Island County Feeder Bluff and Accretion Shoreform Mapping: Final Report

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PURPOSE AND SCOPE

The purpose of this task was to definitively map feeder bluffs and accretion shoreforms along the entire shore of both Whidbey and Camano Islands. Although coastal drift cells were mapped years ago, more spatially explicit characterization of the physical processes occurring within each drift cell had not been comprehensively mapped within Island County to modern mapping standards. Unlike other recent related studies in the Puget Sound region, the work was based on field-based mapping of current conditions, and not just on analyses of existing Geographic Information System (GIS) data sets collected by others for varying purposes during the past.

Work that went into the mapping relied on on-site mapping using direct observation, with investigation into published sources and historic data when necessary, including published maps, map atlases, USGS documents, bulkhead inventories, oblique and vertical air photos, and LiDAR. This work was designed to meet Best Available Science standards.

The following geomorphic shoretypes were mapped for the shores of both Whidbey Island and Camano Island:

- Feeder bluffs (delineated in feeder bluff and feeder bluff exceptional)
- Accretion shoreforms
- Transport zones
- Modifications (bulkheads and other structures) in all areas except accretion shoreforms
- Recommendations for nearshore conservation (such as through acquisition or conservation easements) and/or restoration were mapped *opportunistically* where possible.

The overall goal of this project was to provide detailed geomorphic mapping data of the coast of Island County (212 miles of shore; ShoreZone, DNR 2001) that could be used for GIS analysis in combination with existing and yet to be collected data for nearshore conservation and restoration planning. This data was intended to provide the coastal geomorphic context for salmonid restoration actions being planned or undertaken within WRIA 6. A secondary purpose for this project was to provide basic data for a characterization of ecosystem processes, which is required for Shoreline Master Plan updates under the Shoreline Management Act.

The use of primarily geomorphic indicators observed in the field is not new for characterizing coastal systems in the Puget Sound region. For example, the now widely used net shore-drift mapping published by the Washington Department of Ecology employed these same methods (for example, Schwartz et al. 1991, Johannessen 1992).

This project was not scoped to perform conservation or restoration prioritization, but was planned as building the expanding GIS database for Island County through inclusion of current, accurate information on the geomorphic character of county shores. It is important to note that conservation and restoration recommendations were based on field observations with only limited further investigation following fieldwork. These recommendations were based on physical characteristics (and not shoreline ecology) observed within some drift cells, particularly for drift cells that contain estuaries and/or salt marshes. This was based on coastal processes, and apparent erosion and sediment input reduction, but was not intended to be comprehensive—which would be beyond the scope of this project.

COASTAL PROCESSES BACKGROUND

Regional Bluffs and Beaches

Puget Sound and the adjacent straits and bays in Island County are the central features in the Puget Lowland, and consist of a complex series of generally north-south trending deep basins. The Sound and Straits were created by the repeated advance and scouring of glacial ice-sheets, the most recent of which advanced into the area around 15,000 to 13,000 years ago (Easterbrook 1992). Glacially derived sediment dominates the region (Easterbrook 1976). These deposits, along with less common interglacial deposits are exposed in coastal bluffs. Bluffs, sometimes referred to as sea cliffs in the literature, are present along the majority of the length of the study area shores. Bluffs are relatively recent landforms, which formed in the "fresh" landscape left behind after the most recent ice-sheet advance (Vashon advance). Sea levels were generally rising with the global melting of ice-sheets up until approximately 5,000 years ago. This is thought to be the time when the current configuration of bluffs began to evolve (Downing 1983). Bluff heights reach up to 200 ft in the county.

The elevation and morphology of coastal bluffs in the study area varies greatly due to differences in upland relief, geologic composition and stratigraphy, hydrology, orientation and exposure, erosion rates, mass wasting mechanisms, and vegetation (Shipman 2004). Marine bluffs are subjected to wave attack at the toe of the slope, which contributes to intermittent bluff retreat through mass wasting events (commonly referred to as landslides) such as slumps and debris avalanches. Although landslides can also be initiated by hydrologic processes and land use/development changes, wave attack is a long-term driving force in bluff failures in Island County. As forwarded by Emery and Kuhn (1982), a steep, sharp-crested, unvegetated bluff profile with sparse debris at the toe of the bluff is indicative of an actively retreating marine bluff dominated by marine erosion. This is the case in many county bluffs, but there are also many subtleties in area bluffs that vary across the county and are beyond the scope of this report to document.

Beaches composed of gravel and sand are ubiquitous in the study area, whether at the toe of bluffs or along very low elevation backshores. The morphology and composition of beaches in the study area are controlled by sediment input, wave climate, and shore orientation. Bluff sediment input, primarily glacially deposited units, is the primary source of beach sediment in Puget Sound and the Northern Straits. Landslides and erosion of these bluffs deliver sediment to the beach in moderate quantities. A secondary sediment source is rivers and streams, however, river and stream sediment input is thought to be responsible for on the order of 10% of beach sediment in the Sound and Straits, with the majority (approximately 90%) originating from bluff erosion (Keuler 1988).

The most basic control over beach characteristics is wave climate, which is controlled by the open water distance over which winds blow unobstructed (fetch), and the orientation of a shore relative to incoming waves. Low wave energy beaches are composed of poorly sorted sediment with a relatively narrow backshore and intermittent vegetation. Higher wave energy beaches contain areas with well-sorted sediment, often consisting of cobble, over a broad intertidal and supratidal area. Beach sediment size is strongly influenced by the available sediment coming from bluff erosion as well as wave energy, and therefore varies considerably across the county.

Beaches are accumulations of sediment along a shore. As sediment is transported along a beach, it must be continuously replaced for the beach to maintain its integrity. The erosional nature of the majority of Puget Sound and Northern Straits beaches is evident in that most beaches generally consist of a thin veneer of sediment that is only 3-10 inches thick vertically, atop eroding glacial deposits.

A beach serves as a buffer against direct wave attack at the bluff toe. The value of a "healthy" beach fronting a coastal bluff should not be underestimated for absorbing storm wave energy. A gravel berm can serve as a resilient landform with an ability to alter shape under different wave conditions, effectively dissipating most wave energy. Extreme waves do reach bluffs causing erosion, which delivers sediment to the beach and is vital to maintaining the beach. Therefore, bluffs, beaches, and nearshore areas are *completely connected as integral parts of a coastal system*. Past and current management typically treated the bluffs and beaches as separate parts of the coastal system, which has resulted in substantial negative impacts to coastal erosion, nearshore habitats and wildlife.

Net Shore-drift

To understand the processes controlling nearshore systems and their continued evolution, the three-dimensional sediment transport system must be examined. The basic coastal processes that control the “behavior” of the beach will be explained first and then put into the context of “drift cells.”

Shore drift is the combined effect of **longshore drift**, the sediment transported along a coast in the nearshore waters, and **beach drift,** the wave-induced motion of sediment on the beachface in an alongshore direction. While shore drift may vary in direction seasonally, **net shore-drift** is the long-term, net effect of shore drift occurring over a period of time along a particular coastal sector (Jacobsen and Schwartz 1981).

The concept of a **drift cell** has been employed in coastal studies to represent a sediment transport sector from source to terminus along a coast. A drift cell is defined as consisting of three components: a site (erosional feature or river mouth) that serves as the sediment source and origin of a drift cell; a zone of transport, where wave energy moves drift material alongshore; and an area of deposition that is the terminus of a drift cell. Deposition of sediment occurs where wave energy is no longer sufficient to transport the sediment in the drift cell.

Net shore-drift mapping in most of Island County was completed in the 1980s by Ralph Keuler in a USGS map (1988). Net shore-drift mapping of southern Whidbey Island was completed by Johannessen (1992) for the WA Dept. of Ecology, with data distributed in Schwartz et al. (1991) and on-line at Ecology’s Digital Coastal Atlas. The net shore-drift studies were conducted through systematic field investigations of the entire coast to identify geomorphologic and sedimentologic indicators that revealed net shore-drift cells and drift direction. The methods employed in net shore-drift mapping utilized 9-10 well-documented, isolated indicators of net shore-drift in a systematic fashion (Jacobsen and Schwartz 1981).

The approach and interpretation by Schwartz et al. (1991) was the most valid, in our opinion, and was also consistent with other efforts around the Puget Sound region. However, another previous littoral drift mapping effort, the Coastal Zone Atlas of Washington (WA Dept. of Ecology 1979), relied exclusively on historic wind records. That method is known as wave hindcasting, where inland wind data records were used for the determination of net shore-drift, without consideration of local variations in winds, landforms, or coastal morphology. Drift directions indicated in the atlas series have commonly been proven inaccurate by extensive field reconnaissance (i.e. Jacobsen and Schwartz 1981, Johannessen 1993). When the geographic complexity of the Puget Sound and Northern Straits, and subsequent variability of the surface winds, in addition to the seasonal variability of atmospheric circulation and the locally varying amount of drift sediment are considered, the geomorphic approach described above is better suited to the physical conditions of the region than traditional engineering methods like hindcasting.

Net shore-drift is strongly influenced by several oceanographic parameters. The most important of which are waves, which provide the primary mechanism for sediment erosion, inclusion of sediment into the littoral system, and transport. The Puget Sound and Northern Straits are composed of inland waters exhibiting an extreme range of wave regimes. Storm wave heights reach relatively large size during prolonged winds, in contrast to chop formed during light winds, which have little geomorphic effect on coasts (Komar 1998).

Fetch has been proven to be the most important factor controlling net shore-drift in fetch-limited environments (Nordstrom 1992). This has been demonstrated in the Puget Sound and Northern Straits by a number of scientists (Downing 1983). Due to the elimination of ocean swell in protected waters, waves generated by local winds are the primary transport agents in the littoral zone. The direction of maximum fetch that acts on a shoreline segment will correspond with the direction of the largest possible wave generation, and subsequently, the direction of greatest potential shore-drift. Where fetch is limited the wind generates the largest waves possible in fairly short time periods.

Shore Modifications

Erosion control or shore protection structures are common in the study area. Residential and industrial bulkheading (also called seawalls) are typically designed to limit the erosion of the backshore area or bluff, but have numerous direct and indirect impacts on nearshore systems. Seawalls and bulkheads have been installed more routinely in the past few decades as property values have risen and marginal lands were developed. The effects of bulkheads and other forms of shore armoring on physical processes have been the subjects of much concern in the region (for example, PSAT 2003). Macdonald et al. (1994) completed studies assessing the impacts to the beach and nearshore system caused by shore armoring at a number of sites. Additional studies on impacts from shoreline armoring have quantitatively measured conditions in front of a bulkhead and at adjacent un-bulkheaded shores and showed that in front of a bulkhead the suspended sediment volume and littoral drift rate all increased substantially compared to unarmored shores, which resulted in beach scouring and lowering along the armored shores studied (Miles et al. 2001).

A bulkhead constructed near the ordinary high water mark (OHWM) in a moderate energy environment increases the reflectivity at the upper beach substantially, causing backwash (outgoing water after a wave strikes shore) to be more pronounced. Increased backwash velocity removes beach sediment from the beachface, thereby lowering the beach profile (Macdonald et al. 1994). A bulkhead constructed lower on the beach causes greater impacts (Pilkey 1988). Construction of a bulkhead at or below OHWM results in coarsening of beach sediment in front of the bulkhead (Macdonald et al. 1994). Relatively fine-grain size sediment is mobilized by the increased turbulence caused by the bulkhead (Miles et al. 2001), and is preferentially transported away, leaving the coarser material on the beach. This process also leads to the removal of large woody debris (LWD) from the upper beachface. Over the long term, the construction of bulkheads on an erosional coast leads to the loss of the beach (Fletcher et al. 1997, Douglass and Bradley 1999).

Of all the impacts of shore armoring in the Puget Sound and Northern Straits, sediment impoundment is probably the most significant negative impact (PSAT 2003). A structure such as a bulkhead, if functioning correctly, 'locks up' bluff material that would otherwise be supplied to the net shore-drift system. This results in a decrease in the amount of sediment available for maintenance of down-drift beaches. The negative impact of sediment impoundment is most pronounced when armoring occurs along actively eroding bluffs (Macdonald et al. 1994, Griggs 2005). Additionally, the extent of cumulative impacts from several long runs of bulkheads is a subject of great debate in coastal research and management communities.

Coastal Processes and Nearshore Habitat

Shore modifications, almost without exception, damage the ecological functioning of nearshore coastal systems. The proliferation of these structures has been viewed as one of the greatest threats to the ecological functioning of coastal systems (PSAT 2003, Thom et al. 1994). Modifications often result in the loss of the very feature that attracted coastal property owners in the first place - the beach (Fletcher et al. 1997).

With bulkheading and other shore modifications such as filling and dredging, net shore-drift input from bluffs is reduced and beaches become 'sediment starved.' The installation of structures typically results in the direct burial of the backshore area and portions of the beachface, resulting in reduced beach width (Griggs 2005) and loss of habitat area. Beaches would also become more coarse-grained as sand is winnowed out and transported away. When fines are removed from the upper intertidal beach due to bulkhead-induced impacts, the beach is often converted to a gravel beach (MacDonald et al. 1994). A gravel beach does not provide the same quality of habitat as a finer grain beach (Thom et al. 1994). Large woody debris (LWD) is usually also transported away from the shore following installation of bulkheads, with corresponding changes in habitat. This leads to a direct loss of nearshore habitats due to reduction in habitat patch area.

Habitats of particular value to the local nearshore system that may have been substantially impacted include forage fish (such as surf smelt) spawning habitat. These habitat areas are only found in the upper intertidal portion of fine gravel and sand beaches, with a high percentage of 1-7 mm sediment (Pentilla 1978). Beach sediment coarsening can also affect hardshell clam habitat, by decreasing or locally eliminating habitat.

Bulkheading also leads to reduction in epibenthic prey items, potentially increased predation of salmonids, loss of organic debris (logs, algae) and shade, and other ecological impacts (Thom et al. 1994). The reduction in beach sediment supply can also lead to an increase in coastal flooding and wave-induced erosion of existing low elevation armoring structures and homes.

Nearshore habitat assessments in the Puget Sound and Northern Straits have found that large estuaries and small 'pocket' estuaries provide very high value nearshore habitat for salmon as well as other species (Beamer et al. 2003, Redman and Fresh 2005). Reduction in net shore-drift volumes due to bulkheading and other modifications and site-specific impacts induced by modifications can cause partial or major loss of spits that form estuaries and embayments. Therefore, with consideration of all these factors, shore modifications can have substantial negative impacts on nearshore habitats.

METHODS

The entire shore of Camano and Whidbey Island where drift cells occurred was delineated into segments as one of six different geomorphic shoretypes. The shoretypes were: Feeder Bluff Exceptional, Feeder Bluff, Transport Zone, Accretion Shoreforms, Modified, and No Appreciable

Drift. Toe erosion and landsliding were mapped as ancillary data within/across these five different segments where evidence of these features was present.

Geomorphic Shoretypes

The **feeder bluff exceptional** classification was applied to rapidly erosional bluff segments. This classification was meant to identify the highest volume sediment input areas per lineal foot. This classification was not common in the study area.

The **feeder bluff** classification was used for areas of substantial sediment input into the net shore-drift system. Feeder bluff segments identify segments that have periodic sediment input with a longer recurrence interval as compared to feeder bluff exceptional segments.

Transport zone segments represented areas that did not appear to be contributing appreciable amounts of sediment to the net shore-drift system, nor showed evidence of long-term accretion. This classification was also meant to identify areas that were not actively eroding. However, transport zones typically experience landsliding and/or erosion but at a very slow long-term rate.

The **accretion shoreform** classification was used to identify areas that were depositional in the past or present. Accretion shoreforms were present in the form of spits, points, or barrier beaches, as well as wide beach-backshore areas along bluff-backed beaches. These areas are sometimes referred to loosely as "no-bank" shores.

The **modified** classification was used to designate areas that have been altered to a state where it was unknown whether or not it contributed sediment or not. The modified classification was not mapped on accretion shoreforms or transport zones. Due to the modifications, these segments typically no longer contributed sediment to the net shore-drift system, although landslides did occur periodically at some bulkheaded bluff areas.

Field Mapping Criteria by CGS

Field mapping criteria of feeder bluff and other units is summarized in this section and also listed in Table 1.

The **feeder bluff exceptional** (rapidly eroding bluff segments) segments were identified by the presence of landslide scarps, and/or bluff toe erosion. Additionally, a general absence of vegetative cover and/or portions of bluff face fully exposed were often used for this classification. Other indicators included the presence of colluvium (slide debris), boulder or cobble lag deposits, and fallen trees across the beachface. Feeder bluff exceptional segments lacked a backshore, old or rotten logs, and coniferous bluff vegetation. An example of a feeder bluff exceptional is shown in Figure 1 and Figure 4.

