 2014c, Coastal engineering report WDFW – Fir Island Farm Snow Goose Reserve, Skagit County, Washington: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-12318-217 for Washington Department of Fish and Wildlife (WDFW), April.

U.S. Army Corps of Engineers (Corps), 2012, Approved work windows for fish protection, all marine/estuarine areas excluding the mouth of the Columbia River (Baker Bay), by tidal reference area.

TABLE 1
LAND USE AREAS

Location	Area	Units
Farm Areas Total	105.2	AC
Tillable Soil	102.4	AC
Ditches and Channels	2.8	AC
Tidal Marsh Area Total	130.9	AC
High Marsh	27.9	AC
Low Marsh	97.6	AC
New Channels	2.6	AC
Existing Channels	2.8	AC
Levee Addition	11.6	AC
Drainage Pond	7.7	AC
Road and Parking Lot	2.2	AC
Undefined areas adjacent to Pond	0.47	AC
Total Project Area	**258.07**	**AC**

Colors correspond to shading in Figure 3

TABLE 2
PROJECT SEED MIXES

Site Location	Scientific Name	Common Name	Unit Type	Seeding Rate (lbs/acres)	Acres
Dike and Storage Pond Side Slopes	*Triticum aestivum x Elytrigia elongata (hybrid)*	Wheatgrass, sterile[1]	PLS	10	7.9
	Agrostis stolonifera	Creeping bentgrass		3	
	Festuca rubra	Fescue, Creeping Red		15	
	Festuca trachyphylla	Fescue, Hard		10	
	Lolium perenne 'Amazing GS'	Ryegrass, 'Amazing GS' Perennial		20	
	Lolium perenne ssp. multiflorum	Ryegrass, Annual or Italian		20	
*	*Triticum spp.*	Winter wheat	PLS	60	18.3
	Agrostis stolonifera	Creeping bentgrass		3	
	Distichlis spicata	Inland saltgrass		6	
Zone 2: High Marsh (> Elev. 7 ft)	*Triticum spp.*	Winter wheat	PLS	60	2
	Agrostis stolonifera[2]	Creeping bentgrass	Seed	3	
	Carex Lyngbyei[2]	Lyngbye's sedge		18	
	Juncus balticus[2]	Baltic rush		2	
Zone 3: High Marsh (> Elev. 7 ft)	*Triticum spp.*	Winter wheat	PLS	60	2
Zone 4: High Marsh (> Elev. 7 ft)	None	N/A	N/A	N/A	5.6
Zone 5: Low Marsh (< Elev. 7 ft)	*Triticum spp.*	Winter wheat	PLS	60	84.9
	Agrostis stolonifera	Creeping bentgrass		3	
	Schoenoplectus acutus	Hardstem bulrush		4	
	Schoenoplectus maritimus	Alkali bulrush		8	
Zone 6: Low Marsh (< Elev. 7 ft)	*Triticum spp.*	Winter wheat	PLS	60	12.7

Notes:

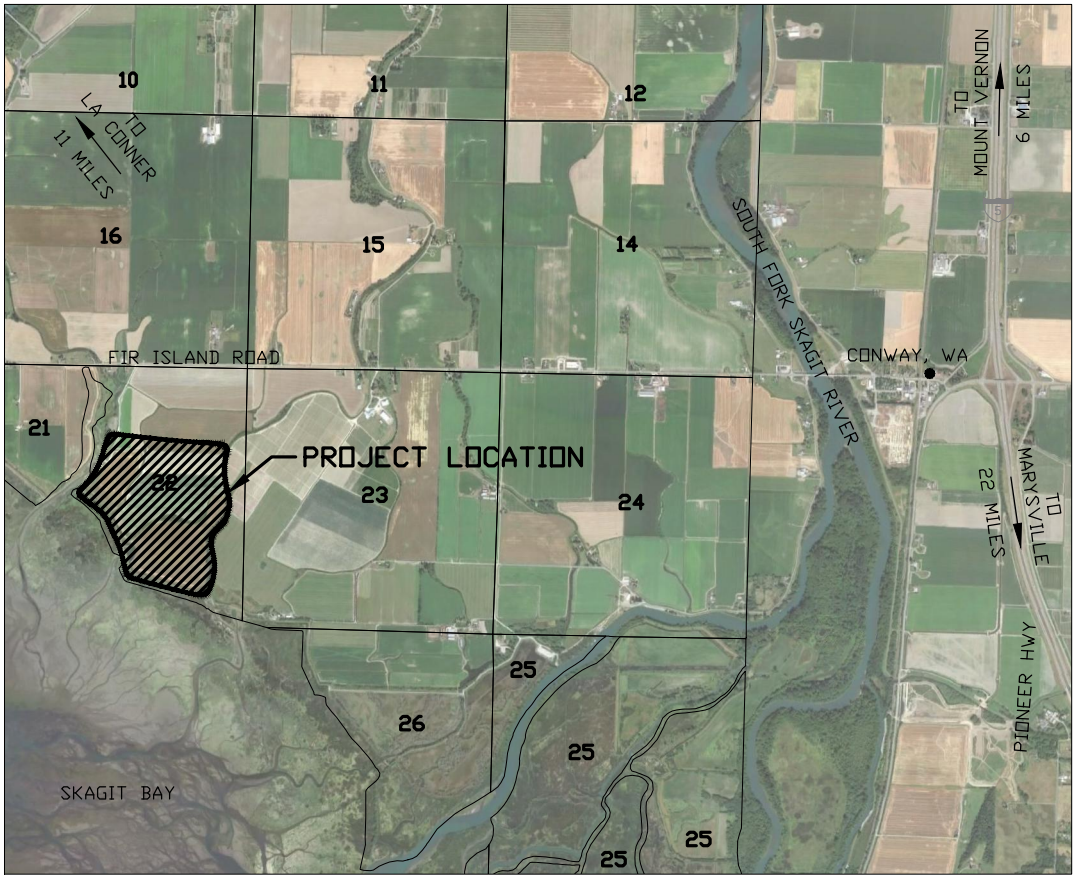
[1] Sterile wheatgrass shall be a single-season cover crop for erosion control purposes, such as Regreen™ or similar.

[2] Native seed to be collected from adjacent high marsh environment in Skagit Bay and shall be free of *Typha sp.* seed.

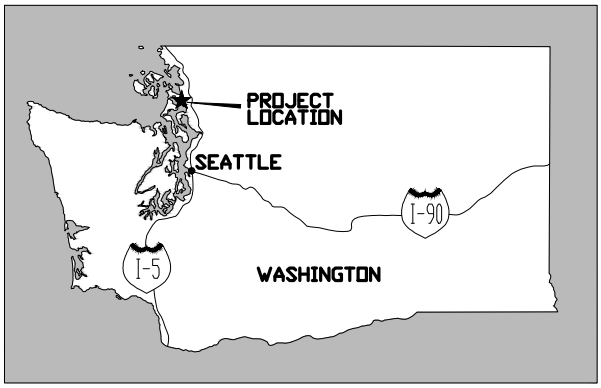
ft = feet

N/A = not applicable

PLS = Pure Live Seed



VICINITY MAP
SCALE: 1" = 4000'



LOCATION MAP

Fir Island Farm
Estuary Restoration Project
Skagit County, Washington

PROJECT VICINITY

MAY 2014 21-1-12318-224

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

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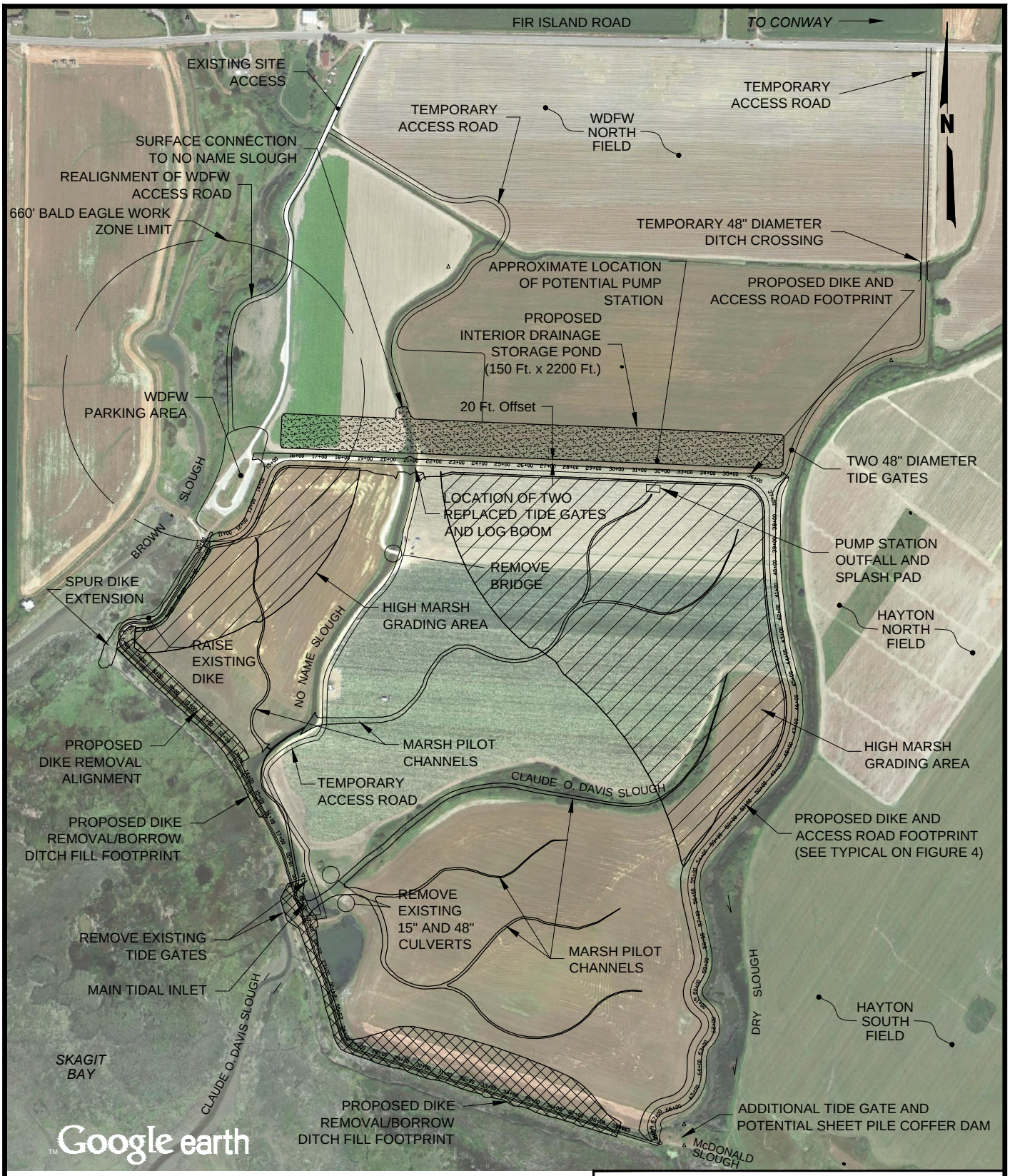

0 600 1200

Scale in Feet

NOTE

Map adapted from aerial imagery provided by Google Earth Pro, Image U.S. Geological Survey, Image Island County, reproduced by permission granted by Google Earth ™ Mapping Service.