The **feeder bluff** classification (areas of substantial sediment input into the net shore-drift system) were identified by the presence of historic slide scarps, a lack of mature vegetation on the bank, and intermittent bank toe erosion (Figure 1 and Figure 4)). Other indicators included downed trees over the beach, coarse lag deposits on the foreshore, and bank slope.

Transport zone segments (areas that did not appear to be contributing appreciable amounts of sediment to the net shore-drift system, nor showed evidence of long-term accretion) were delineated based on the lack of erosional indicators (discussed above for feeder bluff exceptional and feeder bluff segments) and the lack of accretion features such as a wide backshore area or spit

(Figure 1). This classification was also meant to identify areas that were not actively accreting. However, transport zones typically experience landsliding and/or erosion but at a very slow long-term rate.

The **accretion shoreform** designation (areas that were depositional in the past or present) was identified based on the presence of several of the following features: broad backshore area, backshore vegetation community, spit and/or lagoon landward of a spit (Figure 2 and Figure 6). Additional indicators for delineating an accretion shoreform were the presence of relatively fine-grained sediment or the presence of very old drift logs in the backshore.

The **modified** classification (areas that have been altered with bulkheads, revetments, or shoreline landfills) were mapped in areas where modifications were present and such that the bluff or bank no longer contributed sediment to the beach system (Figure 2 and Figure 5). The modified classification was not mapped at transport zones or accretion shoreforms, and it is important to note that many of these shoretypes contained bulkheads, and were not mapped as modified. When a feeder bluff has been bulkheaded, the bluff in the modified segment generally acts like transport zone due to the modification.

The **no appreciable drift** classification was used in areas where there was no appreciable volume of net sediment transport. This classification was from the original net shore-drift mapping (termed no appreciable net shore-drift or NANSD) and occurred in areas where there was insufficient wave energy to transport sediment or where the shore was highly modified

Ancillary Data Mapping Criteria

Toe erosion was mapped where a discernable, near-vertical erosion scarp was present at the toe of the bank/bluff where there was a general absence of backshore and stable log accumulation. Toe erosion areas were only mapped where the scarp was visible and not covered by colluvium, and appeared to have been active within the previous 2-3 years (Figure 2). The bluff toe at these sites had therefore been exposed to direct wave attack within the previous 2-3 years. If the toe erosion scarp extended more than 10 ft vertically, it was mapped as toe erosion and a landslide.

Landslides were mapped that were believed to be active in the past 3 years. Landslides typically had a relatively steep, exposed bluff face relative to surrounding bluff areas (Figure 2). Many of the mapped landslides had an arcuate headwall scarp pattern at the upper extent of the landslide, but this was not required criteria for mapping. Other evidence of landslides included downed trees or the presence of colluvium (slide debris) near the toe of the slope.

Mapping Procedures

All features were mapped from a small boat using a handheld Garmin Etrex Venture GPS unit in the UTM Zone 10 NAD83 projected coordinate system. GPS waypoints were marked at the beginning and end of each feature. The waypoints were correlated to segments, ancillary data, and notes that were recorded in a field book.

A total of 2,657 waypoints were collected over 13 field days. The west side of Camano Island was mapped on April 16th and 17th, 2004. The east side of Camano Island was mapped on May 13th and 14th, 2004. The east side of Whidbey Island was mapped on May 27th-29th and July 7th-9th, 2004. The west side of Whidbey Island was mapped on July 21st-23rd, 2004.

The GPS was downloaded using GPSU 4.02, creating a text file of the positions and waypoints. The text file was opened in Excel in order to delete header rows and unnecessary columns for it to import into ArcMap 9.0. The Excel file was then saved as a comma separated file and imported into ArcMap 9.0 using the “Add x,y data” under the tools menu, creating an event. The event was then exported from ArcMap 9.0 in the ESRI shapefile format and assigned the appropriate projection that they were collected in (UTM Zone 10 NAD83), within ArcCatalog.

The points were added into ArcMap, along with digital background information (historical topographic sheets (T-sheets), US Geological Survey (USGS) quadrangles, WA Department of Natural Resources (DNR) black and white orthophotos from 1990, and a shoreline shapefile (Shorezone). Features were heads up digitized within ArcMap at a scale of 1:3,000 using the field book(s) and the points were interpolated normal to the shoreline. The features were snapped to the Shorezone shoreline and to the ends of each feature, except where the Shorezone shoreline substantially deviated from the Mean High Water (MHW) line. In those cases, the features were digitized along the MHW line of the USGS quadrangle (see T31N, R2E, Section 20, SE ¼ and Section 28, NE ¼)). In cases where the Shorezone shoreline went inland inside of a lagoon/estuary the features were digitized “across” the channel, leaving a gap at the channel outlet and remaining on the waterward side of lagoon/estuary (see Race Lagoon: T31N, R2E, Section 7, NE ¼).

Smith Island did not have a Shorezone shoreline so features were digitized to the MHW line on the quadrangle and were extended below that line in order to connect to “Minor Island” (USGS quadrangle name), which would follow the mapping convention of Keuler who showed sediment transport from Smith Island to Minor Island.

All shores were inspected using the 2001 oblique aerial photos provided by the WA Dept. of Ecology to examine areas where questions were noted in the field and to ensure that no clear errors were present in the field mapping data. The photos were useful for examining upland areas that were not always visible from the water or from the beach. However, field mapping was the primary data source and it took precedence over photo examination.

Sometimes it was difficult to determine whether an area was modified or an accretion shoreform. Historic Topographic Sheets (T-sheets) from the late 1800’s and black and white vertical aerials from 1957 and 1958 were examined to help determine if the area was natural with shoreline modification or if it was artificial fill with shoreline modification. Historical T-sheets were downloaded for all of Island County from the University of Washington (UW) River History website: http://rocky2.ess.washington.edu/riverhistory/tsheets/. The T-sheets were georeferenced by UW and were added into ArcMap for examination. Vertical black and white aerial photos from 1957 and 1958, provided by Island County, were scanned as black and white TIFFs at 600dpi and were georeferenced by CGS for visual comparison and historical examination.

Geomorphic shoretype data were examined by drift cell. Drift cell digital data used for analysis were provided by the Washington Department of Ecology. Errors in the digitizing process were discovered by CGS, as has occurred in other areas (Johannessen and Chase 2002, Shipman pers. comm.). It has become apparent that the digitizing process performed by Ecology was not adequately error-checked. Reasons for this was the scale of the original mapping (1:1000,000 in the case of much of Island County) and ambiguities in mapping of divergence zones between drift cells, among other reasons. For these reasons, the digital net shore-drift dataset was error checked and alterations were made based primarily on the original mapping, and when that was unclear, based on knowledge of Island County coasts and the professional judgment of Jim Johannessen. (The entire digital dataset is in need of error checking and correcting state wide.) Drift cell boundaries in the digital files were altered where necessary. Drift cells endpoints were adjusted to reflect the actual positions, classifications were changed where necessary, and several new cells were created by CGS in the Snakelum Point area, where original mapping did not appear to be correct. All changes to the Ecology net shore-drift files were documented and are listed in Table 2.

The final map products were produced at a 1:24,000 scale, which has an accuracy standard of 67 ft or better for 90% of known points (United States National Map Accuracy Standards). The reported accuracy of the GPS unit while mapping in the field (with WAAS enabled) was below 20 ft for approximately 80% of the time and below 30 ft for the remaining approximately 20% (field checked throughout the day), thus complying with National Map Accuracy Standards.

PREVIOUS MAPPING COMPARISON

Methods

Shoreline mapping of Island County done by Keuler (1988) and the Department of Ecology were in paper map form. These maps were scanned at 200 dpi, then georeferenced to USGS Digital Ortho Quads. The shoreline features from these different maps were digitized alongshore as polylines, at 1:12,000 scale, snapping to the shoreline delineated by the DNR Shorezone Inventory. The Shorezone Inventory also delineated shoreline features alongshore, which were already in digital format. The feature used from the Shorezone Inventory was “Chng_type”.

Similar shoreline features from different sources were displayed on screen for comparison. Areas where similar features overlapped the mapping results were said to agree and areas where they did not overlap were said to disagree. Appropriate polyline shapefiles were digitized at 1:24,000 scale representing areas of agreement and disagreement. The lengths of the ‘agree’ and ‘disagree’ shapefiles were calculated using the calculate length option under Xtools 3.1 function. This calculated the length of all the polylines in feet. The total ‘agree’ and ‘disagree’ lengths were calculated by summing the length column in the attribute table for each polyline.

The ‘agree’ and ‘disagree’ polyline lengths were input into an Excel spreadsheet where basic statistics were calculated.

Shoreline lengths for Whidbey Island, Camano Island, and the comparison area were determined from the Shorezone Inventory shoreline. The Shorezone shoreline was more detailed than some other mapping techniques, delineating shorelines of embayments. Embayments with shorelines landward of open water shorelines were not used for comparison because some mapping was only along the open water shoreline.

Results of Comparison of Previous Work

Prior to commencing the data collection phase of the project, previous data from a portion of the study area was analyzed and compared. Approximately 46 miles of marine shoreline near the middle of the southern half of Whidbey Island was chosen for the variety of shores present. Mapping for the Coastal Zone Atlas (CZA) was published in 1979 (WA Dept. of Ecology 1979). Keuler mapped most of Island County in the early-mid 1980’s while working for the US Geological Survey (USGS 1988). This mapping was not published until 1988. Shorezone Inventory mapped Island County in 1999 and 2000 (WA DNR 2000). The 2004 mapping by CGS was compared to previous work and the previous mapping sources were also compared.

Maps and tables comparing previous work are all presented in Appendix A. Overall, the previous mapping did not agree well. The highest correlation was 64% agreement between the Shorezone Inventory and the CZA Uplands Processes. This was likely the highest correlation because segment classifications were combined down to only two classifications before being compared. The lowest correlation was 29% agreement between the Shorezone Inventory and the CZA Beach Processes. The comparison mapping of CGS Transport Zone, Keuler Neutral, Shorezone Stable, the Coastal Zone Atlas Uplands Processes Not Feeding, and the Coastal Zone Atlas Beach Processes Equilibrium consistently had the lowest correlation.

Mapping by CGS agreed with Keuler's mapping 45% of the time. The highest agreement (75%) was between CGS Accretion Shoreform and Keuler Depositional, a classification that had little ambiguity. CGS Transport Zone only agreed with Keuler's Neutral 10% of the time in the comparison area.

CGS mapping agreed with the Shorezone Inventory 50% of the time. The combined CGS Feeder Bluff Exceptional and Feeder Bluff agreed 78% of the time with Shorezone Erosional. CGS Transport Zone agreed with Shorezone Stable only 8% of the time.

Mapping done by CGS agreed with the CZA Uplands Processes 33% of the time. The highest correlation (52%) was between CGS combined Feeder Bluff Exceptional and Feeder Bluff and the combined Feeding Substantial and Feeding. The lowest correlation was between CGS Transport Zone and the CZA Uplands Processes Not Feeding.

Mapping by CGS agreed 33% of the time with the CZA Beach Processes. CGS combined Feeder Bluff Exceptional and Feeder Bluff agreed 34% of the time with the CZA Beach Processes Eroding. CGS Transport Zone only agreed 1% of the time with the CZA Beach Process Equilibrium.

Keuler mapping agreed 53% of the time with the Shorezone Inventory. The highest correlation (66%) was between Keuler combined Eroding Substantial and Eroding Slow and Shorezone's Erosional. Keuler Neutral only agreed 11% of the time with Shorezone Stable.

Mapping by Keuler only agreed 30% of the time with the CZA Beach Processes. The Eroding classification had 31% agreement. Keuler Neutral agreed with CZA Beach Processes Equilibrium only 4% of the time.

Mapping done by Keuler agreed with the CZA Uplands Processes 54% of the time. The highest correlation (45%) was between Keuler combined Erode Substantial and Erode Slow and the CZA Uplands Processes combined Feeding Substantial and Feeding. Keuler Neutral only agreed 17% of the time with the CZA Uplands Processes combined Not Feeding and Modified.

Shorezone mapping agreed only 29% of the time with the CZA Beach Processes, which was the lowest correlation out of all the comparisons made for this study. Shorezone Erosional agreed 35% of the time with the CZA Beach Processes Eroding. Shorezone Stable only agreed 4% of the time with the CZA Beach Processes Equilibrium. Shorezone Accretional also only agreed 4% of the time with the CZA Beach Processes Accreting.

Mapping by Shorezone agreed 64% of the time with the CZA Uplands Processes, which was the highest correlation out of all the comparisons made for this study. Shorezone Erosional agreed 62% of the time with the CZA Uplands Processes' combined Feeding Substantial and Feeding.

Shorezone Stable agreed 50% of the time with the CZA Uplands Processes combined Not Feeding and Modified.

FEEDER BLUFF SEGMENT RANKING PROTOCOL

Methods

The objective of the feeder bluff ranking protocol was to quantitatively analyze individual feeder bluff (and feeder bluff exceptional) segments based on their relative importance as nearshore sediment sources. Other shoretypes (transport zone, accretion shoreform, modified) were not ranked in any way; instead the object of this portion of the study was focused just on current feeder bluffs. Segment scores convey the value of each bluff segment as a source of suitable sized sediment for the beach system. A potential application of this data is to evaluate the negative impacts to sediment supply posed by the construction of a bulkhead within a specific segment. The rankings could also be used as a tool for evaluating the conservation importance of various bluff segments for acquiring easements or other forms of protection.

Several criteria were employed in drift cell selection. The drift cells were selected from throughout the county such that they both included mapped feeder bluff, feeder bluff exceptional, and accretion shoreform segments. Two representative drift cells were selected to apply the ranking system. This was intended to provide test cases and serve as a prototype for potential application to the rest of the county shores. In order to test the ranking with a minimum of ambiguity, short and discreet drift cells were desired.

Following drift cell selection, the ranking criteria were established based on the relative influence that each of the selected variables valuing nearshore sediment sources. Variables used in the scoring were limited to data measured using GIS (e.g. fetch) and available data sets including: data from CGS field mapping, slope stability from the Coastal Zone Atlas (WA Dept. of Ecology 1979), surficial geology (DNR 2001), bluff elevation (using LIDAR), and net shore-drift mapping (Keuler 1988, Johannessen 1992). The surficial geology was used for geology data, due to the lack of geologic sections for most of the county shores, which would be far more useful and indicative of sediment in the full height of bluffs. The LIDAR provided very detailed topography that was superior and more up-to-date than USGS quadrangles.

Points were assigned to each parameter with increments to describe the range of conditions at each individual feeder bluff segment (Table 3). The bluff shoretype mapped in the field in this study was used to characterize overall level of sediment input. Specifically, feeder bluff exceptional segments were given points relative to feeder bluff segments. Scoring increments for each variable are displayed in Table 3. The landscape context (within each drift cell) was evaluated for each segment differently within the drift cell. The distance from the drift cell origin or divergence zone was used to indicate the likelihood that the segment was erosional. Next, the maximum fetch was measured from each segment to the farthest land mass. The degree of fetch from a beach is strongly correlated with the wave energy to which that beach is exposed, and thus its erosion potential.

Physical characteristics of each segment of feeder bluff or feeder bluff exceptional were then determined to allow for comparison and ranking of the segments relative to each other. The height of each bluff segment was measured directly from the LIDAR imagery, using the average bluff height each segment. Bluff height is a direct indicator of the volume of sediment recruited from the uplands in a single mass movement. Surficial bluff geology was weighted to grant higher points to deposits containing relatively high percentages of gravel and coarse sand, which are valuable beach-building materials. In this case, Vashon advance outwash deposits, sometimes referred to as Esperance sand locally, provide the greatest percentage of beach-forming sediment (almost 100%) and were thus weighted the highest (Easterbrook 1968). Till has a moderate amount of gravel and sand (Easterbrook 1992), while glaciomarine drift (Qgdm(e)) has lesser volumes.

Landslide data from the Coastal Zone Atlas (WA Dept. of Ecology 1979) slope stability mapping (GIS coverage available from Ecology) was also used as an indicator of the likelihood of a segment contributing substantial sediment to the beach system. Bluff segments with a history of landslide activity were assigned points in two categories, below 50% of the segment length with mapped slides and above 50% of the length with mapped slides. CGS current conditions mapping data were used for recent landslides and toe erosion with the same reasoning and classes (Table 3).

RESULTS

CGS Mapping Statistics by Drift Cell

Feeder bluff and accretion shoreform mapping was performed for all of Island County. Coastal Geologic Services, Inc. conducted field mapping that documented the current geomorphic conditions of the Island County marine shoreline in the spring and summer of 2004. Field data were transferred into ArcGIS where Mapping segments were delineated as contiguous alongshore units that were then analyzed by net shore-drift cell, as described in the *Methods* section, above. The study area was divided into sub-areas of similar nature to allow for data to be compared and summarized.

Basic statistics of the shore segment types were compiled after the mapping was finalized in order to describe the occurrence of shoretypes by sub-area and by drift cell. County-wide, a total of 941 shore segments were mapped in the study area (Table 4). The greatest number of units mapped was feeder bluff (319), which accounted for 30% of the total county shore length. The next most commonly occurring shoretype was modified (235), accounting for 12% of the county (note that modified was only mapped where feeder bluff would have otherwise been mapped). The shoretype with the fewest number of segments mapped was feeder bluff exceptional (59), accounting for 8% of the county length.

There were 137 mapped accretion shoreforms (Table 4). Accretion shoreforms were the longest segments, with a mean length of 2,812 ft. An important reason for this was the fact that accretion shoreform segments were not broken up by the presence of modifications such as bulkheads. Examples of long accretion shoreform segments were at Keystone, West Beach at Deceptions Pass State Park, and at Elger Bay. Therefore, accretion shoreforms accounted for the largest percent of the total county shore (37%). Transport zone was mapped at 190 segments, accounting for 13% of the study area shore.

Mean lengths for all four types of shore segments ranged from 510 to 2,812 ft (Table 4). The minimum length of all mapped segments was 27 ft. The shortest mean segment length was for modified shore segments at 510 ft, which represents the length of mapped contiguous bulkheads or other modifications.

This remainder of this section summarizes results of these analyses of current geomorphic conditions by drift cell. Data is organized by sub-area, starting from north Whidbey Island and going clockwise around the island, around Smith Island, then from north Camano Island clockwise around the island (Figure 8). Place names used here were taken from the USGS 1:24,000 scale quadrangles, unless otherwise noted. All shoretype mapping is presented in 5 large format (24 by 48 inch) map sheets, attached in Appendix B.

North Whidbey

The North Whidbey sub-area encompassed the northeastern portion of Whidbey Island. It started at northernmost Whidbey at the Deception Pass bridge and extended alongshore to the east and south, including Crescent Harbor, Oak Harbor, and Penn Cove. The sub-area terminated at the

City of Coupeville. The sub-area was 206,853ft (39.2 mi) alongshore making it the longest sub-area in the study area.

The North Whidbey sub-area included 17 drift cells. The marine shoreline consisted of bedrock, pocket beaches, vegetated to unvegetated bluffs, sandy and/or gravelly bluffs to till bluffs, high elevation bluffs to low bank, no bank, and modified shores.

WHID-24/ WHID-25

Drift cell WHID-24/WHID-25 was a bedrock reach within Deception State Park that was mapped as No Appreciable Drift. This drift cell began approximately 1,000 ft west of the Deception Pass Bridge and extended 1.5 miles east and then south into Cornet Bay. Due to the bedrock along the shoreline this cell had the highest percentage of transport zone mapped in the study area.

Pocket beaches located within bedrock outcrops were mapped as accretion shoreforms, accounting for 22% of the reach. The majority of the reach (73%) was mapped as transport zone, which in this reach signified bedrock shoreline. Only 5% of the shoreline was mapped as feeder bluff, where toe erosion and a small landslide were evidence that the area contributed sediment to the beach.

WHID-24

Drift cell WHID-24 originated at a broad divergence zone and had generally southwestward drift that terminated in southern Cornet Bay. The first half of the 2.6 mile long cell was forested and undeveloped, except for the narrow road just landward of the bank. The terminus of the cell was a low bank developed area with marinas, a large State Park boat launch area, and residential bulkheading.

Transport zones (50%; in stable, forested banks containing native species) and feeder bluffs (17%) dominated the first two thirds of the cell. Landslides (2%) and toe erosion (17%) were mapped primarily along the first half of the cell and usually were located within feeder bluffs. The last third of the cell was primarily an accretion shoreform (26%) with some modified (7%) shoreline with fill and bulkheads.

WHID-23

Drift cell WHID-23 originated at a broad drift divergence zone and had southeastward drift that terminated at Ala Spit (also called Ben Ure Spit). This cell began in forested and undeveloped land and transitioned to high bluff and low bank that had residential development.

Two feeder bluff segments (31%) dominated the beginning of the cell with a transport zone in between. Transport zones accounted for 41% of the cell length and were the transition from feeder bluffs at the beginning of the cell to the accretion shoreform (26%) at the cell terminus. The accretion shoreform started in front of a low bank shore and ended in a wide beach in the relatively protected small embayment west of Ala Spit. Landslides (2%) and toe erosion (13%) occurred along the feeder bluff at the cell origin and also along the transport zone approximately in the middle of the cell.

WHID-22

Cell WHID-22 had net shore-drift to the north for 1.9 miles to the terminus at Ala Spit (Ben Ure Spit). The cell transitioned from forested high bluff to low bank and terminated at the spit.

Feeder bluffs (28%) and transport zones (43%) were interspersed along most of the cell leading to the accretion shoreform (26%) at Ala Spit. The shoreline was modified (3%) just south of the base of the spit. A bulkheaded accretion shoreform was located approximately 1,800 ft south of Ala Spit where a wide backshore area was present. Landslides (4%) and toe erosion (12%) were located near the cell origin and were correlated to feeder bluffs.

WHID-21

Cell WHID-21 had southwestward drift for1.3 miles to the cell terminus in inner Dugualla Bay. The cell originated in forested high bluff and transitioned quickly to forested medium elevation bluff to low bank at the terminus. The cell had some development of the uplands and shoreline modifications.

Most of the cell was feeder bluffs (25%) and transport zones (49%), interspersed with modified shoreline (16%). A mid-bay spit, mapped as an accretion shoreform, was located at the cell terminus. This segment accounted for only 10% of the cell, as the majority of the bay width contained a spit that advanced northwards from the adjacent drift cell to the south (WHID-20). The pre-development Dugualla Bay estuary extended almost 2 linear miles west of the spits. The former wide estuary channel that ran between the two spits has been armored and now contains a road and a tide gate, with water pumped out of the estuary. Landslides (1%) and toe erosion (11%) were primarily located within the feeder bluffs.

WHID-20

Cell WHID-20 had net shore-drift to the northeast then northwest that terminated in Dugualla Bay. This 8.2 mile long cell was primarily forested high bluff including areas without roads or many houses but low bank and modified shoreline were also present.

Feeder bluff exceptional segments (9% of cell length) were present near the cell origin and northeast of Mariner’s Cove in a high, sandy bluff of glacial deposits that had contributed sediment to the system. Feeder bluffs (16%) and transport zones (40%) were interspersed throughout most of the cell. A marina channel and jetty were located at Mariner’s Cove in a historic no-bank area. Accretion shoreforms (33%) were primarily at/near the cell terminus but were also dispersed throughout the cell in small and large wide beach and backshore areas, due to the large sediment supply in the general Strawberry Point area. Landslides (1%) and toe erosion (9%) were primarily near the cell origin and usually corresponded to feeder bluffs and feeder bluff exceptional segments but several were mapped along transport zones in the middle of the cell.

WHID-19

Cell WHID-19 had westward drift for 1.2 miles terminating at the neck north of Polnell Point. The cell was primarily low to moderately forested high bluff that tapered to low bank. This short cell had the highest percentage of feeder bluff exceptional mapped in Whidbey Island and the second highest percentage mapped in the study area.

Feeder bluff exceptional (46%)and feeder bluffs (35%) dominated most of the cell with minor modified shore (3%). An accretion shoreform (16%) was located at the terminus of the cell. Landslides (5%) and toe erosion (37%) were located within feeder bluff exceptional and feeder bluff segments primarily near the cell origin.

WHID-18

Cell WHID-18 originated at a narrow divergence zone at the south end of the Polnell Point headland and had northward drift for 0.7 miles, along the east side of Polnell Point, to the base of the peninsula. The cell was undeveloped high bank that tapered to low bank with backshore.

The cell began as feeder bluff exceptional (39%) and feeder bluff (30%), which transitioned to an accretion shoreform (31%) at the terminus. Landslides (4%) and toe erosion (25%) were located within the feeder bluff exceptional segment near the cell origin.

WHID-17

Cell WHID-17 had drift north then west along Crescent Harbor terminating near the boat ramps and marina at the Naval Air Station. The 4.7 mile long cell was primarily poorly vegetated medium elevation bluff that transitioned to low bank with backshore.

The cell began as feeder bluff exceptional (6%) with a feeder bluff and accretion shoreform located near the cell origin. Feeder bluff (42%) dominated most of the cell with some transport zones (5%) interspersed, which led to the primary accretion shoreform (42%) at the western end of the cell. The terminus was modified (armored with a large revetment: 5%) shoreline located waterward of the roadway.

WHID-16

Cell WHID-16 began at the drift divergence at the southern end of Maylor’s Point and ran 2.1 miles up the east shore to terminate at the northeast base of Maylor’s Point. The cell ranged from poor to well vegetated medium elevation bank near the cell origin to modified no bank near the cell terminus. This cell had the second highest percentage of modified mapped in the study area.

The cell origin was mapped as feeder bluff exceptional (8%). Feeder bluffs (43%) were present along the first half of the cell and down drift from the feeder bluff exceptional segment. A transport zone (4%) was located between feeder bluff segments near the middle of the cell. An accretion shoreform (3%) was located just up drift of the groin-modified segment (42%) located at the cell terminus. The rock groin was located just up drift of the modified shoreline apparently constructed to trap sediment before reaching the marina, which created a wide beach accretion shoreform and moved the “natural” terminus south of the modified area. Landslides (5%) and toe erosion (29%) were located within feeder bluff and feeder bluff exceptional segments within the first half of the cell. The cell terminus was modified shoreline within the Whidbey Island Naval Base docks, marina, and boat ramp.

WHID-15

Cell WHID-15 began at the drift divergence at the southern end of Maylor’s Point and extended 1.5 miles northwest. The cell terminated at the northeast portion of Maylor’s Point, near Maylor’s marsh. The cell began as poor to well vegetated medium elevation bluff that tapered down to no bank shore with saltmarsh in the backshore.

The first third of the cell was mapped as feeder bluff (30%) and feeder bluff exceptional (5%). The majority (59%) of the cell was mapped as an accretion shoreform (spit), which fronted Maylor’s marsh. The modified (6%) shore near the beginning of the cell was from the older US Army Corps of Engineers shore defense demonstration project. A horizontal timber wall with vertical piles and rock at the ends along with a reach of tires placed around piles was all that remained. Landslides (6%) and toe erosion (19%) were mapped in the first third of the cell and were correlated to feeder bluff and feeder bluff exceptional segments.

WHID-14/WHID-15

Cell WHID-14/WHID-15 was mapped as no appreciable drift. The 1.7 mile long drift cell began at the northwest tip of Maylor's marsh and terminated at the city of Oak Harbor. The cell contained low/no bank and was highly modified. This cell had the highest percentage of modified mapped in the study area.

Most (75%) of the cell was modified with riprap to protect upland roads. The southern end of the drift cell that had Maylor's marsh in the backshore was mapped as an accretion shoreform (25%). There were remnant piles fronting the accretion shoreform from a failed pile wall and a failed tide gate. The failed pile wall was constructed when Oak Harbor was dredged for the proposed sea plane base and material was placed east of the historic spit that ran north off the southwest point of Maylor's Point, which created Maylor's marsh. The marsh was historically used as a fish hatchery. The northwestern end of the drift cell was filled and riprap was placed as protection. No landslides or toe erosion were present.

WHID-14

Cell WHID-14 began at a broad divergence at Blowers Bluff and had 3.3 miles of northward drift, terminating at the city of Oak Harbor. The cell origin was unstable, poor to well vegetated, high elevation sandy bluff that transitioned to medium elevation bluff, which tapered to no bank at the terminus.

Feeder bluffs (48%) were mapped in the first two thirds of the drift cell, with three transport zones (5%) interspersed. Shoreline modifications (12%) were mapped near the origin where a wood pile wall protected a tram that ran down the bluff and also near the middle of the drift cell where wood pile walls were present in front of single family residences. The last third of the cell was a no bank accretion shoreform (35%) with short reaches of riprap at the terminus. An accretion shoreform segment was located near the middle of the drift cell where the bluff was well vegetated and a backshore was present. Landslides (12%) and toe erosion (24%) correlated with feeder bluff segments and were most prevalent near the drift cell origin.

WHID-13

Cell WHID-13 began at a broad drift divergence at Blowers Bluff. The drift cell had 4.1 miles of westward drift and terminated at the northwestern extent of Penn Cove. The cell originated at a moderately vegetated, unstable, sandy, high elevation bluff (Blowers Bluff). Most of the cell ranged from poor to well vegetated medium elevation bluff to low/no bank.

Feeder bluff (51%) segments were concentrated near the drift cell origin but were present throughout the entire cell. A feeder bluff exceptional (5%) segment was mapped near the middle of the cell. Transport zone (14%) segments were dispersed throughout the last two thirds of the drift cell. Accretion shoreform (22%) segments were located throughout the drift cell. The drift cell originated at Blowers Bluff and went south then west with sediment deposited at Penn Cove Park and also 3,000 to the west where shoreline orientation changed and sediment deposited as well as moved alongshore. Penn Cove Park began as a spit with a lagoon that filled over the years. The accretion shoreform had a broad sandy beachface and had accumulated a significant amount of large woody debris. Drift continued west and bluffs contributed sediment along the way and the drift cell terminated at an accretion shoreform segment. Shoreline modifications were mapped throughout the cell and ranged from wood pile walls and concrete bulkheads to large boulder revetments.

WHID-12

The Ecology net shore-drift cells WHID-12 through WHID-9 were altered because of the shoreline mapping. Drift cells WHID-11 and WHID-10 end points were shifted to the center of mapped accretion shoreform, whereas WHID-10 did not previously extend to the accretion shoreform. These changes are documented in the *Changes to Net Shore-Drift Cells* (Table 2).

Cell WHID-12 had 1.1 miles of northward drift that originated at the Mueller Park headland and terminated at the northwestern extent of Penn Cove. The drift cell was low/no bank shore, mostly consisting of Vashon Drift, fronting homes or a road (Madrona Way). The cell contained limited sediment supply and was moderately modified with some artificial fill.

Feeder bluffs (18%) were mapped at the origin of the cell and along a couple of low bank areas at the east end of the headland fronting Kennedys Lagoon and also 950 ft north of there where the bank was waterward of Madrona Way. Transport zones (25%) were mapped at the cell origin dispersed within feeder bluff segments and also dispersed throughout the last half of the drift cell. Accretion shoreforms (21%) were located on the south side of the headland fronting Kennedys Lagoon, and also at the spit at the terminus. The drift cell was moderately modified (38%) from residential bulkheads with some artificial fill and also riprap protecting Madrona Way. The lagoon has been modified with a road fronting it since at least 1871 (T-sheet #1254). Landslides (3%) and toe erosion (14%) were mapped throughout the cell and correlated with feeder bluff segments.

WHID-11

Cell WHID-11 originated at the Mueller Park headland at the western extent of Penn Cove. The cell had 0.6 miles of southward drift that terminated at the southwestern extent of Penn Cove. The drift cell ranged from low/no bank to moderately vegetated medium elevation bluff. The cell was moderately modified.

Feeder bluffs (25%) and transport zones (12%) were interspersed throughout the middle of the drift cell. Modified (36%) shores were mapped at the cell origin and throughout the cell where residential bulkheads and/or riprap were present. Two short accretion shoreform (27%) segments were located at the south end of Mueller Park headland, near the middle of the drift cell, where a small embayment at the lagoon entrance had collected sediment as well as at the cell terminus. Landslides (1%) and toe erosion (18%) occurred mostly within feeder bluff segments but were found within a transport zone also.

WHID-10

Cell WHID-10 began 1 mile west of the city of Coupeville and had westward drift that terminated at the southwestern extent of Penn Cove. The 1.1 mile long drift cell ranged from low bank to high elevation well forested bluff to modified. This cell was mostly high elevation forested bluff that had not contributed sediment. This cell had the second highest percentage of transport zone mapped in the study area.

Feeder bluff (12%) segments were located along the middle of the drift cell. Most (70%) of the cell was mapped as transport zone where high elevation forested bluffs had not contributed sediment. Modified (6%) shores were mapped within the middle of the cell and were adjacent to the two feeder bluff segments within the larger transport zone segments. The modified segments consisted of riprap armoring the bluff toe and a concrete seawall with fill behind it. An accretion shoreform (12%) was mapped at the cell terminus. Landslides (3%) and toe erosion (24%) were mapped throughout the cell and correlated with feeder bluffs and transport zones.