Fir Island Farm
Estuary Restoration Project
Skagit County, Washington

PROJECT SITE PLAN

MAY 2014 21-1-12318-224

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FIG. 2

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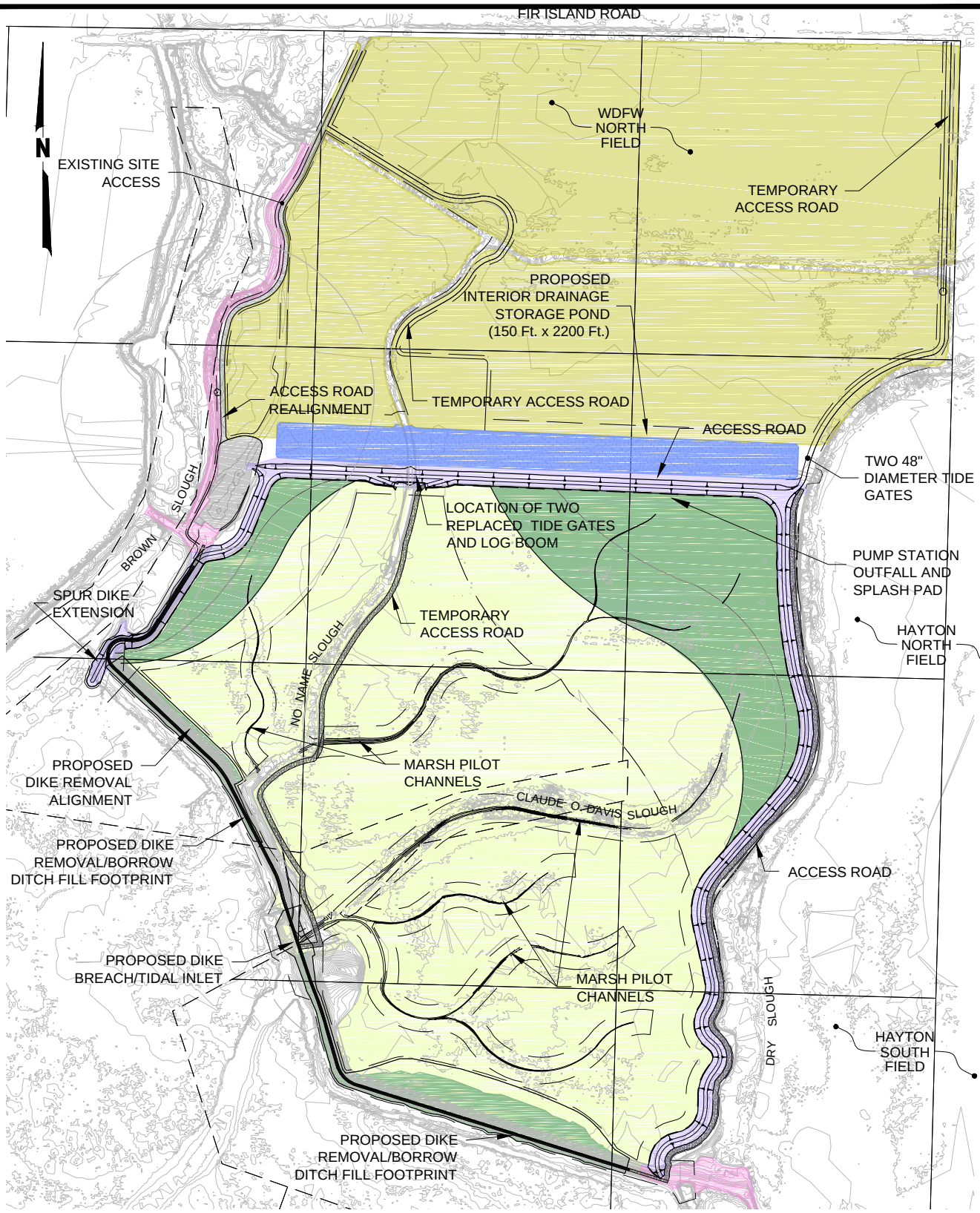

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Scale in Feet

FARM AREAS
POND FOOTPRINT
HIGH MARSH CREATION
LOW MARSH CREATION
ACCESS ROAD
EXISTING LEVEE
PROPOSED LEVEE

Fir Island Farm
Estuary Restoration Project
Skagit County, Washington

LAND USE AREAS

MAY 2014 21-1-12318-224

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FIG. 3

Filename: I:\WIP\21-1\12318 Fir Island\CAD\Mass Balance Calcs.dwg Date: 05-16-2014 Login: cmh

APPENDIX A

60 PERCENT DESIGN PLANS
(Bound and Attached)

APPENDIX B

60 PERCENT DESIGN – OUTLINE SPECIFICATIONS LIST

FIR ISLAND FARM - ESTUARY RESTORATION
CONSTRUCTION CONTRACT SPECIFICATIONS LIST

Division	Section	Description	Spec Writer
00		**Procurement and Contracting Requirements**	
	000110	Table of Contents	WDFW
	000115	List of Drawing Sheets	S&W
	001113	Advertisement for Bids	WDFW
	002110	Instructions for Bidders	WDFW
	004143	Bid Form	S&W
	004313	Bid Security Form	WDFW
	004336	Proposed Subcontractors Form	WDFW
	006133	Performance and Payment Bond	WDFW
	007200	General Conditions	WDFW
	007300	Supplementary Conditions	WDFW
01		**General Requirements**	
	011000	Summary of Work	S&W
	011400	Work Restrictions	S&W
	012200	Unit Prices	S&W
	013100	Meetings and Coordination	S&W
	013210	Construction Schedule and Reporting	S&W
	013300	Submittals and Submittal Procedures	S&W
	014000		
	014100	Regulatory Requirements	S&W
	015000	Temporary Facilities and Controls	S&W
	015700	Environmental Protection and Controls	S&W
	015800	Historical, Archaeological and Cultural Resources	S&W
	017700	Execution and Closeout Requirements	S&W
02		**Existing Conditions**	
	xxxxx	TBD	
	024116	Structure Demolition	S&W
03		**Concrete**	
	032000	Concrete Reinfocing	S&W
	033000	Cast-In-Place Concrete	S&W
05		**Metals**	
	055300	Metal Gratings	S&W
07		**Thermal and Moisture Protection**	
	071000	Damproofing and Waterproofing	S&W
26		Electrical	
	xxxxxx	TBD	S&W
31		**Earthwork**	
	311000	Clearing and Grubbing	S&W
	312000	Earthwork	S&W
33		**Utilities**	
	334200	Culverts	S&W
	334500	Storm Utility Drainage Pumps	S&W
	334600	Subdrainage	S&W
	334726	Storm Drainage Ponds	S&W
	337119	Electrical Underground	
35		**Waterway and Marine Construction**	
	354100	Levees	S&W
	354237	Riprap Bank Protection	S&W

APPENDIX C

BID SHEET AND ENGINEERS ESTIMATE OF PROBABLE COST (UNDER SEPARATE SUBMITTAL)

APPENDIX C-1
BID SHEET

Item	Description	Quantity	Units	Unit Cost	Item Cost
1.0	Contractor Administration, Submittals, Closeout				
1.01	Bonding	1	LS		
1.02	Permits	1	LS		
1.03	Submittals (Schedules, Shop Drawings, Manufacturer Specs)	1	LS		
1.04	Construction Pay Surveys (Grade Checks, Settlement Monitoring)	1	LS		
1.05	As Built Survey	1	LS		
2.0	Mobilization and Demobilization				
2.01	Mobilization	1	LS		
2.02	Demobilization	1	LS		
2.03	Final Site Cleanup - Post Inspection	1	LS		
2.05	Removal of Temp Haul Routes	11,810	CY		
3.0	Site Preparation, Temporary Facilites				
3.01	Contractor Field Office and Toilets	12	MO		
3.02	Fir Island Road Traffic Control	120	DAY		
3.03	High Visibility Fence	96	FT		
4.0	Temporary Erosion and Sediment Control				
4.01	Stabilized Construction Entrance (Quarry Spalls)	400	TON		
4.02	Silt Fence	12,570	FT		
4.03	Diversion of Water	1	LS		
4.04	Floating Silt Curtain	1,600	FT		
4.05	Coir Logs, Wattles	31,482	FT		
4.06	Gravel Check Dams	19	TON		
4.07	Street Cleaning	120	HR		
5.0	Earthwork				
5.01	Dike Alignment Stripping	12,017	CY		
5.02	Riprap Toe Excavation, Haul and Spreading	5,443	CY		
5.03	Pond Excavation, Dewatering, Haul	77,085	CY		
5.04	Tidegate Excacvation, Dewatering, Haul	407	CY		
5.05	Pilot Tidal Channel Excavation and Spreading	4,042	CY		
5.06	Existing Levee Excavation including Haul	20,214	CY		
5.07	Geotextile Reinforcement	68,600	SY		
5.08	Crushed Surfacing Base Course Incl. Haul	69,903	TON		
5.09	Dike Fill Including Haul	148,160	TON		
5.10	High Marsh Fill Grading	82,935	CY		
5.11	Sand Drainage Blanket (Filter Diaphragm)	135	TON		
5.12	Pipe Annulus Backfill	169	TON		
5.13	Riprap Bedding	8,203	TON		
5.14	Riprap (Levee Sideslope)	37,681	TON		
5.15	Riprap (Pump Station Outfall)	99	TON		
5.16	Topsoil	5,679	TON		
6.0	Drainage				
6.01	24" RCP	135	FT		
6.02	24" FES + Grate	2	EA		
6.03	48" HDPE Pipe	564	FT		
6.04	48" Pipe (Haul Route Crossing)	200	FT		
6.05	48" Top Hinge Tidegate	1	EA		
6.06	48" Side Hinge Tidegate	4	EA		
6.07	Pump Station	1	LS		
7.0	Vegetation and Plantings				
7.01	Bulk Seed Procurement	9,056	LB		
7.02	Native Marsh Seed Procurement	2	AC		
7.03	Hydroseed Marsh	126	AC		
7.04	Hydroseed w/ Tackifier Mulch	8	AC		
7.05	Marsh Plantings				
7.05	Irrigation	1	LS		
8.0	Miscellaneous				
8.01	Log Boom	1	LS		
8.02	Settlement Monitoring Plate Installation & Weekly Survey	20	WK		
8.03	Fish Screen and Defishing	1	LS		
8.04	Fence Relocation	900	ft		
				Equipment, Labor, and Material Costs	
				Taxes (9.5%)	
				Construction Cost	
				Construction Supervision	
				Cost with 20% Unknown Cost Contingency	

APPENDIX D

STEERING COMMITTEE AND CONSOLIDATED DIKING DISTRICT 22 (CDD22) COMMENT / RESPONSE TESTS

Date:5/1/14

WDFW FIR ISLAND FARM FINAL DESIGN PROJECT

COMMENT TRACKING TABLE

Study Sponsor: Washington Department of Fish & Wildlife

Study Parnters: Skagit Conservation District, Seattle City Light, Western Washington Agriculture Association