East Whidbey

The East Whidbey sub-area encompassed the eastern middle shore of Whidbey Island. The sub-area extended from the city of Coupeville south to Sandy Point (the point east of the city of Langley), including Holmes Harbor and Hackney (Baby) Island. The sub-area extended 197,288 ft (37.4 miles) alongshore making it the second longest sub-area in the county.

The East Whidbey sub-area was comprised of 13 drift cells. The marine shoreline consisted of high to medium elevation, moderately to well vegetated sandy bluff, no bank, modified, medium elevation till bluff, cuspate forelands, spits, concrete and other types of bulkheads, some of which had been filled out over the intertidal.

WHID-9

Cell WHID-9 originated at the city of Coupeville and had eastward drift that terminated at Long Point. The 2.7 mile long cell ranged from medium elevation poor to well vegetated bluff to low/no bank to modified.

Feeder bluffs (36%) were mapped near the drift cell origin, along the east side of Loveloy Point, and east of Long Point where the medium elevation bluff had contributed sediment. Transport zone (18%) segments were mapped at the cell origin and in the middle of the drift cell between Loveloy Point and Long Point. Accretion shoreform (27%) segments were located just west of the city boat launch area, east of Loveloy Point where it became no bank, and along Long Point, the cuspate foreland at the drift cell terminus. The cell was 19% modified, which was mapped near the cell origin, which consisted of riprap or concrete bulkheads. Landslides (6%) and toe erosion (29%) were correlated with feeder bluff and transport zone segments.

WHID-8b

Cell WHID-8b began at the small headland between Long Point and Snakelum Point and had 0.7 miles of westward drift that terminated at Long Point. The drift cell ranged from high elevation, sandy bluffs composed largely of till that were poor to well vegetated, to medium/low elevation vegetated bank, to no bank.

Feeder bluffs (30%) were concentrated at the cell origin along the high sandy bluff. The shore was modified (32%) in the middle of the cell and was associated with development of the medium elevation bluff, with a short modified segment located within the feeder bluffs. A short transport zone (1%) segment was located within the modified segments. The narrow cuspate foreland at the cell terminus (Long Point) was mapped as an accretion shoreform, which comprised 37% of the drift cell length. Landslides (8%) and toe erosion (11%) were mapped near the drift cell origin and were associated with feeder bluffs. Historically, when compared to the 1888 T-sheet, the cuspate foreland appeared to have been fairly stable.

WHID-8a

Cell WHID-8a originated at the point west of Snakelum Point and had 0.7 miles of eastward drift that terminated at Snakelum Point. The cell began as high elevation, sandy, well vegetated bluff that tapered down quickly to low/no bank. Net shore-drift in this area (originally mapped by Keuler 1988) was reinterpreted in this report by breaking this area into a new drift cell.

Feeder bluffs (34%) were mapped at the beginning of the drift cell. The high bluff tapered to a low/no bank transport zone (16%) segment. The large cuspate foreland at the terminus was mapped as an accretion shoreform and comprised the remaining 50% of the cell length. Toe erosion (14%) was mapped along the feeder bluff segment at the cell origin.

WHID-8

Cell WHID-8 began at a zone of divergence located approximately 1 mile south of Honeymoon Bay within Holmes Harbor. The cell had 14.8 miles of northward drift that terminated at Snakelum Point, making it the longest drift cell in the study area. The cell ranged from high elevation poor to well vegetated bluff to medium poor to well vegetated bank to no bank to modified. There was a high percentage of high sandy and/or gravelly bluffs that had contributed sediment, some of which was deposited along the way at accretion shoreform segments that were historic lagoons or cuspate forelands, associated with a change in shoreline orientation or low elevation areas (historic lagoons).

Feeder bluff exceptional (2%) segments were mapped near the cell terminus; south of Snakelum Pt and south of Harrington Lagoon where the high sandy bluffs had contributed significant sediment. Feeder bluff (40%) segments were mapped throughout the drift cell and were associated with high elevation sandy bluffs that had contributed sediment. Well vegetated bluffs that had no evidence of sediment contribution were interspersed with feeder bluff segments and were mapped as transport zones, constituting 19% of the drift cell length. Modified (11%) shores were mapped throughout the drift cell and were associated with residential bulkheads. Large intertidal fill and bulkheading that had created land for homes was mapped on the north facing shore within Honeymoon Bay, just north of Dines Point, and just north of Pratts Bluff. Accretion shoreform (28%) segments were also mapped throughout the drift cell and were often associated with a change in shoreline orientation or a historic low elevation area. Accretion shoreform segments were mapped along the cuspate forelands located just south of Honeymoon Bay, at Dines Point, and at the terminus at Snakelum Pt. They were also located within the somewhat protected bay of Honeymoon Bay, south of Pratts Bluff and north of North Bluff where it was historically a lagoon with marsh habitat in a low elevation area, and along the shores of Race and Harrington Lagoon which were lagoons historically with some artificial fill on the north end of Harrington Lagoon. Landslides (5%) and toe erosion (23%) were mapped throughout the drift cell and were highly correlated to feeder bluff exceptional and feeder bluff segments but some were mapped along transport zones also.

WHID-7

Cell WHID-7 began at a zone of divergence located approximately 1 mile south of Honeymoon Bay within Holmes Harbor and had 1.9 miles of southward drift that terminated at southwest Holmes Harbor. (The Ecology net shore-drift cells terminus was adjusted to end at the center of the mapped accretion shoreform in southwest Holmes Harbor.) The cell ranged from high elevation well vegetated sandy bluff to medium elevation cleared bluff to no bank and modified.

The cell was mostly feeder bluff (51%) segments, which were concentrated at the cell origin, but were also mapped within the southern quarter of the drift cell. The bluff area near the cell terminus was largely modified (41%) with residential bulkheads and wood pile walls, some of which were filled and extended over the intertidal. The two relatively small cuspate forelands that were near the middle of the drift cell and the terminus were mapped as accretion shoreforms (8%). Landslides (9%) and toe erosion (40%) correlated with feeder bluff segments. Historically the cell was almost completely forested medium elevation bank with uplands that had been cleared and developed.

WHID-6

Cell WHID-6 originated at the headland at the southern extent of Holmes Harbor and had 0.4 miles of southwestward drift that terminated at the accretion shoreform in southwest Holmes Harbor. The cell went from medium elevation vegetated bluff to no bank. This short cell had the highest percentage of feeder bluff mapped for Whidbey Island, and the second highest percentage mapped in the study area.

Feeder bluffs (61%) were mapped at the cell origin where a medium elevation sand and gravel bluff contributed sediment. This transitioned to an accretion shoreform (39%) to the cell terminus. Landslides (7%) and toe erosion (56%) were mapped at the cell origin and were associated with feeder bluffs.

WHID-5

Cell WHID-5 had 0.2 miles of eastward drift that originated at the headland in southern Holmes Harbor and terminated in the embayment in southeastern Holmes Harbor. The cell ranged from medium elevation vegetated bluff to no bank.

The cell origin was mapped as feeder bluff (25%), which transitioned into a transport zone (8%) and terminated at an accretion shoreform (67%). Landslides (7%) and toe erosion (25%) were concentrated at the cell origin and were associated with the feeder bluff segment.

WHID-4

Cell WHID-4 began at a broad divergence zone along the eastern shore of Holmes Harbor and had 2.3 miles of southward drift that terminated at Freeland Park in southeast Holmes Harbor. The cell consisted of high elevation, moderately to well vegetated sandy till bluff, medium elevation sandy, gravelly well vegetated bluffs, low to no bank, and modified. This cell had the highest percentage of toe erosion mapped in the study area.

Feeder bluff (51%) segments were concentrated at the cell origin and the third quarter of the cell. Transport zone (26%) segments were concentrated in the second quarter of the cell but were also dispersed between feeder bluff segments. The drift cell terminus was mapped as an accretion shoreform (6%) at Freeland Park and the low/no bank area to the east. Modified (17%) shores were concentrated near the cell origin but were also mapped within feeder bluff segments within the first three quarters of the cell. Modified shores were usually woodpile or sheet pile walls filled out over the intertidal with homes atop the fill. Landslides (17%) were highly correlated to feeder bluff segments and toe erosion (69%) segments were mapped throughout most of the cell corresponding to both feeder bluff and transport zone segments.

WHID-3

Cell WHID-3 originated at a divergence zone approximately 1 mile south of Beverly Beach along the eastern shore of Holmes Harbor. The 5.8 mile long cell had northward drift up to Rocky Point and then eastward drift that terminated at East Point (also know as Fox Spit). The cell was largely high elevation, moderately vegetated, sandy bluffs with some medium elevation, till bluffs and some no bank. The cell was moderately modified, mostly with concrete bulkheads and bulkheads constructed of other material that had been filled out over the intertidal.

Feeder bluff exceptional (2%), feeder bluff (47%), and transport zone segments (9%) were mapped throughout the cell. Modified shores constituted 31% the cell length and were largely concrete bulkheads in the Whidbey Shores Association at low elevation areas landward of bulkheads where bluff sediment was excavated mechanically and placed behind bulkheads (that were constructed over the intertidal). Accretion shoreform segments accounted for 11% of the cell length and were mapped at the low elevation cuspate forelands; one south of Beverly beach and one to the north, as well as at the terminus at the East Point cuspate foreland. Landslides (13%) and toe erosion (30%) were highly correlated with feeder bluff segments but were also found within some transport zones.

WHID-3b

Cell WHID-3b originated at the northwest end of Hackney Island (locally referred to as Baby Island) and had 0.1 miles of southeastward drift along the southern side of the island. The cell was a short reach of medium elevation till bluff and a spit at the terminus.

The cell origin consisted of feeder bluff exceptional (6%) and feeder bluff (16%) with a short accretion shoreform (78%) segment in between and along the terminus, which was a spit that had prograded to the southeast.

WHID-3a

Cell WHID-3a originated at the northwest end of Hackney Island (locally referred to as Baby Island) and had 0.1 miles of southeastward drift along the northern side of the island. The cell was a short reach of medium elevation till bluff and a spit at the terminus.

The cell origin consisted of feeder bluff exceptional (6%) and feeder bluff (20%), which transitioned to an accretion shoreform (74%) segment along the terminus, which was a spit that had prograded to the southeast.

WHID-2

Cell WHID-2 originated at a divergence zone approximately 2 miles northwest of the city of Langley and had 3.7 miles of northwestward drift that terminated at East Point (also know as Fox Spit). The cell ranged from high elevation, moderately to well vegetated sandy bluff, to no bank, to modified.

Feeder bluff segments (61%) were mapped along most of the cell. Feeder bluff segments were concentrated at the cell origin and the reach between Bells Beach and East Point (Fox Spit), along the high elevation, sandy, moderately vegetated bluff. Accretion shoreform segments constituted 24% of the drift cell. The low elevation area called Bells Beach was mapped as an accretion shoreform segment, near the middle of the drift cell, although it is know that a portion of the low elevation shore was filled. An accretion shoreform segment was also mapped at the cuspate foreland at the drift cell terminus at East Point. Modified (14%) segments were mapped between the cell origin and Bells Beach. The large modified segment immediately south of the Bells Beach accretion shoreform contained concrete bulkheads pushed out over the intertidal with fill and homes. Other modified segments were bulkheads at the bluff toe. There was a short transport zone (2%) just north of the Bells Beach accretion shoreform where the bluff had not contributed sediment. Landslides (15%) and toe erosion (28%) correlated to feeder bluff segments.

WHID-1

Cell WHID-1 originated at a divergence zone approximately 2 miles northwest of the city of Langley. The cell had 3.9 miles of southeastward drift that included the marine shoreline along the city of Langley and terminated at Sandy Point. The cell ranged from high elevation, moderately vegetated, sandy bluff, to no bank, to modified.

Feeder bluffs (52%) dominated the cell and were mapped throughout the cell along the high elevation sandy bluffs that had contributed sediment. Modified (20%) segments were mapped throughout the cell. Concrete bulkheads with intertidal fill were found in the first half of the cell. The marine shoreline along the city of Langley was highly modified with a concrete seawall and some riprap armoring alongshore. Wood pile walls and concrete bulkheads with intertidal fill were mapped between the city of Langley and Sandy Point. Accretion shoreform (21%) segments were mapped near the cell origin along a low elevation area that had a broad backshore. An accretion shoreform segment was located along the marine shoreline of the city of Langley where the beach was built up in front of concrete bulkheads. The cell terminus was a cuspate foreland (Sandy Point), which was mapped as an accretion shoreform. Three transport zone (7%) segments were mapped throughout the cell where the high elevation bluff had not contributed sediment. Landslides (14%) and toe erosion (26%) were mapped throughout the cell.

South Whidbey

The South Whidbey sub-area encompassed the southern marine shore of Whidbey Island. The sub-area extended from Sandy Point (1.5 miles east of the city of Langley) south to Possession Point and then west to Bush Point, including Cultus Bay, Useless Bay, and Mutiny Bay. The sub-area extended 177,880 ft (33.7 miles) alongshore making it the fourth longest sub-area in the study area.

The South Whidbey sub-area contained 7 drift cells. The marine shoreline consisted of medium to high elevation, unvegetated to well vegetated sandy silty bluffs, medium to high elevation, poorly vegetated, sandy till bluff, no bank, low elevation, and modified shores.

IS-1

Cell IS-1 originated at a divergence zone at Possession Point. The cell had 10 miles of northward drift that terminated at Sandy Point. The cell consisted of medium to high elevation, unvegetated to well vegetated, sandy silty bluffs, no bank, and modified marine shores.

A feeder bluff exceptional (2%) segment was mapped at Possession Point, the drift cell origin. Feeder bluff (48%) segments were concentrated within the first and last quarter of the drift cell but were also present in the mid cell. Accretion shoreform (39%) segments were mapped throughout the cell. They were concentrated along the eastern side of Possession Point, at Glendale, Clinton, Randall Point, at a short spit half way between the city of Clinton and Sandy Point, and a short segment at the cuspate foreland at the terminus (Sandy Point). Modified (10%) segments were mapped throughout the cell and were most often concrete bulkheads and fill out over the intertidal; often in an attempt to “lengthen” a developed low elevation area for more single-family residences. Two short transport zone (1%) segments were located within the first quarter of the drift cell where the high elevation, fairly stable bluff. Landslides (17%) and toe erosion (23%) were correlated with feeder bluff segments.

IS-2

Cell IS-2 began at a zone of divergence at Possession Point and had 1.6 miles of northwestward then northeastward drift. The cell ranged from high elevation, poorly vegetated, sandy bluff that tapered to low elevation bank, to no bank, and modified.

Feeder bluff exceptional (32%) was mapped at the cell origin at Possession Point. The cell transitioned to feeder bluff segments (11%) that were interspersed with modified (15%) segments. Modified segments usually consisted of riprap armoring along the marine shoreline, the largest segments were the Possession Point boat launch and the bulkhead-groin at the base of Sandy Hook spit. The Sandy Hook spit (where the Sandy Hook Yacht Club is located) at the cell terminus, although extensively modified in the late 1950s, was mapped as an accretion shoreform (42%). Landslides (16%) and toe erosion (24%) were mapped within the first half of the drift cell and correlated with feeder bluff exceptional and feeder bluff segments.

IS-2/IS-3

IS-2/IS-3 was mapped as 2.2 miles of no appreciable drift. The reach began at the northern end of Sandy Hook, ran south along the east side of Sandy Hook spit and then into the northern end of

Cultus Bay. This reach terminated at the end of the eastward trending spit. The cell consisted of low elevation, well vegetated bluffs, low/no bank, and modified reaches. The cell was well protected and shallow with minimal sediment inputs and transport. This cell was the only reach with no appreciable drift mapped in the study area. Mapp9ing was carried out in this reach due to the presence of accretion beaches.

A little more than half (58%) of the cell was mapped as no appreciable drift. Accretion shoreform (31%) segments were mapped on the inner sides of the two spits within the cell as well as the northwestern corner of Cultus Bay where sediment had accumulated in a broad beach. The north south trending dike north of the northern spit within Cultus Bay was mapped as modified (11%).

IS-3

Cell IS-3 originated at Skatchet Head and had 1.9 miles of northeastward drift that terminated at the distal end of the spit in northern Cultus Bay. The cell consisted of high elevation, moderately vegetated, sandy silty bluffs, medium elevation, well vegetated bluffs, low/no bank areas, and modified shores.

The drift cell origin at Skatchet Head was mapped as modified (36%) where the shoreline was heavily armored with riprap protecting home sites that were filled out over the intertidal, which prevented material from the high elevation, sandy bluff from entering the cell. The middle of the cell was mapped as transport zones (10%) with a short feeder bluff (4%) segment within the transport zones. The long, undeveloped spit at the cell terminus was mapped as an accretion shoreform (50%).