Study Consultant: Shannon & Wilson Inc., The Nature Conservancy

No.	Date	Party	Report Section, Page, Paragraph	Party Comment	Responder	Responder Response
GENERAL COMMENTS						
1	6/5/2013	SCDD#22		The district is concerned that the new tide gate in the setback dike in No Name Slough will not work. Gravity flow through this gate will be impacted by sediment deposits and drift logs . There is a concern that the channel will fill in.	DRC	The design considers the potential for reduced drainage and increased tailwater elevations on the setback dike, new tidegates and pond. This is discussed and presented in the interior drainage report, February 2014, and amended April 2014. A log boom will be included in the project to protect the new tidegates.
2	6/5/2013	SCDD#22		Given the districts concern about silt and logs impacting the gravity drainage through a new tidegate in No Name Slough, the district suggested re-routing the drainage in No Name Slough to new tide gates connecting to Brown Slough and Dry Slough.	DRC	Rerouting No Name Slough into Dry Slough could impact neighboring farm properties. We recommend isolating No Name Slough to the extent possible to avoid these potential effects.
3	6/5/2013	SCDD#22		The district feels a pump will be needed in No Name Slough to maintain drainage.	DRC	Pump stations are considered and recommended in the forthcoming Interior Drainage Engineering Design Report, April 2014.
4	6/5/2013	SCDD#22		The district wants the new dike along Dry Slough set back at least 20 feet to accommodate equipment access along the slough to conduct maintenance dredging.	DRC	An access and maintenance width of 20 feet has been included in the design.
5	6/5/2013	SCDD#22		The district feels that setting back the new dike along Dry Slough will reduce the seepage under and through the dike.	DRC	Seepage will slightly increase to Dry Slough resulting from the setback dike project. The increase in seepage will be accomodated through a third tidegate on Dry Slough.
6	6/5/2013	SCDD#22		The district is concerned that sediment from the restoration site will be exported into the estuary resulting in offshore shoaling that could impact the district's gravity drainage in Brown, Dry and No Name Sloughs.	DRC	Sedimentation exported from the site is one possibility. Another is that the project may draw sediment from the Skagit Bay area towards the project along shoaling areas. Either way, sedimentation has been considered in the design and the potential effects on interior drainage have been addressed through pump station and additional tidegates to the system.
7	6/5/2013	SCDD#22		The district supports WDFW's plan to perform baseline and future monitoring to observe changes in tidal channel, interior drainage channel and farm groundwater conditions. Monitoring will include level, temperature and conductivity loggers in surface and groundwater observation wells, as well as periodic surveys of drainage and tidal channel conditions.	DRC	Comment noted. Agree.
8	6/5/2013	SCDD#22		The district thinks connecting the new drainage storage pond for No Name Slough to Dry Slough via a floodgate is a good idea.	DRC	The project design includes a connection from the new storage pond to Dry Slough via (2) 48inch tidegates.
9	6/5/2013	SCDD#22		The district would like to include a flood flow return structure (floodgate) into the new setback dike. The district has acknowledged that a flood flow return structure is not part of the existing drainage infrastructure at the site and therefore is not part of WDFW's commitment to maintain the district's existing drainage. The district also acknowledged that additional drainage modeling needs to be completed by the district in order to determine the optimum locations for flood flow return structures on Fir Island.	DRC	The Fir Island Estuary Restoration project does not include a floodgate in Dry Slough.
10	6/5/2013	SCDD#22		The district supports retaining and extending the existing dike element along Brown Slough in order to protect the Brown Slough tidegates from drift logs and to minimize drainage and sediment from the restoration site impacting Brown Slough.	WDFW - BWW	Response currently pending completion of ongoing analysis and modeling.
11	2/27/2014	SCDD#22		The district would like the spur dike extesion to be armored with rock.	DRC	The spur dike extension will have rock protection on the east side of the dike.
DRAFT GEOTECHNICAL AND HYDROGEOLOGIC DATA REPORT						
1	9/27/2013	Jenny Baker		Looks like there's a lot of sand everywhere on site, below a thin layer of silt. The terms "loose sand" and "flowing sand" make me think its very unconsolidated, permeable and unstable – I'd like to know more.	DRC	The underlying sand layer allows more seepage, which is evaluated and discussed in the interior drainage report. Sand is a coarse material and can be more stable than silts or clays. The caveat to this is sand is "liquefiable" and can become unstable in seismic "shaking" conditions.
2	9/27/2013	Jenny Baker		I'm not sure how to interpret the permeability, stability, and settlement results. I'd like to know more. What do all of these mean for the design?	DRC	The geotechnical data report will be interpretted and analyzed in the geotechnical design report, available April 2014.
3	9/27/2013	Jenny Baker		Are the soils excavated from pilot channels suitable for new dike fill? Seems like they might be. Is that being looked at/considered?	DRC	Soils from the upper Hm layer from the pond may be suitable. This will be addressed in the geotechnical design report, available April 2014.
DRAFT HYDRODYNAMIC MODELING ANALYSIS						
1	10/15/2013	Tom Slocum		I disagree with the conclusions about flooding risk prevention, which seem to be the basis for designing your new dike 1 to 2 feet higher than the surrounding DD22 dikes. Dave said at one point that NRCS' dike standards were the same as the Corps' standards, but a key element in NRCS' planning process is judging what level of flood risk is acceptable at the particular project site, and then designing the dike accordingly. What is WDFW trying to protect by having higher dikes than the surrounding area? I can't think of a compelling reason to provide greater protection of WDFW's crop land north of the new dike than currently exists behind DD22's dike. It's just farmland without any structures, and if there is some overtopping of salt water in an extreme event, WDFW isn't in a worse position than any other farm owner out there. Likewise, scour over the backside of the new dike won't be any worse than on DD22's best existing dikes. From the point of view of using state salmon $ cost effectively, the kind of dikes that Shannon and Wilson designed at Fisher Slough seem pretty extravagant.	DRC	The proposed dike design follows the NRCS design standards, as was established by WDFW in developing the contract. One would expect to have different dike design configurations when comparing the current dike design that follows current design standards with dikes built at the turn of the century, and through the 1950s and 60s, that likely did not follow engineering standards, and are likely substandard by today's measures. We recommend following current accepted design standards, which will likely be greater in level of protection than historic dike constructions.

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WDFW FIR ISLAND FARM FINAL DESIGN PROJECT

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1	1/27/2014	Tom Slocum		I reviewed the draft coastal engineering report and am providing the following comment. In my opinion, the engineering analysis related to tidal elevation, wave height, sea level rise, scour hydraulics and other relevant engineering factors appears to be technically sound and very thorough. The primary concern that I have is not with this analysis itself, but with the resulting dike design. As I have said in previous stakeholder committee review comments, I feel the design approach uses an inappropriately conservative risk analysis. The dike height and the extent of rock armoring on the seaward face will substantially reduce the risk of overtopping and erosion compared with that for the surrounding DD22 dike system. In my view, this added level of risk reduction is not warranted, because if a situation such as a repeat of the 2004 flood damages or breaches the surrounding DD22 dikes, then the new dike at the Fir Island Farm project site will be an isolated island that doesn't really protect anything. The design report states that it adopts NRCS' level 2 dike standard, but then essentially ignores the risk-assessment that is the basis of NRCS' standard. NRCS' standard explicitly allows for a reduced level of flood protection on farm land because the potential damage from overtopping or dike failure on farm land would be much less than, for example, in a densely populated residential or commercial area. In my opinion, building the proposed dike to 15.0' elevation and armoring the entire seaward side with rock with mean diameter of 2 feet disregards the risk assessment that is explicit in the NRCS design standards. From the standpoint of funding the entire project with salmon habitat restoration funding, in my opinion it would be hard for the funding agency to justify the increased level of protection of the proposed dike relative to the existing dike that is removed, without seeing a substantial contribution from SDD22 to cover the added cost of the increased level of service.	DRC	In my opinion, the proposed design follows the current design standards, and considers other factors such as sea level rise. The dike is being raised 0.5ft to 1.5ft, and this includes 0.9ft of Sea Level Rise over 50 years. If you take that away, we are raising the dike at most 0.6ft, which is not much, and not a "substantial" improvement. The difference between the Class I and Class II standards is relatively narrow for the level of protection criteria. We used the observed extreme tide in the most recent 20 year period, which is roughly the 25-year event. We did not research the entire historical tide record to statistically cacluate the 25-year tide. We did not use the maximum observed tide, or 100-year maximum tide, so we do not meet the NRCS Class I standard. With respect to the dike level of protection for a Risk 2 category, this allows overtopping at a 25-year (4 percent chance of overtopping each year) and 87 percent chance of overtopping in 50 years. Also, the NRCS dike design manual does not appear to consider or distinguish between freshwater river flood overtopping and salt-water flood overtopping, where farms inundated with salt-water may have much more significant, and long term impacts to farming than those along freshwater systems. Also, consider that the existing dikes are substandard and built several decades ago, some at the turn of the century. Dike design standards have changed significantly in the last 10 years, let alone 100 years. I would suggest we should design to current standards and not try to "match" existing conditions because we know they are substandard.
2	11/2/2013	Jenny Baker		Section 3.0 The model assumes that the marsh is not vegetated. What is the effect of assuming the marsh is vegetated? Of specific interest is the amount of ponding on the marsh.	Zhaoqing, DRC	DRC - The model assumes existing and proposed areas are vegetated. We are following up with Zhaoqing on what roughness coefficients were used in the model for the vegetated areas.
3	11/2/2013	Jenny Baker		Section 4.0 Why are you choosing the sea level rise predictions for the year 2100? It would seem that something sooner would be more appropriate given typical design timeframes/lives.	DRC	After receiving this comment, the project team decided to use a 50-year design and Sea Level Rise period.
6	11/6/2013	SCDD#22		CDD#22 is concerned that the restoration will result in off shore sediment shoaling that will impact drainage similar to what has occurred in Wiley Slough. John Wolden	Zhaoqing, DRC	Sediment shoaling may occur. The interior drainage study addressed this by evaluating erosion, sedimentation and vegetation effects on the tailwater of the storage pond tidegates. The system was designed to accommodate changes and increases in low tide elevations resulting from sedimentation.
DRAFT INTERIOR DRAINAGE STUDY						
2	12/5/2013	Tom Slocum		I believe that Figure A15 has a slight error where it shows the drainage from Dry Slough going north into the existing "Dry Slough East" storage pond, and then going west along a ditch to the No Name system. I've done detailed field measurements in that area and, at least in spring 2009 (?), when I did the measurements, the flow definitely went the opposite direction, i.e. all into Dry Slough. I can provide channel profile survey data on this if it helps. Probably a good idea to confirm this with DD22. So I still think that it would be feasible to include an overflow from your new storage pond going east into the Dry Slough system, if extra drainage capacity were needed.	DRC	I did not find which figure you are referring to, but understand the comment. No Name Slough and Dry Slough are only connected at very high flows, likely above water elevation 5.0ft (NAVD88). This can be observed by comparing Figures A-10 (Dry Slough 1.3) and A-13 (No Name Slough 2.1). These data loggers are essentially at either end of the ditch, and they do not have the same water elevation patterns, therefore are not connected at low flows. At high flows, depending on which ditch is higher, the flow can go either direction. We do not force the water in either direction and let the model solve the directions depeding upon flow conditions in No Name or Dry. An overflow going east into Dry is included.
1	12/5/2013	Tom Slocum		Here is why I think this: the existing tidegates at Claude Davis, plus the overflow from the ditches going east into the "Dry Slough East" storage pond* already handle this drainage pretty well. Even with the time delay caused by moving the new dike to the north (as described in the hydraulic report), it seemed to me from Dave's presentation on Monday that the new pond could store the existing seepage and runoff, and the proposed new tidegates at No Name could drain it. I'd prefer to see a design/ evaluation of additional tidegates installed at No Name (if needed) before doing alot of design on a new pump station.	DRC	We analyzed adding tidegates from the new storage pond to Dry Slough. The data is included in the forthcoming Interior Drainage Report April 2014. Adding the tidegates only nominally lowers the storage pond water elevations by (0.1ft-0.2ft). The primary factor affecting the storage pond water surface elevations is the tailwater on the gates. Also, adding water into Dry Slough could impact the Hayton farm fields.
3	12/2/2013	Tom Slocum		Good meeting today. I like S&W's analysis on interior drainage. I think they asked the right questions and answered them pretty well.	DRC	Thank you.
4	12/2/2013	Tom Slocum		I personally don't want to see $50K spent on the pump station design. In my opinion, the internal drainage study showed that impact to drainage above the existing baseline condition can be dealt with pretty well using the planned storage pond and two new tidegates through the dike at No Name Slough. Since this drainage system is designed primarily for WDFW's land, I don't see the point of upgrading drainage capacity by adding a pump station. The situation is different than Wiley, where the impacts were primarily off-site on private property. If S&W's analysis turns out to be wrong and drainage becomes a problem, then WDFW won't be under the same kind of pressure as at Wiley to immediately mitigate the problem, but can take time to evaluate and do a step by step approach to adjust drainage.	DRC	We disagree. The additional tidegates can nominally lower the storage pond elevations, but a pump station is needed to drain down to existing low tide elevations, because of the tailwater effects. We also looked further upstream and the water elevation effects propogate upstream along almost the entire system and have the potential to impact several hundred acres of low lying land. Also, more water into Dry Slough could impact the Hayton farm fields. We recommend both a pump station and two tidegates to Dry Slough and a third tidegate at the bottom of Dry Slough for the project. Financing retrofits after the fact when problems occur is challenging at best.