IS-4

Cell IS-4 originated at Skatchet Head and had 8.4 miles of northwestward drift that terminated at Deer Lagoon at the northern extent of Useless Bay. The cell consisted of medium to high elevation, well to moderately vegetated, sandy silty bluffs, no bank, and modified shores.

Feeder bluff exceptional (18%) segments were concentrated near the cell origin, from Skatchet Head to Indian Point, with one segment also mapped near the cell terminus. Feeder bluff (28%) segments were mapped near the cell origin and along the northern half of the cell. Accretion shoreform (48%) segments were mapped west of Skatchet Head, along Maxwelton Beach, at a short segment mid cell, and at the long spits at the cell terminus. Short transport zone (4%) segments were dispersed throughout the cell. Landslides (18%) and toe erosion (23%) were mapped throughout the drift cell and mostly correlated with feeder bluff exceptional and feeder bluff segments but did overlap one transport zone segment.

IS-5

Cell IS-5 originated 1.5 miles east of Double Bluff and had 2.5 miles of northeastward drift along the Useless Bay shore to terminate at Deer Lagoon. The cell originated as high elevation, poorly vegetated, sandy silty bluff, that transitioned to no bank.

The cell origin was mapped as feeder bluff exceptional (26%), which supplied abundant sediment to the accretion shoreform, which constituted the remainder of the cell (74%). Landslides (15%) and toe erosion (18%) were mapped at the cell origin and correlated with the feeder bluff exceptional segment.

IS-6

Cell IS-6 originated 1.5 miles east of Double Bluff and had 7.2 miles of north then northwestward drift that terminated at Bush Point. The cell consisted of medium to high elevation, poor to moderately vegetated, sandy silty bluff, followed by medium to high elevation, poorly vegetated sandy till bluff, and finally no bank shore and small modified reaches.

Feeder bluff exceptional (23%) and feeder bluff (22%) segments were mapped at the cell origin at Double Bluff and along the medium elevation, sandy till bluff north of Mutiny Bay. The west facing shoreline along Mutiny Bay was mapped as accretion shoreform (48%) along with the cuspate foreland at the cell terminus (Bush Point). Transport zones (6%) were mapped throughout the cell where the bluff was not contributing sediment. Short modified (1%) segments were mapped between Mutiny Bay and Bush Point where small wood pile walls with fill over the intertidal were present as a base for trams from the uplands. Landslides (13%) and toe erosion (25%) were highly correlated with the feeder bluff exceptional and feeder bluff segments, but there was slight overlap of one transport zone segment.

West Whidbey

The West Whidbey sub-area encompassed the northwestern marine shore of Whidbey Island. The sub-area extended from Bush Point to Deception Pass, including Admiralty Bay, Fort Casey and Fort Ebey state parks, and Smith Island. The sub-area extended 183,014 ft (34.7 miles) alongshore making it the third longest sub-area in the study area.

The West Whidbey sub-area was comprised 6 drift cells, 4 along Whidbey Island and 2 along Smith Island. The marine shoreline consisted of low elevation, poorly vegetated, sandy gravel bluff, and low elevation spit complex, followed by high elevation, poorly vegetated, sandy gravel bluffs, followed by medium to low bank, poorly vegetated, sandy bluffs, high elevation, poorly to well vegetated, sand, gravel, and till bluffs, and no bank and modified shores.

WHID-28

Cell WHID-28 originated at a broad divergence zone west of Lake Hancock and had 6.7 miles of southward drift that terminated at Bush Point. The drift cell consisted of low to high elevation, poorly to well-vegetated, sand and gravel bluff, and no bank shore. This cell had the highest percentage of landslide mapped in the study area.

A feeder bluff exceptional (5%) segment was mapped near the cell origin. Feeder bluff (51%) segments were mapped throughout the cell, including all of South Whidbey State Park. Accretion shoreform (37%) segments were mapped at the cell origin along the beach fronting Lake Hancock. Accretion shoreform segments were also mapped at the middle of the cell at Lagoon Point and along the small spit just south of Lagoon Point. The cuspate foreland (Bush Point) at the cell terminus was also mapped as an accretion shoreform. Transport zones (7%) were mapped in between the accretion shoreform segments and the feeder bluff segments except at the cell origin. Landslides (37%) and toe erosion (54%) were mapped throughout the cell and correlated to feeder bluff exceptional and feeder bluff segments, with minor overlap of one transport zone.

WHID-27

Cell WHID-27 originated at a broad divergence zone west of Hancock Lake. The cell had 4.5 miles of northward then westward drift that terminated within Admiralty Bay, 1.3 miles east of the Keystone Ferry terminal. The cell consisted of medium to high elevation, poorly to well vegetated, sand, gravel, and till bluffs, modified shores, with a long spit at the cell terminus.

Feeder bluff exceptional (12%) segments were mapped within the first third of the drift cell. Feeder bluff (32%) segments were mapped along the middle of the cell. Accretion shoreform (36%) segments were mapped at the cell origin and terminus. Modified (13%) segments were mapped near the middle of the cell and consisted of riprap or concrete walls for protection of home sites. A transport zone (7%) segment was mapped immediately up-drift of the accretion shoreform near the cell terminus. Landslides (16%) and toe erosion (23%) were mapped along the feeder bluff exceptional and feeder bluff segments.

WHID-26

Cell WHID-26 began at a divergence zone at Partridge Point and had 8.9 miles of southeastward drift that terminated within Admiralty Bay, 1.3 miles east of the Keystone Ferry terminal. The drift cell consisted of high elevation, poorly vegetated, sand and gravel bluffs, no bank low elevation, and modified shores. This cell had the second highest percentage of landslide mapped in the study area.

Two large feeder bluff exceptional (18%) segments were mapped at and near the drift cell origin, a short segment near the middle of the cell, and a short segment near the cell terminus at Admiralty Head. Feeder bluff (25%) segments were concentrated near the cell origin and dispersed through the middle of the cell with one short segment at Admiralty Head. Transport zone (17%) segments were mapped along the middle of the cell. Accretion shoreform (37%) segments were mapped along the barrier beach with a backshore lagoon (Peregos Lake) between Partridge Point and Ebey's Landing, one along Ebey's Landing and along the long barrier at the cell terminus. Modified (3%) shores were mapped at the Keystone Ferry Terminal landing and jetty. Landslides (34%) and toe erosion (50%) were mapped throughout the cell and were associated with feeder bluff exceptional, feeder bluff, and some transport zone segments.

WHID-25

Cell WHID-25 began at a divergence zone at Partridge Point and had mostly northeastward then eastward drift terminating approximately 1,000 ft west of the Deception Pass Bridge. The drift cell was 14.6 miles long, making it the second longest drift cell in the study area. The cell consisted of high elevation, poorly vegetated, sandy gravel bluffs, medium to low bank, poorly vegetated, sandy bluffs, no bank, low elevation, and modified shores. The cell consisted of characteristically high elevation sandy and gravelly bluffs, which had significant exposure to the Strait of Juan de Fuca and supplied sediment to the accretion shoreforms that accounted for 50% (7.3 miles) of this long cell.

Feeder bluff exceptional (19%) segments were mapped at the cell origin and dispersed throughout the first 2.9 miles of the drift cell. Feeder bluff (21%) segments were concentrated in the first third of the cell with a reach of dispersed segments in between two large accretion shoreform segments along the Whidbey Island Naval Air Station shore. Relatively short transport zone (8%) segments were mapped throughout the cell. The northernmost and north facing transport zone shore segments were bedrock. Accretion shoreform segments (50%) accounted for roughly the last half of the cell. They consisted of the 2.4 miles south of Rocky Point, and then from the Whidbey Island Naval Air Station north along Deception Pass State Park, fronting Cranberry Lake. Several shore accretion shoreform segments were also mapped at kettles with barriers near the cell origin. Modified (2%) shores were mapped near the cell origin at the wood pile wall and Libby Road public access, to the north along a boat launch and also along a riprap bulkhead; both built out over the intertidal.

SM-1

Cell SM-1 was a short 1.4 mile long drift cell that originated at the southwest end of Smith Island, ran along the north side of the island, and terminated at the distal end of the northeast trending spit that extended east from the island. The cell consisted of low elevation poorly vegetated gravelly sand bluff and low elevation spit complex.

Feeder bluff exceptional (17%) was mapped at the cell origin, which transitioned to a transport zone (10%). The last 73% of the drift cell was mapped as an accretion shoreform that terminated at the distal end of the detached spit to the northeast of Smith Island.

SM-2

Cell SM-2 originated at the southwest end of Smith Island. It had 1.6 miles of northeastward drift that ran along the south side of Smith Island and terminated at the distal end of the northeastward trending spit. The cell consisted of low elevation poorly vegetated gravelly sand bluff and low elevation spit complex.

Feeder bluff exceptional (26%) was mapped at the cell origin that transitioned to a feeder bluff (8%) segment. The last 66% of the cell was mapped as an accretion shoreform that began near the northeast end of Smith Island, extended to the northeast, and terminated at the distal end of the detached spit to the northeast.

North Camano

The North Camano sub-area encompassed the northeastern marine shore of Camano Island. The sub-area extended from Utsalady clockwise around the Camano Island shoreline and terminated at Barnum Point, including English Boom, Juniper Beach, and Livingston Bay. The sub-area extended 68,127 ft (12.9 miles) alongshore making it the sub-area with the shortest shore in the study area.

The North Camano sub-area was comprised of 6 drift cells. The marine shoreline consisted of low to high elevation, poorly to moderately vegetated, sandy bluff, high to medium elevation, sand and gravel bluffs, high elevation, moderately to well vegetated, gravelly sand bluffs, no bank low elevation, mud flat/delta, and modified shores.

CAM-2

Cell CAM-2 originated at Brown Point and had 1.1 miles of southward drift that terminated at Utsalady. The cell consisted of high elevation moderately vegetated sandy gravel bluffs and low elevation no bank

Feeder bluff (36%) segments were mapped along the cell origin. Two short transport zones (4%) were mapped near the middle of the cell. The last 34% of the cell was mapped as an accretion shoreform, along the shore of Utsalady. Modified shores (26%) were mapped in the first half of the cell and consisted of concrete bulkheads, riprap, and wood pile walls filled out over the intertidal.

CAM-1

Cell CAM-1 originated at Brown Point and had 1.6 miles of eastward drift that terminated near English Boom. The cell consisted of medium to high elevation, well vegetated, gravelly sand bluffs, no bank, low elevation areas, and mud flat/delta.

Feeder bluff (29%) segments were concentrated down-drift of Arrowhead Beach, with one short segment at the cell origin. A transport zone (17%) segment was located near English Boom, just down-drift of the feeder bluff segment. Accretion shoreform (53%) segments were mapped near the cell origin along Arrowhead Beach and along the cell terminus where the shoreline starts to blend into mud flats and the Stillaguamish River delta.

CAM-1/CAM-13

Cell CAM-1/CAM-13 was a 3.5 mile long reach that was mapped as no appreciable drift as it consists of the island shoreline where it meets the Stillaguamish River delta. Due to the nature of the marshy shore and delta accretion the entire reach was mapped as an accretion shoreform (100%). This reach had the highest percentage of accretion shoreform mapped in the study area.

CAM-12

Cell CAM-12 originated at the headland east of Livingston Bay and had 1.1 miles of eastward drift that terminated at Juniper Beach. The cell consisted of high elevation, moderately vegetated, sandy bluffs, and no bank, low elevation areas.

Feeder bluff exceptional (4%) was mapped at the cell origin, which transitioned to feeder bluff (35%). The last 61% of the cell was mapped as an accretion shoreform, much of which was densely developed. Landslides (4%) and toe erosion (10%) were mapped near the cell origin and were associated with the feeder bluff exceptional and feeder bluff segments.

CAM-11

Cell CAM-11 originated at the headland east of Livingston Bay and had 1.5 miles of northward then westward drift that terminated in Livingston Bay. The cell consisted of high to medium elevation bluffs composed of till and sandy units, to no bank low elevation areas.

Feeder bluff exceptional (11%) was mapped at the cell origin. Feeder bluff (15%) segments were mapped just down-drift of the feeder bluff exceptional segment at the cell origin, and also in the middle of the cell. Accretion shoreform (62%) segments were mapped near the middle of the cell along Sundine Beach and along the cell terminus within Livingston Bay. Three short transport zone (12%) segments were mapped near the middle of the cell and were located between feeder bluff and accretion shoreform segments.

CAM-10

Cell CAM-10 originated just north of Barnum Point and had 4.2 miles of generally northward drift that terminated in northern Livingston Bay. The cell consisted of low to high elevation, poorly to moderately vegetated, sandy bluff, no bank low elevation, and modified shores. This relatively long cell had the second highest percentage of accretion shoreform mapped in the study area.

Feeder bluff (8%) segments were mapped near the cell origin and near the middle of the cell. Transport zones (3%) were mapped in between feeder bluff and accretion shoreform segments. Accretion shoreform segments (86%) were mapped near the cell middle, along Luna Beach, and along the cell terminus within Livingston Bay. Modified shores (3%) were mapped immediately south of the Luna Beach accretion shoreform segment where a wood pile wall was armoring the bluff toe. Barnum Point likely contributed considerable volumes of sediment in combinations with the divergence zone located at the west end of the larger headland.

East Camano

The East Camano sub-area encompassed the southeastern marine shore of Camano Island. The sub-area extended from Barnum Point along the eastern shore of Camano Island to Camano Head at the southern tip of Camano Island. The sub-area extended 68,575 ft (13.0 miles) alongshore making this sub-area shore the second shortest in the study area.

The East Camano sub-area was comprised of 2 drift cells. The marine shoreline consisted of high elevation, poorly vegetated, sandy till bluff, and medium to low elevation, well vegetated bluff, no bank, low elevation, and modified shores

CAM-9

Cell CAM-9 originated at a broad divergence zone just northeast of Barnum Point and had 0.5 miles of southwestward then northwestward drift that terminated at the entrance to Triangle Cove. The cell consisted of high elevation, poorly vegetated, sandy till bluff, and medium to low elevation, well vegetated, sandy till bluff. Due to its short length this cell had the highest percentage of feeder bluff exceptional mapped in the study area. This cell had the highest percentage of toe erosion mapped for Camano Island, and the second highest percentage mapped in the study area.

Feeder bluff exceptional (60%) and feeder bluff (20%) segments were mapped along the cell origin around Barnum Point. These transitioned to a transport zone (15%) and terminated along an accretion shoreform (5%) on the east side of the entrance channel to Triangle Cove. Landslides (15%) and toe erosion (56%) were mapped along the cell origin and correlated to feeder bluff exceptional and feeder bluff segments.

CAM-8

Cell CAM-8 originated at a divergence zone at the southern end of Camano Island, at Camano Head, and had northwestward then northward drift that terminated at the end of the spit fronting Triangle Cove. This 12.5 mile long cell was the fourth longest cell in the study area. The cell consisted of high to medium elevation, moderately to well vegetated, sand, gravel, and till bluff, no bank, low elevation, and modified shores.

Feeder bluff exceptional (5%) segments were mapped at the cell origin and near the middle of the cell. Feeder bluff (22%) and transport zone (23%) segments were dispersed throughout the cell. Accretion shoreform (33%) segments were also mapped throughout the cell; along Tillicum Beach, Sunny Shore Acres, Cornell, Camano Country Club, Cavelero Beach, and along the spit fronting Triangle Cove at the cell terminus. These spits and other accretion features occurred where the shore orientation changed and spit progradation extended offshore, or in several cases, where embayments were once present, such that spits prograded in the direction of net shore-drift. Landslides (5%) and toe erosion (19%) were mapped throughout the cell and were mostly associated with feeder bluff exceptional and feeder bluff segments but there were several occurrences in transport zone segments.

West Camano

The West Camano sub-area encompassed the western shore of Camano Island. The sub-area extended from the southern tip of Camano Island at Camano Head and along the western shore of the island and terminated at Utsalady in the north. The sub-area extended 115,692 ft (21.9 miles) alongshore making it the longest sub-area on Camano Island and the third to shortest sub-area in the study area.

The West Camano sub-area comprised 5 drift cells. The marine shoreline consisted of mostly high bank shores of varying geologic deposits along with several spits and other low elevation shores. Bluff elevation generally ranged up to 250 ft high.

CAM-7
Cell CAM-7 originated at the southern tip of Camano Island at Camano Head and had 1.3 miles of northwestward drift that terminated at Pebble Beach. The cell consisted of high elevation, poorly to moderately vegetated sand, silt, and gravel bluff, no bank, low elevation, and modified shores.

Feeder bluff (11%) exceptional segments were mapped near the beginning of the drift cell along Camano Head. Feeder bluff (27%) segments were mapped throughout the cell. Transport zone (20%) segments were mapped near the middle of the cell. Modified (15%) shores were mapped near the middle of the cell and near the cell terminus where primarily wood pile walls were filled out over the upper beach. Accretion shoreform segments were mapped near the end of the cell and along the cuspate foreland at the cell terminus. Landslides (9%) and toe erosion (40%) were mapped along the first half of the cell and were correlated to feeder bluff exceptional and feeder bluff segments.

CAM-6
Cell CAM-6 began at a broad divergence between Mabana and Pebble Beach and had 1.3 miles of southeastward drift that terminated at Pebble Beach. The cell consisted of high elevation, moderately to well vegetated, sand and gravel bluff, no bank low elevation, and modified shores. This cell had the highest percentage of feeder bluff mapped in the study area.

Feeder bluff (53%) and transport zone (15%) segments were mapped throughout the cell. Short modified (21%) segments also occurred throughout the cell. These consisted of wood pile walls filled out over the intertidal for houses or boat houses, and riprap armoring at the bluff toe (the longest segment near the middle of the cell).

CAM-5
Cell CAM-5 began at a broad divergence zone approximately 1.5 miles north of Pebble Beach and had 5.5 miles of northwestward drift that terminated within Elger Bay. The cell consisted of medium to high elevation, poor to well vegetated, sandy bluff, no bank low elevation, and modified shores. The cell was well modified (38% of cell length) with wood pile walls and riprap armor filled out over the upper beach.

Feeder bluff exceptional (13%) segments were mapped within the first half of the cell, just south of Mabana and along Camp Diana. Feeder bluff (29%) segments were mapped throughout the cell. They were concentrated near the cell origin and the first third of the cell but were also mapped near the cell terminus. Transport zone (3%) segments were mapped throughout the cell. Accretion shoreform (17%) segments mapped at several locations in the cell were associated with a change in shoreline orientation. The large barrier beach at the cell terminus was also mapped as an accretion shoreform. Modified (38%) segments were mapped throughout the cell. The modified shore segment near the cell origin was riprap armoring fronting homes filled out over the intertidal. Wood pile walls, or riprap, filled out over the intertidal or along the bluff toe were most common and were concentrated within the last quarter of the cell. Landslides (3%) and toe erosion (20%) were mapped throughout the cell and highly correlated with feeder bluff exceptional and feeder bluff segments but landslides were also found within transport and at bulkheads.

CAM-4
Cell CAM-4 began at a divergence zone at Lowell Point and had 0.7 miles of northeast then eastward drift that terminated at the tidal channel in Elger Bay. The cell consisted of medium to

high elevation, poor to moderately vegetated, sand, gravel, and till bluff, no bank low elevation, and modified shores.

Feeder bluff exceptional (29%) segments were mapped near the cell origin, separated by a concrete seawall filled out over the intertidal that was mapped as modified (15%). Short feeder bluff (8%) and transport zone (6%) segments were mapped near the middle of the cell. The area near and at the cell terminus was mapped as an accretion shoreform (42%). Toe erosion (29%) was mapped along feeder bluff exceptional and feeder bluff segments within the first half of the cell.

CAM-3

Cell CAM-3 began at a divergence zone at Lowell Point and had northwestward, then northward, then eastward drift that terminated at Utsalady. The cell consisted of high elevation, well to poorly vegetated bluff of varying composition, medium elevation, well to moderately vegetated bluff, no bank low elevation, and modified shores. This 13.4 mile long cell was the longest on Camano Island, and third longest in the county.

Feeder bluff exceptional (3%) segments were mapped within the first half of the cell, mostly around Lowell Point (cell origin) and at the northern end of Camano Island State Park. Feeder bluff (33%) and transport zone (12%) segments were mapped throughout the cell. Accretion shoreform (34%) segments were mapped throughout the cell. They were mapped along the southern part of Camano Island State Park, Saratoga Shores, Cama Beach, Indian Beach, Potomac Point, Rockaway Beach, Madrona Beach, Maple Grove Beach, and near the cell terminus at Utsalady Point. Accretion shoreform segments were either associated with a change in shoreline orientation or where a spit had prograded across an embayment. Modified (18%) segments were mapped throughout the cell and were mostly wood pile walls filled out over the upper beach. Concrete bulkheads and riprap also occurred in this drift cell.

Feeder Bluff Segment Ranking Protocol

The feeder bluff ranking protocol was developed to produce a numeric ranking for specific feeder bluff segments that would indicate the relative "value" of the segment in terms of sediment input into the coastal system. After reviewing drift cells throughout the study area for a relatively short cells that contained feeder bluffs and accretion shoreform(s), and that were relatively separate from the surrounding drift cells and other complicating features, two drift cells selected. The drift cells represent the overall range of conditions present around both Whidbey and Camano islands in terms of bluff height, geology, and wave exposure. The first cell selected was the short drift cell extending from Maylors Point to Maylors Marsh in Oak Harbor (WHID-15, Map 1 & 3). This cell was 1.5 miles long with northwestward net shore-drift. The cell started at a medium bank shore and extended to the large accretion shoreform that forms Maylors Marsh.

The second drift cell selected for employing the ranking protocol was cell IS-2 located on southeast Whidbey Island. This cell originated at the high bank shore of Possession Head and had generally northward net shore-drift for just over a mile to the large spit (accretion shoreform) at Sandy Hook in Cultus Bay. This cell had feeder bluff and feeder bluff exceptional segments with bluff heights ranging up to 340 ft. This area has been known for moderately high frequency of landsliding as well as deep-seated slide complexes (WA Dept. of Ecology 1979; although this area was mapped differently in the more recent geologic mapping compilation (DNR 2001).

Following the completion of several initial segment rankings for cell WHID-15 and IS-2 with available data, an expanded protocol was created that could utilize additional data not already in the project GIS. The use of additional data was thought to refine the accuracy of the ranking protocol. The use of the additional parameters (surficial geology, historic landslides) made the ranking more robust, and made it more defensible as well. An advantage of additional parameters was that they allowed for the increase in the length of time of "sampling" by including historic landslide data. This would avoid depending solely on present conditions and decrease the chances of recent events overly biasing the data as compared to long-term trends that may vary in some places. An example of this was the use of historic landslides from the Coastal Zone Atlas (WA Dept. of Ecology 1979) and from DNR mapping (DNR 2001). Landscape context data (such as fetch and location within a drift cell) did not rely on recent field mapping and therefore helped offset the relative importance of the most recent data.

The results for net shore-drift cell WHID-15, with all parameters included (Table 3) are presented in Figure 9. The drift cell contained 3 feeder bluff segments and 1 feeder bluff exceptional segment that together covered almost one-half of the total drift cell length. Several short reaches of modified shore were present between the feeder bluff segments near the cell origin. The US Army Corps constructed a series of bulkheads out of different materials as a demonstration project in the 1970s in this area. Only a few of the bulkhead reaches remained at the time of the fieldwork for this project.

The four segments in cell WHID-15 scored similarly for several parameters, as the fetch, bluff height, and surficial geology were all almost the same. Sediment C scored for being a feeder bluff exceptional, while the distance from the divergence zone scoring was reduced for segment D (Figure 9). Recent landslides were mapped during the Current Conditions mapping only at segment C and D, along less than 50% of the segment lengths. No recent slides were mapped in the other 2 segments. Recent toe erosion was mapped in segments A, C and D, with greater than 50% in segment C and D (and higher points). No historic landslides were mapped in these segments. When scores were totaled, segments C and D had the highest ranking in the drift cell, with scores of 26 and 20, respectively. This was mostly due to the presence of recent slides and toe erosion, along with feeder bluff exceptional mapping for segment C. The total range of the 4 segment scores was 14-26. Overall, the results from this final form of the ranking protocol seemed appropriate for this medium bank, moderate wave energy shore.

The feeder bluff segment location and ranking results for cell IS-2 are presented in Figure 10. The bluffs in the Possession Head area differ dramatically from the bluffs at Maylors Point. Segment A was a feeder bluff exceptional segment and segments B-E were mapped as feeder bluff, and were separated by bulkheads. Only segment A received moderate points for low distance from the drift cell divergence zone, as the other segments were much more distant. The fetch was high for all segments with exposure down the length of the Main Basin of Puget Sound. The bluff height was among the highest in the entire county at segment A and high points were added for this (up to 12), while the other segments had bluffs of decreasing height and points. Likewise, recent landslides and toe erosion generally decreased along the drift cell. Segment A was the only segment with mapped historic slides, with greater than 50% of the segment mapped with landslides.

The feeder bluff segment scores in cell IS-2 ranged from 9 to 44. This high range seems appropriate given the large scale progression from very high, rapidly eroding feeder bluff exceptional to low bank, moderate exposure shores without recent or historic landslides in the central portion of the drift cell. When compared to results from drift cell WHID-15, the lowest scored segments in cell IS-2 ranked the lowest, which seemed appropriate.

This ranking protocol was developed using available data. It would be more powerful and substantially more accurate if additional information were added. In particular, details on bluff geology and erosion rates would be very useful. Bluff geology would be best quantified by using stratigraphic columns, also know as geologic sections, which show the vertical distribution of different geologic units. The different units have very different grain size distribution, which results in very different sediment supply characteristics for the beach system (and habitats). Geologic sections exist for isolated sites around the county, as shown in mapping by the USGS (Pessl and others 1989) and the Coastal Zone Atlas (WA Dept. of Ecology 1979). The creation of additional sections covering bluff areas around the county would allow for the use of data from the full height of the bluff, instead of relying on surficial geology data only. If the old and new section data were combined with new grain size data for different geologic units, this would allow for quantification of sediment input in specific grain size classes. Similar work has been done in recent years in England (Balson et al. 1996, Balson et al. 1998), which can serve as a model for this type of work.

Additionally, incorporation of landslide mapping from an earlier period would make the landslide data more robust. The best data source for this would be the 1957-58 air photos in the Island County Engineering vault. This would diminish the reliance on recent data and make the updated ranking more accurate.

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Table 1. Feeder Bluff Field Mapping Criteria

Feeder Bluff Exceptional Mapping	
Presence of (priority in order): 1. Bluff/ bank 2. Recent landslide scarps 3. Bluff toe erosion 4. Abundant sand/gravel in bluff 5. Colluvium/ slide debris 6. Primarily unvegetated or vegetated slumps 7. Trees across beach 8. Boulder/ cobble lag 9. Steep bluff (relative alongshore)	***Absence of:*** 1. Shoreline bulkhead/ fill 2. Backshore 3. Old/ rotten logs 4. Coniferous bluff vegetation 5. Bulkhead
Feeder Bluff Mapping	
Presence of (priority in order): 1. Bluff/ bank 2. Past landslide scarps 3. Intermittent toe erosion 4. Moderate amount sand/gravel in bluff 5. Intermittent Colluvium 6. Minimal vegetation 7. Trees across beach 8. Boulder/ cobble lag 9. Steep bluff (relative alongshore)	***Absence of:*** 1. Shoreline bulkhead/ fill 2. Backshore 3. Old/ rotten logs 4. Coniferous bluff vegetation
Transport Zone Mapping	
Presence of (priority in order): 1. Coniferous bluff vegetation 2. Apparent relative bluff stability 3. Gentle slope bluff (relative alongshore) 4. Unbulkheaded transport zone adjacent	***Absence of:*** 1. Visible landslide scarps 2. Toe erosion 3. Backshore & backshore vegetation 4. Old/ rotten logs 5. Colluvium 6. Trees across beach 7. Bulkhead
Modified Mapping	
Presence of (priority in order): 1. Bluff/ bank 2. Shoreline bulkhead (mostly intact) 3. Substantial shoreline fill	***Absence of (Accretion Shoreform):*** 1. Backshore & backshore vegetation 2. Lagoon/ wetland/ marsh behind berm 3. Backshore “platform” 4. Old/ rotten logs 5. Fine, well-sorted sediment (relative alongshore) 6. Bulkhead
Accretion Shoreform Mapping	
Presence of (priority in order): 1. Backshore & backshore vegetation 2. Lagoon/ wetland/ marsh behind berm 3. Backshore “platform” 4. Old/ rotten logs 5. Fine, well-sorted sediment (relative alongshore)	***Absence of:*** 1. Bank/ bluff in backshore 2. Toe erosion at bank 3. Landslide scarps 4. Boulders on beachface 5. Bulkhead
No Appreciable Drift Mapping	
Presence of (priority in order): 1. NAD mapping (WWU-Ecology) 2. Embayment/ lagoon shore 3. Low wave energy	***Absence of:*** 1. Active beachface 2. Accretion Shoreform indicators

Table 2. Changes to WA Dept. of Ecology NSD digital data

NSD cell (DCELL_NR)	Change made by CGS
CAM-1/CAM-13	CGS change from UN to NAD
CAM-1/CAM-13	This drift cell was extended at the south end to connect to CAM-12. This cell should be called CAM-1/CAM-12
CAM-10/CAM-11	This UN was divided in half and the west half was merged with CAM-10 and the east half was merged with CAM-11 so as those two drift cells converge in the middle
CAM-2/CAM-3	This UN was divided in half and the north half was merged with CAM-2 and the south half was merged with CAM-3 so as those two drift cells converge in the middle
CAM-4/CAM-5	CGS change from UN to NAD and split at the creek channel entrance in Elger Bay and the west half was merged with CAM-4 and the east half was merged with CAM-5 so as those two drift cells converge at the channel entrance, with the creek channel waterward of the spit being NAD
CAM-6/CAM-7	This UN was deleted and replaced with CAM-6 from the north and CAM-7 from the south both of which now extend to meet at the tip of Pebble Beach
CAM-8/CAM-9	CGS change from UN to NAD with the northeast end being truncated to the NAD - AS boundary.
IS-1/WHID-1	This UN was deleted and merged with the RtoL WHID-1 drift cell so that it and IS-1 meet at the tip of Sandy Point
IS-2/IS-3	This drift cell was extended at both ends to meet IS-2 at the south east end and meeting up to IS-3 at the west end.
IS-4/IS-5	CGS change from UN to NAD
SM-1	This cell was extened to the NE tip of "Minor Island" following the mapping convention of Keuler who showed sediment transport from Smith Island to Minor Island
SM-2	This cell was extened to the NE tip of "Minor Island" following the mapping convention of Keuler who showed sediment transport from Smith Island to Minor Island
WHID-10	This LtoR cell was truncated at both ends. The terminus was truncated to the middle of the AS (2004 CGS mapping) in the SW corner of Penn Cove. The origin was trucated to the middle of the divergence zone (which was created by CGS from interpretting Keuler's mapping).
WHID-11	This RtoL cell had its origin truncated to the approximate middle of the Mueller Park headland, and its end point extended to the middle of the AS (2004 CGS mapping) in the southwest corner of Penn Cove.
WHID-11/WHID-12	This DZ cell ws created at the Mueller Park headland at the western extent of Penn Cove from interpretting Keuler's mapping (1988).
WHID-12	This LtoR cell was extended at the origin to the approximate middle of the Mueller Park headland.
WHID-12/WHID-13	This drift cell was truncated at the mouth of the lagoon. The west end was merged with WHID-12 and the east end was merged with WHID-13.
WHID-15	The northern end of this cell was terminated just around the corner at the NW point of Maylors Marsh. The extra length around the corner of this cell was merged with NAD cell WHID-14/WHID-15.
WHID-18	This drift cell was extended to the north to meet drift cell WHID-19.
WHID-19	This drift cell was extended to the west southwest to meet drift cell WHID-18.
WHID-2/WHID-3	This UN was deleted and replaced with WHID-3 from the west and WHID-2 from the east, both of which now extend to meet at the tip of East Point
WHID-20/WHID-21	This UN was deleted and merged with the LtoR WHID-20 drift cell
WHID-24/WHID-25	CGS change from UN to NAD
WHID-26/WHID-27	This UN was divided in half and the west half was merged with WHID-26 and the east half was merged with WHID-27 so as those two drift cells converge in the middle
WHID-28/IS-6	This UN was deleted and replaced with WHID-28 from the north and IS-6 from the south both of which now extend to meet at the tip of Bush Point
WHID-3a	This RtoL cell was created by CGS for "Baby Island" or "Hackney Island" (USGS quadrangle)

NSD cell (DCELL_NR)	Change made by CGS
WHID-3a/WHID-3b	This DZ cell was created by CGS for "Baby Island" or "Hackney Island" (USGS quadrangle)
WHID-3b	This LtoR cell was created by CGS for "Baby Island" or "Hackney Island" (USGS quadrangle)
WHID-4	This LtoR cell was extended to the middle of the accretion shoreform (2004 CGS mapping) tha twas in southeast Holmes Harbor.
WHID-4/WHID-5	This UN was divided in half and the west half was merged with WHID-5 and the east half was merged with WHID-4 so as those two drift cells converge in the middle
WHID-5	This RtoL cell was truncated to the middle of the accretion shoreform (2004 CGS mapping) that was in southeast Holmes Harbor.
WHID-6	This LtoR cell was truncated to the middle of the accretion shoreform (2004 CGS mapping) that was in southwest Holmes Harbor.
WHID-6/WHID-7	This UN was divided in half and the north half was merged with WHID-7 and the south half was merged with WHID-6 so as those two drift cells converge in the middle
WHID-7	This RtoL cell was extended to the middle of the accretion shoreform (2004 CGS mapping) that was in southwest Holmes Harbor.
WHID-8	The North end of this drift cell was terminated at Snakelum Pt, creating 2 new NSD cells W of Snakelum Pt.
WHID-8/WHID-9	This UN was deleted and replaced with WHID-9 from the west and WHID-8a from the east, both of which now extend to meet at the tip of Long Point
WHID-8a	CGS creation due to the termination of WHID-8 at Snakelum Pt and the belief that drift is to the West for this area
WHID-8b	CGS creation due to the termination of WHID-8 at Snakelum Pt and the belief that drift is to the East for this area.
WHID-9	This RtoL cell was extended at the origin to the middle of the DZ (which was created by CGS from interpretting Keuler's mapping) approx.1 mile west of Coupeville.
WHID-9/WHID-10	This DZ cell ws created approx 1 mile west of Coupeville from interpretting Keuler's mapping (1988).