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5	12/2/2013	Tom Slocum		I can live with adding a 3rd tidegate at the mouth of Dry Slough to improve drainage through Dry Slough. It adds some extra benefit for the Hayton Farm and is a nice gesture to the Haytons and DD21 for a modest additional cost (I assume on the order of $40K to $50K). But the costs of designing, constructing and operating a pump station will be an order of magnitude greater than this. If S&W really thinks some extra drainage capacity is needed on the FIF property, then could they consider designing a high-flow connection over to Dry Slough, to take advantage of the extra capacity of the new tidegate there? As I've mentioned before, I'm concerned about the FIF project becoming a precedent for future SRFB-funded projects, and I don't like the idea of setting a precedent of adding additional drainage or flood protection capacity beyond what's needed to compensate for impacts to the existing condition.	DRC	See previous responses.
4	11/6/2013	SCDD#22		CDD#22 thinks that the existing dikes are placed on top of Tacoma Silt/Clay and that the new dike will be placed on Skagit Silt which has different seepage characteristics. CDD#22 wants us to evaluate the seepage characteristics of the site relative to existing and proposed conditions. Gary Jones	DRC	Soil properties along the existing and proposed dike setback have a fair bit of data. The soils along the setback dike are generally similar in composition and not signficantly less clay or more sandy. Therefore seepage rates will likely be similar to existing conditions.
5	11/6/2013	SCDD#22		CDD#22 asked whether a clay cutoff will be included in the new levee design similar to the Wiley Slough marine dike. Bob Hughes	DRC	We do not recommend clay cutoff as they need to be deep to be effective. We recommend managing seepage flows through the surface water pond and ditch drainage system.
7	11/6/2013	SCDD#22		CDD22 recognizes that a flood return tidegate structure in beyond the responsibility of the restoration project. CDD#22 recognizes that there could be cost efficiencies for the district if they could include a flood return tidegate structure into the restoration permits and levee construction process. CDD#22 are uncertain that building a new flood return tidegate into the restoration project is the best location for this structure on the Fir Island landscape. At this time, CDD#22 was not able to commit to conducting the analysis necessary to determine the optimal location for a flood return tidegate structure(s) or to design this structure to coincide with the FIF design and construction timeline. Stan Nelson	DRC	Comment noted.
DRAFT COASTAL ENGINEERING REPORT						
1	2/7/2014	Jenny Baker		Throughout "levee" and "dike" are both used – maybe choose one for consistency?	DRC	Revised for consistency.
2	2/7/2014	Jenny Baker	Section 4.1	I found Section 4.1 difficult to follow. I think it would be helpful to refer to a specific figure or two that demonstrate particular points being made or features being referenced.	DRC	Revised section to be more clear, especially the end discussing the tailwater effects and the questionable low tide elevation predictions of the hydrodynamic model.
3	2/7/2014	Jenny Baker	Section 4.1	Other comments on section 4.1:		
4	2/7/2014	Jenny Baker	Page 4	Page 4, first paragraph - Excavation of the main tidal inlet breach would limit the potential for adverse erosion and sedimentation in the tidal channels – do you mean on the site? In Skagit bay? Or both?	DRC	Both. Added clarifier.
5	2/7/2014	Jenny Baker	Page 4	Page 4 – second paragraph –a map of preferential flow path locations would be helpful.	DRC	Added preferential flow path identifiers to Figures 2-9.
6	2/7/2014	Jenny Baker	Page 4	Page 4, third paragraph – terminology is confusing - predicted effect? = ponding? = "hydrodynamic effect"?	DRC	Revised for clarification.
7	2/7/2014	Jenny Baker	Page 4	Page 4, third paragraph – "tailwater control" - what does that mean? A feature that controls the level to which the water can drop such as a culvert or ___ is called a "tailwater control"?	DRC	Added description of "tailwater" as the downstream water surface elevation that controls the opening, closing and flow conditions through the tidegate. It is a common hydraulic engineering term for culvert systems.
8	2/7/2014	Jenny Baker	Page 4	Page 4, third paragraph – you make a comparison and refer to figure 1, but figure 1 doesn't show a comparison – I found this confusing.	DRC	It should be Figure 10, revised.
9	2/7/2014	Jenny Baker	Page 5	Section 4.2, Page 5 - NRCS = Natural Resources Conservation Service	DRC	Not "National"...ooops.
10	2/7/2014	Jenny Baker	Page 5	Page 5, last paragraph - Incorporating additional height to accommodate the average estimates SLR over a 50-year span makes sense. Is it necessary to plan for the higher side of the uncertainty bracket as well? (The average of plus or minus 0.5 ft is 0.)	DRC	The project design uses the average SLR value at year 50 of 0.93ft. The additional 0.5ft height comment has been removed.
11	2/7/2014	Jenny Baker	Page 10	Page 10, paragraph beginning with "Shoreline sediment shoaling..." - Is the sediment supply at the site limited or not?	DRC	It is unknown if the site is sediment limited, and states that likely some sedimentation occur. The amount is unknown.
12	2/7/2014	Jenny Baker	Page 12	Page 12, first and last bullet - multiple truck trips are likely to have a big effect on the marsh plain and can cause logistical issues (trucks getting stuck) - is benefit worth the risk?	DRC	The recommended reuse are for very short hauls. This will be more apparent in the 60% design. As an example, existing dike removal and inlet dredge materials will be placed and dozed directly along the backside of the existing dike removal. The pond excavations will be moved directly south to the farm areas for marsh grade increases. The limited distance should reduce hauling problems/risks.
13	2/7/2014	Jenny Baker	Page 13	Bottom of page 13 - The wind direction will push wood debris that travels through the main tidal inlet toward the northernmost (east-west) section of the dike and into the southeast corner of the marsh. Should this be N-most and SW corner?	DRC	The prevailing winds are from two directions Northwest and Southeast. Therefore we anticipate wood transported through the inlet will end up in either corner.
14	2/7/2014	Jenny Baker	Page 14	Page 14 - NRCS = Natural Resources Conservation Service	DRC	Ah! Got it.
15	2/7/2014	Jenny Baker	Section 5.5.3	Section 5.5.3, first paragraph - In a previous section it said shear stresses and velocities are not enough to cause erosion along dikes, and selective fill in low areas could reduce effects further. How likely it is that a 6' wide 2' deep channel will develop along the toe of the dike?	DRC	The probability of a low flow channel developing along the dike is unknown. Another way to think about this is "how likely is the dike district to repair the dike in the future if a tidal channel were to develop?"...very unlikely. I defaulted on the conservative side to reduce future maintenance costs for a 50 year project design.
16	2/7/2014	Jenny Baker	Page 21	Page 21 – Recommendations regarding dike width and toe down depth – see previous comment	DRC	It is very likely that the dike will experience heavy wood debris impacts over its lifetime.

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17	2/7/2014	Jenny Baker	Page 21	Page 21 – Recommendations regarding cut, haul and placement of materials – is it possible that some cut materials may be slop and unusable for described purpose? And that travel through marsh plain may have logistical challenges and cause damage and compaction that is difficult to repair?	DRC	See previous response. Cut/fill haul distances are very short. Almost direct cut to fill. We understand the problems with long hauls. The grading plan will reflect this approach.
18	2/7/2014	Jenny Baker	Page 22	Page 22 – misc. recommendations – regarding leaving higher ground for Hit and Miss Gun Club, was this considered in the hydrodynamic modeling? If not, would it affect the results?	DRC	This high ground section was not modeled specifically. It should not affect the results as the high ground that will remain is relatively similar in height to the existing exterior marsh (as seen by tidal flow). The remaining Hunt and Miss Gun club high ground may be impacted and eroded by wind waves. The effects on the modeling results would be minor, if noticeable at all. The modeling grid sizes are only slightly smaller than the high ground, so it would hardly show up in the model geometry.
19	2/7/2014	Jenny Baker	Figure 7	Figure 7 – high shear stress in the middle of the marsh seems odd – I'd like to know more about that.	DRC	The shear stress is water flowing with depth in the excavated pilot channels and spilling onto the marsh plain. We should see erosion, sedimentation occuring in this area.
20	2/7/2014	Jenny Baker	Figure 10	Figure 10 - "project hydrodynamic effect" didn't mean much to me at first glance. Maybe a short caption to explain what's going on would help? My understanding is that the figure shows the water level in Davis Slough under current conditions vs restoration with and without the spur dike over the course of one tidal cycle. Under either restoration scenario, water is expected to pond and not drain to as low a level as it currently does.	DRC	Caption added. I agree with your description about water not draining as low.
21	2/7/2014	Jenny Baker	Figure 11	Figure 11 - showing the Seattle tides added helpful context to the figure (as compared with the previous figure)	DRC	Agree. Did not pull 2003 tidal data to compare with hydrodynamic modeling data.
22	2/7/2014	Jenny Baker	Figure 11	Figure 11 - max water level on previous figure was approx 8'. max water level on this figure is approx, 11' - is this just due to different dates/tides?	DRC	Yes, neap tide vs. spring tide.
23	1/31/2014	B. Williams	Page 4 & 5	The discussion about existing and future tailwater effects is confusing.	DRC	Edited and provided additional explanation of why low tides will not drain as much, described this as the hydrodynamic effect, and described that tailwater is a common engineering term used to describe the flow conditions on the downstream end of a culvert or tidegate controlling opening, closing, flow rates and water elevations.
24	1/31/2014	B. Williams	Page 4 & 5	Why weren't observed tailwater conditions in Claude O Davis used for the modeling?	DRC	The existing and proposed conditions modeling runs were selected in the Feasibility Study. WDFW and Steering committee agreed that the project would analyze Spring 2003 tides and flows for existing and proposed modeling conditions. This phase of study only added the Spur Dike and compared to model runs that had been performed in the previous feasibility study, otherwise we would have needed to rerun existing, without spur dike and spur dike (three runs vs one).
25	1/31/2014	B. Williams	Page 4 & 5	If .7-1 increase is more likely a prediction of future changes, then what is the change that is expected in the immediate future?	DRC	The expected immediate change is 0.7ft to 1.0ft increase in low tide elevations. Revised term "future" to "proposed" conditions.
26	1/31/2014	B. Williams	Page 5	1. I think it is appropriate to incorporate the average predicted SLR of .93 feet for the year 2063 into the dike elevation design. However, I do not think WDFW is responsible to CDD#22 for the .5 foot uncertainty around this estimate. I do not think we need to widen the top width of the dike by 3 feet to accommodate a future dike lift of .5 feet.	DRC	Top width recommendation revised to 15.0ft. Removed recommendation for 18ft top width to accommodate additional 0.5ft of uncertainty for SLR.
27	1/31/2014	B. Williams	Page 5	Why does CDD#22 want a 15 foot wide dike top width? The Wiley Slough marine dike has a 12 foot top width. Some of the Port Susan dikes have a 12 foot wide top width. I recommend we build the top of the dike to 15 feet wide which allows a dike footprint wide enough for an additional .5 foot vertical lift while maintaining a 12 foot wide top width.	DRC	Top width recommendation revised to 15.0ft.
28	1/31/2014	B. Williams	Page 5	What does the dike cross section look like when you include all of the recommendations for armoring, i.e. bedding + 2-3 foot rip rap layer + 1 foot thick top soil? Port Susan dike has a 12 foot core top width with an additional 7.2 feet of armoring. Does the dike top width you are recommending include the 5+ feet of armor and top soil dressing?	DRC	Yes, additional width due to armoring and top soil. The 15ft is the "driveable" surface and can accommodate large equipment and haul trucks to repair dike in emergency situations.
29	1/31/2014	B. Williams	Page 8	Report states a value of 2.2 psf is used to identify likely erosion area for vegetated areas. Is this correct?	DRC	Yes, 2.2psf is average of range for vegetated surfaces 0.4psf to 4.0psf.
30	1/31/2014	B. Williams	Page 9	Page 9 – Is there a crop cover that will not be consumed by snow geese?	DRC	Dave Hughes mentioned mustard, but our natural resources people think this isn't a good idea. We should ask others as part of the planting plans.
31	1/31/2014	B. Williams	Page 12	Page 12 – Fill areas – along entire perimeter of new dike on waterward side? Using available onsite materials, is this possible in addition to establishing a range of elevations across site?	DRC	No. Fill zones are limited. More information will be provided in 60% design plans. See responses to Jenny Baker questions about fill zones.
32	1/31/2014	B. Williams	Page 15	This section states that "This report address the following hydraulic/coastal design criteria only." and Bullet 1 states that "design elevation for coastal dike based on tide heights, storm surge and wind waves." What about SLR?	DRC	Added SLR.
33	1/31/2014	B. Williams	Page 18	1. Recommends side slopes 3:1. Why are we building the dike with 3:1 side slopes? Wiley dikes were built with 2.5:1 side slopes. Do all of the dike side slopes need to be 3:1 (potential erosion areas) or are there sections where 2.5: 1 is adequate (landward side of new dike).	DRC	3H:1V was preliminary recommendation. Revised to 2.5H:1V based on geotechnical stability analysis. Factor of safety achieved with geotextile reinforcement. Without reinforcement, a 3H:1V was likely needed.
34	1/31/2014	B. Williams	Page 19	It is unclear whether none, some or all of the existing borrow ditches will be filled? The borrow ditch fill recommendation is good. Include recommendation for borrow ditch filling on Page 19 as well.	DRC	Included statement for select borrow ditch filling. I use the term "selective" as the site is limited in materials and haul distance is a concern.
35	1/31/2014	B. Williams		Dike alignment along Dry Slough maximize restored area while maintaining max 20 foot setback from Dry Slough.	DRC	20ft setback is included in 60% plans.
36	1/31/2014	B. Williams		For comparison, it would be helpful if the section of the report that discusses how the recommended dike top elevation was developed included a discussion of the dike top elevations for CDD#22's existing dikes and the new marine dike at Wiley Slough.	DRC	Added comment about existing dike elevations.