Table 3. Feeder bluff segment prioritization scheme.

Points	Variable	Data Source
0-5	Feeder bluff exceptional (5)	CGS current conditions mapping
1-2-3	Distance from drift cell divergence zone edge (1=1,000 - 2,000 ft, 2 = 500 - 1,000 ft, 3=<500 ft)	DOE with CGS edits, WA net shore-drift
1-2-4-6	Relative fetch: longest fetch distance measured in GIS (1=2-5 mi., 2=5-10, 4=10-20-, 6=20+)	USGS 7.5" topo maps, DNR shoreline
1-4-6-8-12	Typical bluff height. 1st contour must be within 100 ft of DNR shoreline 1=10-30, 4=30-70, 6=70-120, 8=120-200, 12=200+ ft.	USGS 7.5" topo maps
1-2-3-5	Surficial Geology: dominant unit in segment. Unit scores reflect relative quantity of beach-forming material [coarse sand & gravel] (1=Qgdm(e), 2= Qvt 3=Qls, 5=Qva/Esp. sand)	DNR geology
4-7	Recent landslides mapped by CGS within segment (4=<50% of length, 7=>50% length)	CGS current conditions mapping.
3-6	Older slides (Qls or Uos) within segment (3=<50% of length, 6=>50% length)	Qls=DNR surface geology; Uos=DOE, CZ Atlas
2-3	Recent toe erosion mapped by CGS within segment (2=<50% of length, 3=>50% length)	CGS current conditions mapping

Table 4. CGS Mapping Statistics by drift cell

Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

	Number of Units	Min Length (ft)	Max Length (ft)	Mean Length (ft)	Percent of study area
Feeder Bluff Exceptional	59	80	7,287	1,428	8%
Feeder Bluff	319	49	9,602	796	30%
Transport Zone	190	41	7,779	703	13%
Accretion Shoreform	137	28	23,280	2,812	37%
Modified	235	27	7,416	510	12%
No Appreciable Drift	1				1%
Total	941				100%
The only NAD used in the calculations were from IS-2/IS-3.					

Table 5. CGS Mapping Statistics by drift cell, sorted by Drift Cell

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
CAM -1	8323	0%	29%	17%	52%	1%	0%	0%	0%
CAM-1/CAM -13	18572	0%	0%	0%	100%	0%	0%	0%	0%
CAM -2	5641	0%	36%	4%	34%	26%	0%	13%	9%
CAM -3	70921	3%	33%	12%	34%	18%	0%	3%	22%
CAM -4	3863	29%	8%	6%	43%	15%	0%	0%	29%
CAM -5	29162	13%	29%	3%	17%	38%	0%	3%	20%
CAM -6	6671	0%	61%	0%	39%	0%	0%	7%	56%
CAM -7	7003	0%	50%	0%	8%	41%	0%	9%	40%
CAM -8	65914	5%	22%	23%	32%	17%	0%	5%	19%
CAM -9	2810	60%	20%	15%	5%	0%	0%	15%	56%
CAM -10	22343	0%	8%	3%	87%	3%	0%	1%	1%
CAM -11	7680	11%	15%	12%	62%	0%	0%	7%	7%
CAM -12	5568	4%	35%	0%	61%	0%	0%	4%	10%
IS-1	7680	2%	47%	1%	39%	10%	0%	17%	23%
IS-2	5568	32%	11%	0%	42%	15%	0%	16%	24%
IS-2/IS-3	11737	0%	0%	0%	31%	11%	58%	0%	0%
IS-3	10016	0%	4%	10%	49%	36%	0%	0%	0%
IS-4	44374	18%	28%	4%	48%	2%	0%	18%	23%
IS-5	12959	26%	0%	0%	74%	0%	0%	15%	18%
IS-6	37918	23%	22%	6%	48%	1%	0%	13%	25%
SM-1	7553	17%	0%	10%	73%	0%	0%	0%	0%
SM-2	8403	26%	8%	0%	66%	0%	0%	0%	0%
WHID-1	20486	0%	52%	7%	21%	20%	0%	14%	26%
WHID-2	19630	0%	61%	2%	24%	14%	0%	15%	28%
WHID-3	30586	2%	46%	9%	11%	31%	0%	13%	30%
WHID-3a	731	6%	20%	0%	76%	0%	0%	0%	0%
WHID-3b	769	6%	16%	0%	78%	0%	0%	0%	0%
WHID-4	12207	0%	51%	26%	6%	17%	0%	17%	69%
WHID-5	1082	0%	25%	8%	67%	0%	0%	7%	25%
WHID-6	2317	0%	61%	0%	39%	0%	0%	7%	56%
WHID-7	10217	0%	50%	0%	8%	41%	0%	9%	40%
WHID-8	77985	2%	41%	19%	28%	11%	0%	5%	23%
WHID-8a	3137	0%	34%	16%	50%	0%	0%	0%	14%
WHID-8b	3735	0%	30%	1%	37%	32%	0%	8%	11%
WHID-9	14405	0%	36%	18%	27%	19%	0%	6%	29%
WHID-10	5931	0%	12%	69%	12%	6%	0%	3%	24%
WHID-11	3391	0%	25%	12%	27%	36%	0%	1%	18%
WHID-12	5942	0%	18%	25%	21%	37%	0%	3%	14%
WHID-13	21715	5%	52%	14%	22%	8%	0%	18%	38%
WHID-14	17643	0%	47%	5%	35%	12%	0%	13%	23%
WHID-15/WHID-14	9220	0%	0%	0%	25%	75%	0%	0%	0%
WHID-15	7843	5%	30%	0%	59%	6%	0%	6%	19%
WHID-16	11067	8%	43%	4%	3%	42%	0%	5%	29%
WHID-17	24575	6%	42%	5%	42%	5%	0%	7%	19%
WHID-18	3889	38%	30%	0%	31%	0%	0%	4%	25%
WHID-19	6157	46%	35%	0%	16%	3%	0%	5%	37%
WHID-20	43036	9%	16%	40%	33%	2%	0%	1%	9%
WHID-21	6963	0%	25%	49%	10%	16%	0%	1%	11%
WHID-22	10187	0%	28%	43%	26%	3%	0%	4%	12%
WHID-23	7798	0%	31%	41%	28%	0%	0%	2%	13%
WHID-24	13623	0%	17%	50%	26%	7%	0%	2%	13%
WHID-24/WHID-25	7875	0%	5%	73%	22%	0%	0%	2%	5%
WHID-25	76904	19%	21%	8%	49%	2%	0%	18%	24%
WHID-26	47237	18%	25%	17%	38%	3%	0%	34%	50%
WHID-27	23556	12%	32%	7%	36%	13%	0%	16%	23%
WHID-28	35317	5%	50%	7%	37%	0%	0%	37%	54%

Table 6. CGS Mapping Statistics by drift cell, sorted by Cell Length.

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
WHID-8	**77985**	2%	41%	19%	28%	11%	0%	5%	23%
WHID-25	**76904**	19%	21%	8%	49%	2%	0%	18%	24%
CAM -3	**70921**	3%	33%	12%	34%	18%	0%	3%	22%
CAM -8	**65914**	5%	22%	23%	32%	17%	0%	5%	19%
WHID-26	**47237**	18%	25%	17%	38%	3%	0%	34%	50%
IS-4	**44374**	18%	28%	4%	48%	2%	0%	18%	23%
WHID-20	**43036**	9%	16%	40%	33%	2%	0%	1%	9%
IS-6	**37918**	23%	22%	6%	48%	1%	0%	13%	25%
WHID-28	**35317**	5%	50%	7%	37%	0%	0%	37%	54%
WHID-3	**30586**	2%	46%	9%	11%	31%	0%	13%	30%
CAM -5	**29162**	13%	29%	3%	17%	38%	0%	3%	20%
WHID-17	**24575**	6%	42%	5%	42%	5%	0%	7%	19%
WHID-27	**23556**	12%	32%	7%	36%	13%	0%	16%	23%
CAM -10	**22343**	0%	8%	3%	87%	3%	0%	1%	1%
WHID-13	**21715**	5%	52%	14%	22%	8%	0%	18%	38%
WHID-1	**20486**	0%	52%	7%	21%	20%	0%	14%	26%
WHID-2	**19630**	0%	61%	2%	24%	14%	0%	15%	28%
CAM-1/CAM -13	**18572**	0%	0%	0%	100%	0%	0%	0%	0%
WHID-14	**17643**	0%	47%	5%	35%	12%	0%	13%	23%
WHID-9	**14405**	0%	36%	18%	27%	19%	0%	6%	29%
WHID-24	**13623**	0%	17%	50%	26%	7%	0%	2%	13%
IS-5	**12959**	26%	0%	0%	74%	0%	0%	15%	18%
WHID-4	**12207**	0%	51%	26%	6%	17%	0%	17%	69%
IS-2/IS-3	**11737**	0%	0%	0%	31%	11%	58%	0%	0%
WHID-16	**11067**	8%	43%	4%	3%	42%	0%	5%	29%
WHID-7	**10217**	0%	50%	0%	8%	41%	0%	9%	40%
WHID-22	**10187**	0%	28%	43%	26%	3%	0%	4%	12%
IS-3	**10016**	0%	4%	10%	49%	36%	0%	0%	0%
WHID-15/WHID-14	**9220**	0%	0%	0%	25%	75%	0%	0%	0%
SM-2	**8403**	26%	8%	0%	66%	0%	0%	0%	0%
CAM -1	**8323**	0%	29%	17%	52%	1%	0%	0%	0%
WHID-24/WHID-25	**7875**	0%	5%	73%	22%	0%	0%	2%	5%
WHID-15	**7843**	5%	30%	0%	59%	6%	0%	6%	19%
WHID-23	**7798**	0%	31%	41%	28%	0%	0%	2%	13%
CAM -11	**7680**	11%	15%	12%	62%	0%	0%	7%	7%
IS-1	**7680**	2%	47%	1%	39%	10%	0%	17%	23%
SM-1	**7553**	17%	0%	10%	73%	0%	0%	0%	0%
CAM -7	**7003**	0%	50%	0%	8%	41%	0%	9%	40%
WHID-21	**6963**	0%	25%	49%	10%	16%	0%	1%	11%
CAM -6	**6671**	0%	61%	0%	39%	0%	0%	7%	56%
WHID-19	**6157**	46%	35%	0%	16%	3%	0%	5%	37%
WHID-12	**5942**	0%	18%	25%	21%	37%	0%	3%	14%
WHID-10	**5931**	0%	12%	69%	12%	6%	0%	3%	24%
CAM -2	**5641**	0%	36%	4%	34%	26%	0%	13%	9%
CAM -12	**5568**	4%	35%	0%	61%	0%	0%	4%	10%
IS-2	**5568**	32%	11%	0%	42%	15%	0%	16%	24%
WHID-18	**3889**	38%	30%	0%	31%	0%	0%	4%	25%
CAM -4	**3863**	29%	8%	6%	43%	15%	0%	0%	29%
WHID-8b	**3735**	0%	30%	1%	37%	32%	0%	8%	11%
WHID-11	**3391**	0%	25%	12%	27%	36%	0%	1%	18%
WHID-8a	**3137**	0%	34%	16%	50%	0%	0%	0%	14%
CAM -9	**2810**	60%	20%	15%	5%	0%	0%	15%	56%
WHID-6	**2317**	0%	61%	0%	39%	0%	0%	7%	56%
WHID-5	**1082**	0%	25%	8%	67%	0%	0%	7%	25%
WHID-3b	**769**	6%	16%	0%	78%	0%	0%	0%	0%
WHID-3a	**731**	6%	20%	0%	76%	0%	0%	0%	0%

Table 7. CGS Mapping Statistics by drift cell, sorted by FEEDER BLUFF EXCEPTIONAL (feeder bluff exceptional).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
CAM -9	2810	**60%**	20%	15%	5%	0%	0%	15%	56%
WHID-19	6157	**46%**	35%	0%	16%	3%	0%	5%	37%
WHID-18	3889	**38%**	30%	0%	31%	0%	0%	4%	25%
IS-2	5568	**32%**	11%	0%	42%	15%	0%	16%	24%
CAM -4	3863	**29%**	8%	6%	43%	15%	0%	0%	29%
IS-5	12959	**26%**	0%	0%	74%	0%	0%	15%	18%
SM-2	8403	**26%**	8%	0%	66%	0%	0%	0%	0%
IS-6	37918	**23%**	22%	6%	48%	1%	0%	13%	25%
WHID-25	76904	**19%**	21%	8%	49%	2%	0%	18%	24%
IS-4	44374	**18%**	28%	4%	48%	2%	0%	18%	23%
WHID-26	47237	**18%**	25%	17%	38%	3%	0%	34%	50%
SM-1	7553	**17%**	0%	10%	73%	0%	0%	0%	0%
CAM -5	29162	**13%**	29%	3%	17%	38%	0%	3%	20%
WHID-27	23556	**12%**	32%	7%	36%	13%	0%	16%	23%
CAM -11	7680	**11%**	15%	12%	62%	0%	0%	7%	7%
WHID-20	43036	**9%**	16%	40%	33%	2%	0%	1%	9%
WHID-16	11067	**8%**	43%	4%	3%	42%	0%	5%	29%
WHID-3a	731	**6%**	20%	0%	76%	0%	0%	0%	0%
WHID-3b	769	**6%**	16%	0%	78%	0%	0%	0%	0%
WHID-17	24575	**6%**	42%	5%	42%	5%	0%	7%	19%
WHID-28	35317	**5%**	50%	7%	37%	0%	0%	37%	54%
CAM -8	65914	**5%**	22%	23%	32%	17%	0%	5%	19%
WHID-15	7843	**5%**	30%	0%	59%	6%	0%	6%	19%
WHID-13	21715	**5%**	52%	14%	22%	8%	0%	18%	38%
CAM -12	5568	**4%**	35%	0%	61%	0%	0%	4%	10%
CAM -3	70921	**3%**	33%	12%	34%	18%	0%	3%	22%
IS-1	7680	**2%**	47%	1%	39%	10%	0%	17%	23%
WHID-8	77985	**2%**	41%	19%	28%	11%	0%	5%	23%
WHID-3	30586	**2%**	46%	9%	11%	31%	0%	13%	30%
CAM -1	8323	**0%**	29%	17%	52%	1%	0%	0%	0%
CAM-1/CAM -13	18572	**0%**	0%	0%	100%	0%	0%	0%	0%
CAM -2	5641	**0%**	36%	4%	34%	26%	0%	13%	9%
CAM -6	6671	**0%**	61%	0%	39%	0%	0%	7%	56%
CAM -7	7003	**0%**	50%	0%	8%	41%	0%	9%	40%
CAM -10	22343	**0%**	8%	3%	87%	3%	0%	1%	1%
IS-2/IS-3	11737	**0%**	0%	0%	31%	11%	58%	0%	0%
IS-3	10016	**0%**	4%	10%	49%	36%	0%	0%	0%
WHID-1	20486	**0%**	52%	7%	21%	20%	0%	14%	26%
WHID-2	19630	**0%**	61%	2%	24%	14%	0%	15%	28%
WHID-4	12207	**0%**	51%	26%	6%	17%	0%	17%	69%
WHID-5	1082	**0%**	25%	8%	67%	0%	0%	7%	25%
WHID-6	2317	**0%**	61%	0%	39%	0%	0%	7%	56%
WHID-7	10217	**0%**	50%	0%	8%	41%	0%	9%	40%
WHID-8a	3137	**0%**	34%	16%	50%	0%	0%	0%	14%
WHID-8b	3735	**0%**	30%	1%	37%	32%	0%	8%	11%
WHID-9	14405	**0%**	36%	18%	27%	19%	0%	6%	29%
WHID-10	5931	**0%**	12%	69%	12%	6%	0%	3%	24%
WHID-11	3391	**0%**	25%	12%	27%	36%	0%	1%	18%
WHID-12	5942	**0%**	18%	25%	21%	37%	0%	3%	14%
WHID-14	17643	**0%**	47%	5%	35%	12%	0%	13%	23%
WHID-15/WHID-14	9220	**0%**	0%	0%	25%	75%	0%	0%	0%
WHID-21	6963	**0%**	25%	49%	10%	16%	0%	1%	11%
WHID-22	10187	**0%**	28%	43%	26%	3%	0%	4%	12%
WHID-23	7798	**0%**	31%	41%	28%	0%	0%	2%	13%
WHID-24	13623	**0%**	17%	50%	26%	7%	0%	2%	13%
WHID-24/WHID-25	7875	**0%**	5%	73%	22%	0%	0%	2%	5%

Table 8. CGS Mapping Statistics by drift cell, sorted by FEEDER BLUFF (feeder bluff).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
CAM -6	6671	0%	**61%**	0%	39%	0%	0%	7%	56%
WHID-6	2317	0%	**61%**	0%	39%	0%	0%	7%	56%
WHID-2	19630	0%	**61%**	2%	24%	14%	0%	15%	28%
WHID-1	20486	0%	**52%**	7%	21%	20%	0%	14%	26%
WHID-13	21715	5%	**52%**	14%	22%	8%	0%	18%	38%
WHID-4	12207	0%	**51%**	26%	6%	17%	0%	17%	69%
CAM -7	7003	0%	**50%**	0%	8%	41%	0%	9%	40%
WHID-7	10217	0%	**50%**	0%	8%	41%	0%	9%	40%
WHID-28	35317	5%	**50%**	7%	37%	0%	0%	37%	54%
WHID-14	17643	0%	**47%**	5%	35%	12%	0%	13%	23%
IS-1	7680	2%	**47%**	1%	39%	10%	0%	17%	23%
WHID-3	30586	2%	**46%**	9%	11%	31%	0%	13%	30%
WHID-16	11067	8%	**43%**	4%	3%	42%	0%	5%	29%
WHID-17	24575	6%	**42%**	5%	42%	5%	0%	7%	19%
WHID-8	77985	2%	**41%**	19%	28%	11%	0%	5%	23%
CAM -2	5641	0%	**36%**	4%	34%	26%	0%	13%	9%
WHID-9	14405	0%	**36%**	18%	27%	19%	0%	6%	29%
CAM -12	5568	4%	**35%**	0%	61%	0%	0%	4%	10%
WHID-19	6157	46%	**35%**	0%	16%	3%	0%	5%	37%
WHID-8a	3137	0%	**34%**	16%	50%	0%	0%	0%	14%
CAM -3	70921	3%	**33%**	12%	34%	18%	0%	3%	22%
WHID-27	23556	12%	**32%**	7%	36%	13%	0%	16%	23%
WHID-23	7798	0%	**31%**	41%	28%	0%	0%	2%	13%
WHID-18	3889	38%	**30%**	0%	31%	0%	0%	4%	25%
WHID-15	7843	5%	**30%**	0%	59%	6%	0%	6%	19%
WHID-8b	3735	0%	**30%**	1%	37%	32%	0%	8%	11%
CAM -1	8323	0%	**29%**	17%	52%	1%	0%	0%	0%
CAM -5	29162	13%	**29%**	3%	17%	38%	0%	3%	20%
IS-4	44374	18%	**28%**	4%	48%	2%	0%	18%	23%
WHID-22	10187	0%	**28%**	43%	26%	3%	0%	4%	12%
WHID-11	3391	0%	**25%**	12%	27%	36%	0%	1%	18%
WHID-26	47237	18%	**25%**	17%	38%	3%	0%	34%	50%
WHID-21	6963	0%	**25%**	49%	10%	16%	0%	1%	11%
WHID-5	1082	0%	**25%**	8%	67%	0%	0%	7%	25%
IS-6	37918	23%	**22%**	6%	48%	1%	0%	13%	25%
CAM -8	65914	5%	**22%**	23%	32%	17%	0%	5%	19%
WHID-25	76904	19%	**21%**	8%	49%	2%	0%	18%	24%
CAM -9	2810	60%	**20%**	15%	5%	0%	0%	15%	56%
WHID-3a	731	6%	**20%**	0%	76%	0%	0%	0%	0%
WHID-12	5942	0%	**18%**	25%	21%	37%	0%	3%	14%
WHID-24	13623	0%	**17%**	50%	26%	7%	0%	2%	13%
WHID-20	43036	9%	**16%**	40%	33%	2%	0%	1%	9%
WHID-3b	769	6%	**16%**	0%	78%	0%	0%	0%	0%
CAM -11	7680	11%	**15%**	12%	62%	0%	0%	7%	7%
WHID-10	5931	0%	**12%**	69%	12%	6%	0%	3%	24%
IS-2	5568	32%	**11%**	0%	42%	15%	0%	16%	24%
CAM -10	22343	0%	**8%**	3%	87%	3%	0%	1%	1%
SM-2	8403	26%	**8%**	0%	66%	0%	0%	0%	0%
CAM -4	3863	29%	**8%**	6%	43%	15%	0%	0%	29%
WHID-24/WHID-25	7875	0%	**5%**	73%	22%	0%	0%	2%	5%
IS-3	10016	0%	**4%**	10%	49%	36%	0%	0%	0%
CAM-1/CAM -13	18572	0%	**0%**	0%	100%	0%	0%	0%	0%
IS-2/IS-3	11737	0%	**0%**	0%	31%	11%	58%	0%	0%
IS-5	12959	26%	**0%**	0%	74%	0%	0%	15%	18%
SM-1	7553	17%	**0%**	10%	73%	0%	0%	0%	0%
WHID-15/WHID-14	9220	0%	**0%**	0%	25%	75%	0%	0%	0%

Table 9. CGS Mapping Statistics by drift cell, sorted by TRANSPORT ZONE (transport zone).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
WHID-24/WHID-25	7875	0%	5%	**73%**	22%	0%	0%	2%	5%
WHID-10	5931	0%	12%	**69%**	12%	6%	0%	3%	24%
WHID-24	13623	0%	17%	**50%**	26%	7%	0%	2%	13%
WHID-21	6963	0%	25%	**49%**	10%	16%	0%	1%	11%
WHID-22	10187	0%	28%	**43%**	26%	3%	0%	4%	12%
WHID-23	7798	0%	31%	**41%**	28%	0%	0%	2%	13%
WHID-20	43036	9%	16%	**40%**	33%	2%	0%	1%	9%
WHID-4	12207	0%	51%	**26%**	6%	17%	0%	17%	69%
WHID-12	5942	0%	18%	**25%**	21%	37%	0%	3%	14%
CAM -8	65914	5%	22%	**23%**	32%	17%	0%	5%	19%
WHID-8	77985	2%	41%	**19%**	28%	11%	0%	5%	23%
WHID-9	14405	0%	36%	**18%**	27%	19%	0%	6%	29%
CAM -1	8323	0%	29%	**17%**	52%	1%	0%	0%	0%
WHID-26	47237	18%	25%	**17%**	38%	3%	0%	34%	50%
WHID-8a	3137	0%	34%	**16%**	50%	0%	0%	0%	14%
CAM -9	2810	60%	20%	**15%**	5%	0%	0%	15%	56%
WHID-13	21715	5%	52%	**14%**	22%	8%	0%	18%	38%
CAM -3	70921	3%	33%	**12%**	34%	18%	0%	3%	22%
WHID-11	3391	0%	25%	**12%**	27%	36%	0%	1%	18%
CAM -11	7680	11%	15%	**12%**	62%	0%	0%	7%	7%
IS-3	10016	0%	4%	**10%**	49%	36%	0%	0%	0%
SM-1	7553	17%	0%	**10%**	73%	0%	0%	0%	0%
WHID-3	30586	2%	46%	**9%**	11%	31%	0%	13%	30%
WHID-5	1082	0%	25%	**8%**	67%	0%	0%	7%	25%
WHID-25	76904	19%	21%	**8%**	49%	2%	0%	18%	24%
WHID-28	35317	5%	50%	**7%**	37%	0%	0%	37%	54%
WHID-27	23556	12%	32%	**7%**	36%	13%	0%	16%	23%
WHID-1	20486	0%	52%	**7%**	21%	20%	0%	14%	26%
CAM -4	3863	29%	8%	**6%**	43%	15%	0%	0%	29%
IS-6	37918	23%	22%	**6%**	48%	1%	0%	13%	25%
WHID-14	17643	0%	47%	**5%**	35%	12%	0%	13%	23%
WHID-17	24575	6%	42%	**5%**	42%	5%	0%	7%	19%
IS-4	44374	18%	28%	**4%**	48%	2%	0%	18%	23%
CAM -2	5641	0%	36%	**4%**	34%	26%	0%	13%	9%
WHID-16	11067	8%	43%	**4%**	3%	42%	0%	5%	29%
CAM -5	29162	13%	29%	**3%**	17%	38%	0%	3%	20%
CAM -10	22343	0%	8%	**3%**	87%	3%	0%	1%	1%
WHID-2	19630	0%	61%	**2%**	24%	14%	0%	15%	28%
WHID-8b	3735	0%	30%	**1%**	37%	32%	0%	8%	11%
IS-1	7680	2%	47%	**1%**	39%	10%	0%	17%	23%
CAM-1/CAM -13	18572	0%	0%	**0%**	100%	0%	0%	0%	0%
CAM -6	6671	0%	61%	**0%**	39%	0%	0%	7%	56%
CAM -7	7003	0%	50%	**0%**	8%	41%	0%	9%	40%
CAM -12	5568	4%	35%	**0%**	61%	0%	0%	4%	10%
IS-2	5568	32%	11%	**0%**	42%	15%	0%	16%	24%
IS-2/IS-3	11737	0%	0%	**0%**	31%	11%	58%	0%	0%
IS-5	12959	26%	0%	**0%**	74%	0%	0%	15%	18%
SM-2	8403	26%	8%	**0%**	66%	0%	0%	0%	0%
WHID-3a	731	6%	20%	**0%**	76%	0%	0%	0%	0%
WHID-3b	769	6%	16%	**0%**	78%	0%	0%	0%	0%
WHID-6	2317	0%	61%	**0%**	39%	0%	0%	7%	56%
WHID-7	10217	0%	50%	**0%**	8%	41%	0%	9%	40%
WHID-15/WHID-14	9220	0%	0%	**0%**	25%	75%	0%	0%	0%
WHID-15	7843	5%	30%	**0%**	59%	6%	0%	6%	19%
WHID-18	3889	38%	30%	**0%**	31%	0%	0%	4%	25%
WHID-19	6157	46%	35%	**0%**	16%	3%	0%	5%	37%

Table 10. CGS Mapping Statistics by drift cell, sorted by AS (accretion shoreform).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
CAM-1/CAM -13	18572	0%	0%	0%	**100%**	0%	0%	0%	0%
CAM -10	22343	0%	8%	3%	**87%**	3%	0%	1%	1%
WHID-3b	769	6%	16%	0%	**78%**	0%	0%	0%	0%
WHID-3a	731	6%	20%	0%	**76%**	0%	0%	0%	0%
IS-5	12959	26%	0%	0%	**74%**	0%	0%	15%	18%
SM-1	7553	17%	0%	10%	**73%**	0%	0%	0%	0%
WHID-5	1082	0%	25%	8%	**67%**	0%	0%	7%	25%
SM-2	8403	26%	8%	0%	**66%**	0%	0%	0%	0%
CAM -11	7680	11%	15%	12%	**62%**	0%	0%	7%	7%
CAM -12	5568	4%	35%	0%	**61%**	0%	0%	4%	10%
WHID-15	7843	5%	30%	0%	**59%**	6%	0%	6%	19%
CAM -1	8323	0%	29%	17%	**52%**	1%	0%	0%	0%
WHID-8a	3137	0%	34%	16%	**50%**	0%	0%	0%	14%
IS-3	10016	0%	4%	10%	**49%**	36%	0%	0%	0%
WHID-25	76904	19%	21%	8%	**49%**	2%	0%	18%	24%
IS-6	37918	23%	22%	6%	**48%**	1%	0%	13%	25%
IS-4	44374	18%	28%	4%	**48%**	2%	0%	18%	23%
CAM -4	3863	29%	8%	6%	**43%**	15%	0%	0%	29%
IS-2	5568	32%	11%	0%	**42%**	15%	0%	16%	24%
WHID-17	24575	6%	42%	5%	**42%**	5%	0%	7%	19%
IS-1	7680	2%	47%	1%	**39%**	10%	0%	17%	23%
CAM -6	6671	0%	61%	0%	**39%**	0%	0%	7%	56%
WHID-6	2317	0%	61%	0%	**39%**	0%	0%	7%	56%
WHID-26	47237	18%	25%	17%	**38%**	3%	0%	34%	50%
WHID-28	35317	5%	50%	7%	**37%**	0%	0%	37%	54%
WHID-8b	3735	0%	30%	1%	**37%**	32%	0%	8%	11%
WHID-27	23556	12%	32%	7%	**36%**	13%	0%	16%	23%
WHID-14	17643	0%	47%	5%	**35%**	12%	0%	13%	23%
CAM -3	70921	3%	33%	12%	**34%**	18%	0%	3%	22%
CAM -2	5641	0%	36%	4%	**34%**	26%	0%	13%	9%
WHID-20	43036	9%	16%	40%	**33%**	2%	0%	1%	9%
CAM -8	65914	5%	22%	23%	**32%**	17%	0%	5%	19%
WHID-18	3889	38%	30%	0%	**31%**	0%	0%	4%	25%
IS-2/IS-3	11737	0%	0%	0%	**31%**	11%	58%	0%	0%
WHID-23	7798	0%	31%	41%	**28%**	0%	0%	2%	13%
WHID-8	77985	2%	41%	19%	**28%**	11%	0%	5%	23%
WHID-9	14405	0%	36%	18%	**27%**	19%	0%	6%	29%
WHID-11	3391	0%	25%	12%	**27%**	36%	0%	1%	18%
WHID-22	10187	0%	28%	43%	**26%**	3%	0%	4%	12%
WHID-24	13623	0%	17%	50%	**26%**	7%	0%	2%	13%
WHID-15/WHID-14	9220	0%	0%	0%	**25%**	75%	0%	0%	0%
WHID-2	19630	0%	61%	2%	**24%**	14%	0%	15%	28%
WHID-24/WHID-25	7875	0%	5%	73%	**22%**	0%	0%	2%	5%
WHID-13	21715	5%	52%	14%	**22%**	8%	0%	18%	38%
WHID-1	20486	0%	52%	7%	**21%**	20%	0%	14%	26%
WHID-12	5942	0%	18%	25%	**21%**	37%	0%	3%	14%
CAM -5	29162	13%	29%	3%	**17%**	38%	0%	3%	20%
WHID-19	6157	46%	35%	0%	**16%**	3%	0%	5%	37%
WHID-10	5931	0%	12%	69%	**12%**	6%	0%	3%	24%
WHID-3	30586	2%	46%	9%	**11%**	31%	0%	13%	30%
WHID-21	6963	0%	25%	49%	**10%**	16%	0%	1%	11%
CAM -7	7003	0%	50%	0%	**8%**	41%	0%	9%	40%
WHID-7	10217	0%	50%	0%	**8%**	41%	0%	9%	40%
WHID-4	12207	0%	51%	26%	**6%**	17%	0%	17%	69%
CAM -9	2810	60%	20%	15%	**5%**	0%	0%	15%	56%
WHID-16	11067	8%	43%	4%	**3%**	42%	0%	5%	29%

Table 11. CGS Mapping Statistics by drift cell, sorted by MODIFIED (modified).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
WHID-15/WHID-14	9220	0%	0%	0%	25%	**75%**	0%	0%	0%
WHID-16	11067	8%	43%	4%	3%	**42%**	0%	5%	29%
CAM –7	7003	0%	50%	0%	8%	**41%**	0%	9%	40%
WHID-7	10217	0%	50%	0%	8%	**41%**	0%	9%	40%
CAM –5	29162	13%	29%	3%	17%	**38%**	0%	3%	20%
WHID-12	5942	0%	18%	25%	21%	**37%**	0%	3%	14%
WHID-11	3391	0%	25%	12%	27%	**36%**	0%	1%	18%
IS-3	10016	0%	4%	10%	49%	**36%**	0%	0%	0%
WHID-