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37	2/4/2014	Bob Barnard		Could the fact that the modeled Claude O. Davis main tidal channel inlet "breach" is small enough to cause acceleration account for the reduced drainage at the proposed tide gate? Was the excavated channel recommended in Sec 6 modeled to document improvements? Obviously this would change the tailwater conditions for the interior drainage.	DRC	Overexcavating the inlet channel may have some effect on lowering tailwater conditions. However, by inspection the low tide elevations will be higher, even with a larger inlet, because there is a larger tidal prism (volume of water) filling the area, and longer flow path to drain the area, with the same amount of time to drain on each tidal cycle. Therefore, it will not drain "as much" as current conditions. Additional modeling was not performed to evaluate multiple inlet sizes. The funded modeling scope of work was limited to comparing proposed without spur dike and proposed with spur dike.
38	2/4/2014	Bob Barnard		Did you estimate the volume of material excavated from the main tidal inlet and COD channel? Would this volume provide a meaningful increase in ground elevation in low stress areas (funny how that stuff just disappears when you spread it out)?	DRC	Nearly 80,000cy of excavations from the interior drainage storage pond can provide up to an additional 20 acres of high marsh graded up to three feet deep along the northeastern to northwestern sections of the new setback dike.
39	2/4/2014	Bob Barnard		I found the studies cited concerning sediment supply and dynamics on the bay front somewhat confusing and don't see the connection to your conclusion. I also wonder where you are looking when assessing drainage impacts. This image shows where the problem is at Wiley and the area that I suggest may be a problem for FIF.	DRC	Several studies infer low sediment supplies along the central bay front area, which could impact the long term restoration performance of the Fir Island Farm site. We recommend building higher marsh platforms to the extent feasible to offset these conditions. As far as the potential for adverse sedimentation impacts, such as shoaling in the Wiley Slough channel, channel sedimentation and reduced drainage function has been considered and evaluated in the sensitivity analysis. If sedimentation in these areas occurs, pumping operations may increase and more flow may be shunted to Dry Slough.
40	2/4/2014	Bob Barnard		From a cost and optimal engineering point of view, the levee erosion protection seems excessive. Please consider: Was the significant wave height of 2.7 ft was modeled at the proposed dike or in Skagit Bay? Waves are significantly diminished in enclosed, shallow embayments such as this.	DRC	Lagoons and embayments can provide some protection. The southerly wind wave setup was modeled through the inlet near the setback dike, and the wave setup was shown to be higher on the inside of the dike than the outside, indicating limited wave height attenuation due to bay front marsh effects. As the waves travel over shallower marsh surfaces, the waves become larger, much like a beach.
41	2/4/2014	Bob Barnard	Section 5.4	From a cost and optimal engineering point of view, the levee erosion protection seems excessive. Please consider: Can we clearly associate wood impact with dike failure, especially with a shallow approach like this inside an estuary? Your conclusions in the Sec 4 wood transport section are at odds with Sec 5.5.4 Wood Debris Impacts section.	DRC	My recommendation is to include buried rock protection along the dike to protect from waves and large wood debris impacts. Section 4 describes the anticipated wood transport in the marsh restoration areas. Based on the information contained in Section 4, we downsized rock protection size (based on smaller rootball sizes) listed in Section 5 due to the shallowness of the water depth over the marsh plain. If rock protection is not provided, then the design guidelines suggest flatter slopes (on the order of 5H:1V) which is a significant amount of import material, and also a high cost item. Further reduction in rock protection is related to burial depths. Burial depths are 3feet below marsh grade. For the areas receiving high marsh fill, these toe down depths are being raised 3ft, thereby reducing the volume of rock placed for protection.
DESIGN RECOMMENDATIONS						
1	1/8/2014	CDD#22		Gary: Raised the question of including a flood flow return tidetgate complex into the design. CDD#22 is uncertain that building a new flood return tidegate into the restoration project is the best location for this structure on the Fir Island landscape. At this time, CDD#22 was not able to commit to conducting the analysis necessary to determine the optimal location for a flood return tidegate structure(s) or to design this structure to coincide with the FIF design and construction timeline. CDD22 recognizes that a flood return tidegate structure is beyond the responsibility of the restoration project.	DRC	Comment noted.
2	1/8/2014	CDD#22		Concern about the drainage effect of discharging water from the storage pond into Dry Slough. The project will propose a response study to evaluate additional alternatives for gravity drainage to Dry Slough and a pump station in the interior storage pond.	DRC	Interior drainage response studies complete showing tidegates from the storage pond to Dry Slough, with a pump station, and a third tidegate at the downstream end of Dry Slough mitigate project effects.
3	1/8/2014	CDD#22		Curt: Concerned those materials from deconstructing the existing dike will migrate off site, create a shoal in the outer estuary that impedes gravity drainage. How will the existing dikes be deconstructed so that the dike materials are retained on site to the extent possible? Information on erosion and sediment transport is included in the Coastal Engineering Recommendations report (to be provided in mid-January).	DRC	Existing dike materials will be used to fill the interior ditch next to the dike. Then the remaining materials will be spread directly onto the ditch and marsh in areas with low velocities and low shear stresses. These low velocity areas have low potential for erosion, scour and transport of spread dike materials. We also plan to chain-rake native seed into the spread soils to promote establishment of vegetation, further reducing erosion potential.
4	1/8/2014	CDD#22		The 200 foot width will make maintenance of the pond more difficult. S&W to look into narrowing the pond and extending it to the west. The proposed 200 foot width of the new drainage pond exceeds the reach of a drag line or long reach excavator (est. 60-75 foot reach).	DRC	Pond total width reduced to 150ft, 75ft reach from either side. Details are in Interior Drainage April 2014 report.
5	1/8/2014	CDD#22		Routing the underground power line to the new pump station site via WDFW's access road will require crossing No Name Slough or the drainage ditch if the power line follows an access route on the east side of the property. As such the cable will be vulnerable to maintenance work in the slough. It was suggested that the cable could be laid under a culvert in the slough which would also create an equipment crossing. A bridge could also be installed across the slough and the power line attached to the bridge.	DRC	Going forward in design, we will design electrical utility to protect from farm plow and ditch maintenance equipment. At the ditch, the electrical line will likely be either buried in a protective pipe, or fastened to the bridge or placed higher in the culvert embankment. TBD.
6	1/8/2014	CDD#22		Stan: Requested that a ramp be constructed on the waterward side of the new dike adjacent to the new tidegates in No Name Slough to allow equipment access to the tidegates and trash rack for maintenance.	DRC	Ramp down to marsh located on either side of No Name Slough tidegates.
7	1/8/2014	CDD#22		John: Concerned that a new tidegate in Dry Slough with a side hinge gate will negatively affect the operation of the existing top hinge tidegates. S&W indicated that the Dry Slough gates are not SRTs, so the side hinge would not likely affect drainage performance. The side hinge would be open more of the time.	DRC	Current design plan is to match new tidegate with existing tidegates.

Date:5/1/14

WDFW FIR ISLAND FARM FINAL DESIGN PROJECT

COMMENT TRACKING TABLE

Study Sponsor: Washington Department of Fish & Wildlife

Study Parnters: Skagit Conservation District, Seattle City Light, Western Washington Agriculture Association

Study Consultant: Shannon & Wilson Inc., The Nature Conservancy

No.	Date	Party	Report Section, Page, Paragraph	Party Comment	Responder	Responder Response
8	1/8/2014	CDD#22		Landowner Agreement – it was discussed that a landowner agreement is the type of contract under discussion. The contract will focus on the project features and responsibilities. . It was agreed to initiate the process of developing the landowner agreement after the 60% design has been completed in June. A timeline goal for final landowner agreement completion is with the final design.	DRC	Comment noted. Agree.
8	11/6/2013	SCDD#22		CDD#22 is concerned that the size of the rock proposed for levee toe protection is too small. They suggested 3 and 4 man rock for the base layer. Doyle Schmidt	DRC	We understand this was a general comment at the CDD22 monthly meeting. Calculations for erosion protection are included in the Coastal Engineering Design Report.
9	11/6/2013			CDD#22 stated that only good quality rock should be used for levee toe protection.	DRC	Rock specifications will include specific gravity and wear requirements. Suppliers will need to provide information on rock composition meeting standard riprap material specifications.
10	11/6/2013			CDD#22 is interested in log boom design and would like us to seek their counsel when the log boom is designed. Kim Nelson	DRC	Log boom design is included. We will consult CDD22 at 60%, 90% design for log boom design.
11	11/6/2013	SCDD#22		CDD#22 is concerned about maintaining the log boom deflectors and requested that the new levee include ramp elements to allow equipment access to the tidegates and log boom deflectors.	DRC	Access ramps included on either side of No Name Slough tidegates, and will allow access to log booms.
12	11/6/2013	SCDD#22		CDD#22 wants to maintain enough distance between new levee and Dry Slough to accommodate future maintenance dredging in Dry Slough. Stan Nelson	DRC	20ft access and maintenance width was provided per other comments.
13	11/6/2013	SCDD#22		CDD#22 expressed a concern about the settlement of the new levee and how that would be addressed.	DRC	Geotechnical report is forthcoming. Settlement is estimated at slightly less than 1ft, and will be accomodated in design height of levee.
14		SCDD#22		CDD#22 generally supports the following S&W levee design recommendations that were presented in Dave's power point: Include spur dike alternative along Brown Slough. New levee crest design elevation = 14.5 feet NAVD29. New levee top width of 18 feet. Levee toe erosion protection rock with D50=2.0 feet and toe down scour depth to 3-4 feet. Log boom protection for new tidegates.	DRC	Design has change slightly with 2.5H:1V sideslopes, based on slope stability analyses, and 15ft topwidth.
9	4/23/2014	CDD#22		CDD#22 supports the installation of a new tidegate connection between the pond and Dry Slough.	Brian Williams Dave Cline	Noted
10	4/23/2014	CDD#22		CDD#22 expressed a concern regarding adequate discharge velocities through the new No Name Slough tidegates if No Name Slough drainage is rerouted into Dry Slough and discharged via the pump station.	Dave Cline	The predominant channel forming and maintaining forces will occur via the tidal exchange at the restoration site and not through the surface drainage of No Name Slough.
11	4/23/2014	CDD#22		CDD#22 wanted Dave and Brian to consider adding a second new tidegate at the mouth of Dry Slough.	Brian Williams Dave Cline	Dave expressed concern for the Hayton's south field if more water is routed through Dry Slough. Brian said no to the idea of a second new pump in Dry Slough. Brian noted that there is not enough time to evaluate the effect of a second tidegate in Dry Slough and complete the 60% design by June 15. Brian also noted that WDFW cannot justify installing a second new tidegate at the mouth of Dry Slough when Dave's modeling indicates that one new tidegate will mitigate the restoration projects anticipated seepage effects on Dry Slough.
12	4/23/2014	CDD#22		CDD#22 is concerned that the 20 foot wide corridor is not wide enough to accommodate deposition of the dredged materials and requested an additional 20 feet or a total maintenance corridor width of 40 feet.	Brian Williams	A 40 foot maintenance easement exceeds the width of the district's typical drainage maintenance easements. Increasing the maintenance easement width from 20 feet to 40 feet takes away from the available farmland and/or available restoration area.
13	4/23/2014	CDD#22		CDD#22 expressed a willingness to reduce the pond width by 20 feet to accommodate the additional maintenance corridor width.	Dave Cline	Reducing the drainage pond storage could result in additional pump operation and additional electrical costs for the district.
14	4/23/2014	CDD#22		CDD#22 is concerned that drift logs are going to build up in the NW corner of the restoration site and negatively affect the operation of the No Name Slough tidegates.	Brian Williams	WDFW will incorporate monitoring of the drift logs in the NW corner of the restoration into the monitoring plan as well as adaptive management criteria and actions, i.e. relocation of the drift logs within the restoration site.
15	4/23/2014	CDD#22		CDD#22 is concerned that the culvert in No Name Slough under the access road to the parking lot may become damaged during project construction and may need to be replaced.	Brian Williams Dave Cline	The possibility of having to replace this culvert will be included in the cost estimate for constructing the project.

APPENDIX E

CONSOLIDATED DIKING DISTRICT 22 (CDD22) DESIGN SUMMARY AND LETTER OF SUPPORT

FIR ISLAND FARM
DRAINAGE AND FLOOD PROTECTION INFRASTRUCTURE
DESIGN RECOMMENDATION SUMMARY
SKAGIT COUNTY CDD22 MTG – MAY 7, 2014

DIKE DESIGN

- Alignment - Spur dike configuration to protect Brown Slough drainage functions
- Design Elevation - 15.0ft plus settlement (1.0ft likely during construction – monitor for 5 years post construction)
- Top Width - 15.0ft
- Erosion protection
    - D50 = 2.0ft
    - Thickness = 2.0 – 3.0ft
    - Toe down depth = 3.0 – 4.0ft
    - Bedding = Quarry spall/filter layer and/or geotextile material
    - Topsoil w/ native salt-tolerant grass seed mulch w/ tackifier and establish seed prior to breach
    - Limit erosion potential by ditch and new marsh area fill grading
- Side Slopes – 2.5H:1V (Confirmed in geotech report with geotextile reinforcement)
- Access
    - Crushed rock road surface along top of dike.
    - Periodic passing lanes and egress ramps along top of dike (TBD).
    - Crushed rock (will also be used as construction access) access area along landward toe of dike w/ min. 20ft width (or 40ft width – TBD) between toe of dike and adjacent ditches, sloughs and ponds.
    - Access ramp provided to No Name Slough tidegates (waterward side of dike)
    - Replace/add access gates (TBD)
- Seepage cutoff underneath not included due to ineffectiveness at reducing seepage

DRAINAGE

- Replace Claude O. Davis (2) 48" top-hinge tidegates w/ (2) 48" side-hinge tidegates at No Name Slough / new dike alignment crossing
- Add (1) 48" top-hinge tidegate in Dry Slough
- Add (2) 48" side-hinge tidegates from interior storage pond to Dry Slough, set back in alcove to allow gates to open if Dry Slough is flowing
- Pipes – Anchored, single wall HDPE is preferred
- Provide 1 pump station
    - (3) 3,300 gpm pump – 2 pumps for operations, 1 for backup/maintenance
    - Electrical power routed to pump station and central pond area
    - Pump size and type to be coordinated in next phase of design (screw versus turbine, water vs. grease vs. greaseless seals, power supply, outfall pipe size, power, etc.)
- Replace and expand interior drainage channels w/ interior drainage storage pond along northern edge of dike setback between Dry Slough and No Name Slough
    - Length – 2,200ft
    - Width – 150ft (reduced from 200ft for maintenance dredging, width may be further reduced to provide maintenance access)

Draft

    - Depth – 7ft
    - Volume ~ 77,000cy
- Provide log boom wood debris protection in No Name Slough
- Sedimentation and erosion measures
    - Pre-excavate pilot channels in new marsh areas
    - Excavate main tidal marsh inlet to limit erosion
    - Limit ditch fills in preferential flow paths
    - Seed and plant, irrigate, higher elevation, low shear stress areas to promote marsh establishment

Yellow highlights indicate changes made for presentation at April 23, 2014 meeting.
Green highlights indicate changes made from May 7, 2014 meeting discussion.

Draft

APPENDIX F

INDEPENDENT TECHNICAL REVIEW COMMENT / RESPONSES TABLES

Independent Review Technical Comment Form

Owner	**Washington Department of Fish & Wildlife**
Project	**Fir Island Farm - Estuary Restoration Project, Final Design and Permitting**
Reviewer Name	**Deb Ladd PE, LHg**
Reviewer Firm	**Golder Associates**
Reviewer Email	dladd@golder.com
Reviewer Phone	425 883 0777 (office) or 206 914 7825 (cell)
Date of Review:	10-Apr-14

No.	Report Name	Report Section, Page, Paragraph	Reviewer	Reviewer Comment	Responder	Responder Response	ITR Backcheck Complete
1	Draft Interior Drainage Engineering Report, February 26, 2014	Limitations	D. Ladd	Golder's review focus was on hydrogeological aspects of the report. However, review of other sections of the report and appendices was needed to understand the hydrogeological aspects of the report. We did not review other portions of the report in detail.	N/A	N/A	N/A
2	Draft Interior Drainage Engineering Report, February 26, 2014	Overall	D. Ladd	The report presents several different technical disciplines and evaluations. It would be helpful to note if any particular discipline/evaluation is more sensitive to predicting project impacts than others are.	DRC	Provided some additional explanations regarding sources and scale of sensitivity.	
3	Draft Interior Drainage Engineering Report, February 26, 2014	Overall	D. Ladd	Clearer statement of purpose and conclusions would be very helpful to the reader. It is difficult to determine what the different modeling is being used for. It appears that the overall goal of the study is to determine if there will be detrimental effects from the project on the remaining agricultural land within the diking district. The critical aspect for agriculture appears to be water quantity (groundwater or flooding) and quality (salinity) within the growing zone during critical periods. Conclusions at the end of the report can then speak to the goal and/or note what type of additional studies/evaluations/data are needed to reach a conclusion.	DRC	Provided additional explanation of report study purpose and objectives clarifying analysis of effects on local drainage systems.	
4	Draft Interior Drainage Engineering Report, February 26, 2014	Overall - Seepage Analyses	D. Ladd	It appears that the seepage analyses were done on a steady state basis assuming average observed groundwater conditions. It should be recognized that this assumed condition will need to be re-examined for future geotechnical levee stability analyses.	DRC	Noted. Geotechnical design report will have transient seepage, stability analyses.	
5	Draft Interior Drainage Engineering Report, February 26, 2014	Multiple locations, text and appendices	D. Ladd	The "calculated existing seepage and groundwater inflow condition of 1 cfs (449 gpm)" is mentioned in several locations (pg. 7, Appendix B, Appendix C, possibly other locations). This is reportedly from hydrologic monitoring data for the site (1st paragraph pg. 7 and Section B.1.2). However, we were unable to confirm any details about this calculation or estimate. Because this value appears to be used repeatedly, it should have more complete background or explanation for the procedures used to determine if the value. It would also be helpful to more clearly describe how this value is used in the project.	DRC	A backcheck was performed and additional information added to Appendix B describing the range of observed seepage / baseflows to the existing ditch system.	
6	Draft Interior Drainage Engineering Report, February 26, 2014	Section 4 Page 4 (or earlier)	D. Ladd	Please note vertical datum for elevations in text (NAVD88?)	DRC	NAD83 / NAVD88 Project survey datums referenced.	
7	Draft Interior Drainage Engineering Report, February 26, 2014	Section 4 Page 4 (and throughout report)	D. Ladd	Editorial - Wells are variously identified as B-4w-13 (note lowercase w) and B-5W-13 (caps). IDs in text should be consistent with well IDs in data report (cap "W")	DRC	Corrections made.	
8	Draft Interior Drainage Engineering Report, February 26, 2014	Section 4 Pages 4 - 5	D. Ladd	In bulleted list it would be helpful to note which shallow wells were dry and (in that case) that the average groundwater level is based on deep well only.	DRC	B-5W-13 was the only well to go dry. This is noted in the text.	
9	Draft Interior Drainage Engineering Report, February 26, 2014	Section 3 Pages 3 - 4	D. Ladd	It would be helpful to provide a statement about groundwater use in the area, e.g., are there any domestic or agricultural groundwater users? If so, are there any concerns for impacts.	DRC	Well logs were reviewed from the Ecology website and the Washington State Dept. of Health, Wellhead Protection Area maps were reviewed. Groundwater uses are for crop and farm irrigation. No drinking water resoureces were identified near the project vicinity. Added language to main body of report to this effect.	
10	Draft Interior Drainage Engineering Report, February 26, 2014	Section 4 Page 5	D. Ladd	It would be helpful to note how groundwater elevations compare to slough elevations (or to reference appendices if the information is contained there).	DRC	Statement added to text comparing groundwater elevation to surface water elevations. For areas further interior to the dikes, the groundwater elevation was ~0.4ft to 0.6ft lower than the ditch surface water elevation. Near the dike in the Hayton Field, the groundwater elevation and surface water average elevations were nearly equal, no difference in elevation.	

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Date of Review:	10-Apr-14

No.	Report Name	Report Section, Page, Paragraph	Reviewer	Reviewer Comment	Responder	Responder Response	ITR Backcheck Complete
11	Draft Interior Drainage Engineering Report, February 26, 2014	Section 4 (end) Page 6	D. Ladd	It would be helpful to provide or forward reference information about "critical root zone elevations" when first mentioned.	DRC	Moved root zone criteria descriptions forward to first mention of critical root zones.	
12	Draft Interior Drainage Engineering Report, February 26, 2014	Section 5 Page 6 bullet list	D. Ladd	It is not clear from this list what items are from model vs from other evaluations. Bullet 2 it is not clear what this estimate is and how it was done. Bullet 3 appears to represent all SEEP/W modeling - it would be helpful to state this if true.	DRC	Added description of numerical modeling vs. data based hydraulic conductivity estimates.	
13	Draft Interior Drainage Engineering Report, February 26, 2014	Section 5 Page 6	D. Ladd	Last paragraph summarizes modeling results. The stated 91 to 232 gpm can be found directly in Table B-4. It would be helpful to include the length of levee system that is incorporated into this value. , but the proposed conditions range (62 to 120 gpm) can be directly linked to a result. Additional information should be provided here or in Appendix B to explain this result. - It would also be helpful to provide rates in cfs for consistency across the report.	DRC	Added levee lengths and referenced "combined" flow rate estimate which can be correlated to Table B-4.	
14	Draft Interior Drainage Engineering Report, February 26, 2014	Section 4 Page 7, 1st paragraph and 2nd paragraph	D. Ladd	The "calculated existing seepage and groundwater inflow condition of 1 cfs (449 gpm)" is mentioned here. See comment 3.	DRC	Added reference to Appendix C, which discusses analysis of surface water data for estimating seepage inflows.	
15	Draft Interior Drainage Engineering Report, February 26, 2014	Section 6 Page 9	D. Ladd	Groundwater inflows are apparently used in the mass balance model. However, the basis of groundwater inflows is not clearly stated here or in Appendix D.	DRC	The basis of the recommended groundwater inflows is the surface water monitoring data at the project, and has been edited in the report.	
16	Draft Interior Drainage Engineering Report, February 26, 2014	Section 7 Page 10	D. Ladd	Sensitivity analysis appears to be for surface water components only. This should be stated.	DRC	Added comment reflecting that seepage sensitivity analyses were not perform as part of Appendix D sensitivity analysis.	
17	Draft Interior Drainage Engineering Report, February 26, 2014	Section 7 Page 13 Last bullet	D. Ladd	Based on information presented in the report and the appendices it is difficult to assess what is the cause or basis of uncertainty in seepage estimates. It would be helpful to present a discussion of uncertainty in Appendix B and discuss what data or evaluations would help to reduce the uncertainty.	DRC	Same as previous comment. Additional description provided discussing sensitivity analysis and seepage.	
18	Draft Interior Drainage Engineering Report, February 26, 2014	Figure 1 Project Site Plan	D. Ladd	Would be helpful to more clearly identify "Dry Slough" (text appears faded). Also McDonald Slough is not obviously identified.	DRC	Corrections made.	
19	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B	D. Ladd	Overall it is very time consuming to confirm the modeling layout, assumptions, inputs, etc. in part because of inconsistent labeling. Given that the diking district (CDD22) has questioned the seepage rates, clarity of presentation is important.	DRC	Revised labeling on Figures B-2 through B-11 to use consistent terminology.	
20	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B, B-1 Page B-1	D. Ladd	Editorial - Wells are variously identified as B-4w-13 (note lowercase w) and B-5W-13 (caps). IDs in text should be consistent with well IDs in data report (cap "W")	DRC	Corrections made.	
21	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B, B-1 Page B-2	D. Ladd	Suggest deleting the 2nd paragraph that notes that the authors interpret the aquifer has an under damped response. The 3rd paragraph then says that the Bower-Rice results better match site data. (Also see comment on S&W 2013 data report.)	DRC	Removed reference to interpretationo of under-damped system.	
22	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B, B-1 Page B-2 Section B.1.2	D. Ladd	It is not clear where the seepage inflows provided (1 cfs/449 gpm) were determined from o how they relate to later modeling efforts. (see also comment 3)	DRC	See previous response item 5.	
23	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B, B-1 Page B-3	D. Ladd	The existing conditions (Zone 1) and future conditions (Zones 2 and 3) should be clearly noted in the bullets by "Existing" and "Planned" or similar. It would also be helpful to clearly identify where model sections are located (see comments on Figure B-1).	DRC	Labeled bullets with (Existing) and (Proposed) conditions. Added typical sections to Figure B-1 with note that they represent entire section of levee and are "representative" and not a section specifically cut at that location.	

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Date of Review:	10-Apr-14

No.	Report Name	Report Section, Page, Paragraph	Reviewer	Reviewer Comment	Responder	Responder Response	ITR Backcheck Complete
24	Draft Interior Drainage Engineering Report, February 26, 2014	Section B.2.4, Page B-5	D. Ladd	It would be helpful to identify show the modeled 'sections' on Figure B-1. It would also be helpful to reference a table (Table B-4?) in the discussion.	DRC	Modeled typical sections shown on Figure B-1.	
25	Draft Interior Drainage Engineering Report, February 26, 2014	Section B.2.5 Page B-5 Bullets	D. Ladd	We could not verify the numbers stated in the first bullet and it is not clear if these numbers are directly related to the information in the subsequent bullets. 2nd and 3rd bullet information is contained in Table B-4.	DRC	Bullets revised and more clearly present the seepage estimates in Table B-4.	
26	Draft Interior Drainage Engineering Report, February 26, 2014	Section B.2.5, Page B-5	D. Ladd	The final model results shown on the Figures (B-8, 9, 10) in cfs/ unit length are not clearly correlated to the text because of changing units to gpm. It would be helpful to reference the reader to Table B-4 and the assumed lengths of levees.	DRC	Figures changed to show seepage rates in similar units to Table B-4.	
27	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B, B-1 Page B-3 and Figure B-1	D. Ladd	The identified zones are not clear on Figure B-1. Locations of modeled cross sections would be very helpful.	DRC	Revised Figure B-1 and included typical sections.	
28	Draft Interior Drainage Engineering Report, February 26, 2014	Table B-2	D. Ladd	Color coding for k not explained (geological units?) Would be helpful to include geological unit in table (or add same color coding to Table B- also with explanation) The slug test data is summarized using GeoMean rather than just an average. Please explain why a geomean is not used for the k values from gradation analyses.	DRC	Color coding indicates soil unit. Color coding noted on Table B-3.	
29	Draft Interior Drainage Engineering Report, February 26, 2014	Table B-3	D. Ladd	- Table should note which values are 'assumed' (e.g., Kz/Kh, porosity) - Add notes indicating source of k values. It appears that some are from averages of sieve analysis ad k correlations and some from Geomean of slug tests. - It is not clear why "k" values from slug tests are not used where available. - The line item for slug test data should be clearly identified as the Geomean of multiple tests. - It is not clear how the max and min k values used in SEEP/W modeling were determined from the data.	DRC	Calculated and assumed values noted. K values from slug tests were averaged with grain size estimates. Geomean vs. mean will not significantly affect the hydraulic conductivity estimates.	
30	Draft Interior Drainage Engineering Report, February 26, 2014	Table B-4	D. Ladd	- How was k of levee construction materials determined for seepage models? - Need to clearly state what parameters are inputs and which are outputs (input = all columns thru water levels) - Why are Kz/Kh values different than in Table B-3? - The seepage analysis model inputs vary by location (existing, north, east). Is there reliable data to show that the conditions vary between these locations? (the variation between locations appears to be less than the variation between samples; it would be simpler to use a single set of inputs). - k values used as model inputs in Table B-4 should be readily supported by data in other tables such as Table B-3. There are many cases where the max or min values (or both) are not directly supported by data. For these cases, justification of the choice of model parameters should be provided in the table (or elsewhere). Specifically- support choice of k values for dike fill (and difference in modeled sections); Hm - some values can be justified from Table B-3, many not; Ha values can be justified from Table B-3 but there is no explanation as to why gradation results are considered appropriate for a "low" k value and slug tests results for the "high" k value; He - cannot determine how "low" and "high" k values were selected.	DRC	1. K of levee materials is based on hydraulic conductivity measurements on similar materials for other levee projects. 2. Inputs and outputs labeled. 3. Kz/Kh ratio was modified to estimate high conductivities for sensitivity analysis. 4. The variability of the seepage analysis model inputs is not significantly different (See new table B-5 with K estimates and model values). The max/min are supported by the data and more clearly shown in Table B-5. STEPHEN AND LI TO FINALIZE RESPONSE.	

Independent Review Technical Comment Form

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No.	Report Name	Report Section, Page, Paragraph	Reviewer	Reviewer Comment	Responder	Responder Response	ITR Backcheck Complete
31	Draft Interior Drainage Engineering Report, February 26, 2014	Appendix B, B-1 Page B-3 and Figure B-1	D. Ladd	- The cross sections (A-A', B-B', C-C') are not referenced in the Appendix and should not be shown on this figure. - It would be helpful to add the locations of the modeled sections (Figs B-2, B-3, B-4) to this figure. - The identified zones are not clear on Figure B-1.	DRC	Figure B-1 is updated showing the typical sections.	
32	Draft Interior Drainage Engineering Report, February 26, 2014	Figures B-2, B-3, B-4	D. Ladd	- The locations of the sections (even if 'typical') should be shown on Figure B-1 - Figure labels should include the "Zone" (or section ID) to help the reader locate the model section. - Acronyms should be explained (e.g. WSE, NNS). (Similar for B-5 through B-10.) - All figures should have similar titles so that the reader can compare the generalized section, to the model sections, and model results. - All units should be clearly identified (e.g., is flux in cfs per linear ft?)	DRC	Relabeled Figures B-2, B-3, B-4.	
33	Draft Interior Drainage Engineering Report,	Figures B-5, 6, 7 and B-8, 9, 10	D. Ladd	Figures B-5, 6, 7 and B-8, 9, 10 should have similar names as Figures B-2, 3, 4 so reader can clearly match results to locations and conditions.	DRC	Relabeled Figures with similar names.	
34	Draft Interior Drainage Engineering Report, February 26, 2014	Figure B-10	D. Ladd	Appears incorrectly labeled "West Section"	DRC	Relabaled figure with correct East Zone name.	
35	Draft Interior Drainage Engineering Report, February 26, 2014	Figures B-8, B-9, B-10	D. Ladd	Results from these figures should be identified in the text in the same units as shown on the figures (figures apparently show cfs/ linear foot and text uses total gpm for a length of levee).	DRC	Relabeled figure outputs with similar seepage rates as in text using GPM.	

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Reviewer Email	stonkin@moffattnichol.com
Reviewer Phone	206.622.0222
Date of Review:	10-Feb-14

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1	Draft Interior Drainage Engineering Report, February 26, 2014	General	Susan Tonkin	I am would like to drill deeper into the results / analysis that went into determining the hydrodynamic tailwater effects. See more detailed comments with the Draft Coastal Engineering report.	N/A	N/A	N/A
2	same	Section 1.0, first paragraph	Susan Tonkin	Editorial: It took me a while to work out that "interior" meant "interior to the levees (wherever they are)", not "interior within the project footprint". Could clarify this up front.	DRC	Description of "drainage areas interior to the levee system" provided in Section 1.0.	
3	same	Section 6.0, page 9, paragraphs 2-3	Susan Tonkin	Editorial: It isn't obvious that you are in fact comparing "with project + SLR" with "without project + SLR" (which is what you should be doing, of course). Please clarify in the text.	DRC	Added tet to Section 6.0 introductory paragraph…"Sea level rise was considered for both "Without Project" and "Project" conditions."	
4	same	Section 8.0, page 12, paragraph 1	Susan Tonkin	Editorial: Same issue as the previous comment. Something like: The primary contributing factor apprears to be the predicted hydrodynamic effects… The effects of this factor relative to the without-project condition are increased when SLR is incorporated.	DRC	Added text and language to clarify the project effects with respect to SLR.	
5	same	Section 8.0, page 12, paragraph 1	Susan Tonkin	Editorial: Maybe say "current project design" rather than "proposed project"?	DRC	Disagree - Proposed Project is a common term used throughout the report.	
6	same	Figure 1	Susan Tonkin	It would be helpful to have a figure that shows existing grades	DRC	Overlaying LIDAR elevations on Figure 1.	
7	Draft Interior Drainage Engineering Report, February 26, 2014. Appendix A: Hydrological Monitoring	Section A.1.2.2, page A-4, paragraph 3	Susan Tonkin	Editorial: Change "nearly 1.0 feet lower" to "nearly 1.0 feet less" - "lower" sounds as though the groundwater surface is lower and it's actually higher. Similarly, the statement "the groundwater gradient is towards Skagit Bay" sounds as though seepage flows towards, not away from, the Bay.	DRC	Revised first comment to use the word "Less". Interior farm area groundwater gradient is towards Skagit Bay. Tidal groundwater gradient is towards the farms, only across the dikes, to the ditches on the backside. Two separate groundwater gradients converge in the ditches.	
8	same	Section A.1.2.2, page A-4, paragraph 3	Susan Tonkin	Observed conductivities in the Hayton South groundwater wells - presumably these are not the same as those observed in wells to the north, since the salinity is so much higher.	DRC	Revised this paragraph to better describe observed groundwater elevations and salinities and comparing Hayton North and Hayton South fields.	
9	same	Figures A-1 to A-9	Susan Tonkin	Editorial: Could you add the field name (Hayton South, etc.) to these figures?	DRC	Field location names added to figures.	
10	same	Figure A-4	Susan Tonkin	The average at B-7 doesn't look like 3.47 - can you check this isn't the B-6 average?	DRC	Confirmed, average is calculated from B-7 data.	
11	same	Figure A-15	Susan Tonkin	Editorial: Could you mention the salinity gauge problems in the note here?	DRC	Data processing error. Corrected with most recent data downloads through Feb. 2014.	
12	same	Figure A-15	Susan Tonkin	Are there plans to replace the NNS-2.0 salinity probe, or do you think you have the information you need?	DRC	Data processing error. Corrected with most recent data downloads through Feb. 2014.	
13	Appendix B. Seepage Analysis	Section B.1.2, page B-2, last paragraph on page	Susan Tonkin	The 1 cfs is a very round number - can you provide a range on this?	DRC	A backcheck was performed and additional information added to Appendix B describing the range of observed seepage / baseflows to the existing ditch system.	

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14	same	Section B.1.2, page B-2, last paragraph on page	Susan Tonkin	Editorial: You move back and forth between gpm and cfs a lot, without generally giving both values. Please fix on one and/or provide conversions.	DRC	Provided reference to cfs and gpm for each instance.	
15	same	Section B.1.2, page B-2, last paragraph on page	Susan Tonkin	How do these seepage values compare with typical surface water discharge values within the sloughs?	DRC	1cfs (449gpm) is on the high side of observed maximum baseflows into the system, therefore likely conservative.	
16	same	Section B.1.2, page B-2, last paragraph on	Susan Tonkin	Editorial: You move back and forth between gpm and cfs a lot, without generally giving both values. Please fix on one and/or	DRC	Provided reference to cfs and gpm for each instance.	
17	same	Figure B-10	Susan Tonkin	Where you say Proposed Pond, is this actually Dry Slough? It seems to be the East Section not the West Section?	DRC	Revised label "Dry Slough"	
18	Draft Interior Drainage Engineering Report, February 26, 2014. Appendix C: Surface Water Modeling	Section C.2.2, page C-4, general	Susan Tonkin	It would be helpful to have a block diagram that shows how the different parts of the modeling work together (including where the seepage analysis fits in). I was originally confused as to where exactly you were going with the seepage modeling	DRC	Modeling schematic C-1 has been included in the report.	
19	same	Section C.2.1, page C-5, fourth paragraph on page	Susan Tonkin	Has the 10 percent criterion been vetted by the farmers or other associated stakeholders?	DRC	No, but report has been provided to CDD22. Additional discussion regarding distance of seepage migration based on upper soil layer hydraulic conductivity properties. 10%, 3 days, is likely less than 1ft of seepage front migration from the pond margin.	
20	same	Table C-4	Susan Tonkin	It looks as though this pretty much feeds through the hydrodynamic tailwater effect. Is this right?	DRC	Yes, correct. Some influence from SLR, ESV, SPC, but tidal hydrodynamic tailwater effect dominates.	
21	same	Figure C-1	Susan Tonkin	This seems to assume the marsh will build up in step with the SLR - i.e., it will not be drowned. Do you expect this to be the case? Otherwise I would expect the low (muted) elevation to stay more constant.	DRC	It is uncertain whether the marsh accretion will keep pace with SLR or not.	
22	Draft Interior Drainage Engineering Report, February 26, 2014. Appendix D: Sensitivity Analysis	General	Susan Tonkin	Given CDD22's questions about the seepage rates, can you do a sensitivity analysis that investigates changes in these rates?	DRC	See comment responses for Appendix B, in Golder comments.	
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1	Hydrodynamic Modeling Analysis, September 2013	Section 2.3, page 2.2, first paragraph	Susan Tonkin	What roughness did you use for the marsh interior?	Zhaoqing		
2	same	Section 2.4, page 2.2, third paragraph on page	Susan Tonkin	Was there ever calibration performed for the wse on the Skagit Delta side? Crescent Harbor is a long way away relative to the model scale.	Zhaoqing		
3	same	Figure 2.8	Susan Tonkin	Editorial: Since we are interested in the least saline areas, it would be nice to have a color scale that highlights the low salinity values better	DRC	While interesting and possibly useful, we will not be republishing these figures as they are not critical to the design decision process.	
4	same	Figure 3.12, page 3.16	Susan Tonkin	It seems that the transport is ebb dominant (generally erosional) at this location - am I lining things up correctly?	Zhaoqing		
5	same	Section 4.1.2, page 4.1, last paragraph on page	Susan Tonkin	Large-scale pressure systems in the Pacific Northwest do give large-scale storm surge of a foot or more, which isn't too different from the (very conservative) wind surge calculations provided here.	Zhaoqing		
6	same	Section 4.1.2, page 4.2, first paragraph	Susan Tonkin	Can you confirm precisely what this wind data set is (is it sustained wind)? Is the Whidbey Island gauge representative of conditions in Skagit Bay, or does it represent conditions in the Strait of Juan de Fuca more?	Zhaoqing		
7	same	Section 4.1.3, page 4.2, fourth paragraph on page	Susan Tonkin	Can you confirm the tidal elevation at which waves were generated? Based on a depth of 3m average across the bay, it looks as though low tide was assumed. The waves would be greater at high tide, and greater again if you add SLR.	Zhaoqing		
8	same	Section 4.1.3, page 4.2, fourth paragraph on page	Susan Tonkin	Hb is the breaking wave height, not the offshore significant wave height. (These values are probably not going to be too far apart at this location, however).	Zhaoqing		
9	same	Section 4.1.3, page 4.2, last paragraph on page	Susan Tonkin	Editorial: The equation should show "- bed elevation"	Zhaoqing		
10	same	Section 4.1.3, page 4.3, equation 4.3	Susan Tonkin	Can you confirm whether this is wave setup or wave runup? I'm not familiar with this specific equation, but the value is close to what I would expect from wave setup, which is what you would want to use here.	Zhaoqing		
11			Susan Tonkin				
12			Susan Tonkin				

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1	Draft Coastal Engineering Report, January 10, 2014	Section 4.1, page 4, last paragraph	Susan Tonkin	Regarding the overprediction of muting immediately offshore of the tidegates: is there any input from the modelers about this?	DRC	I have put the question to Battelle and am waiting on a resopnse. I think the higher water elevations on the low tide has to do with model tidal channel resolution. The finite element grids are larger than the channels, resulting in higher than actual ground/surface elevations, that could artificially increase the predicted water surface elevations. I also think there may be some variability in the roughness coefficient for tidal channels in marsh areas. My understanding is that the Battelle model uses a uniform roughness coefficient in marsh areas, without differentiating between tidal channels and vegetated marsh areas.	
2	same	Section 4.1, page 4, last paragraph	Susan Tonkin	I would like to drill down on this. One question would be to look at the model bathymetry and water surface elevations (including profile) across the existing Davis Slough and the proposed Dry Slough. Another consideration is that if the water surface is generally lower, would the wse gradient along No Name Slough actually be greater than predicted here, because of increased friction in the shallower water?	DRC	If the water surface is generally lower than the model predicts, the gradient could be higher. This would result in a lower tailwater elevation, which would reduce the potential for interior drainage impacts. Therefore, I believe we were conservative in our interpretation and application of the hydrodynamic modeling outputs.	
3	same	Section 4.3, general	Susan Tonkin	How much does it matter if the site pulls in sediment from offshore, eroding the central Bay front area? Albeit a very different physical situation, this happened at Crissy Field in San Francisco when a tidal channel was opened out and the adjacent beaches immediately eroded away. If it's not too much of a problem, you could overdredge the main tidal channel to provide more material with which to build up the marsh interior, and expect the shoreline will retreat as the main channel fills back to its equilibrium condition. If it is a big problem, you need to put some significant thought into a monitoring effort and (ideally) have some contingency plans in place.	DRC	Sediment transport from further off-shore into the site would be ideal from a restoration perspective. It is my understanding that WDFW understands that the exterior marshes will erode, and it is expected to some degree. I recommend this infomration be included in the monitoring and adaptive management plans, and a statement that no additional measures will be taken if exterior marshes experience erosion.	

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4	same	Section 4.3, page 10, third paragraph	Susan Tonkin	Editorial: I think you want to replace "likely has higher sediment supply similar to the Wiley Slough site" with "less than the sediment supply at the Wiley Slough site". (If not, I'm not sure what this is saying).	DRC	Sentence revised.	
5	same	Section 5.4, page 16, general	Susan Tonkin	As a general statement, I could quibble with the details of the calculation (selection of wind speed, neglect of wide area storm surge, and how the waves are calculated and used) but the final result seems about right. You may get splashover from high waves at this elevation.	DRC	It is acknowledged that splashover may occur.	
6	same	Section 5.5.1, page 18, general	Susan Tonkin	Would you armor the crest? It could be helpful given the possibility of wave splashover, although the rock size might not need to be so large.	DRC	We have not yet considered or included armoring the shoulders of the levee. I think this should be discussed further in 60% design.	
7	same	Figures 10, 11	Susan Tonkin	Can you state the source of these curves? Which are from the hydrodynamic report and which are from measurements (or elsewhere)?	DRC	All three curves are from the hydrodynamic model.	

APPENDDIX G

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland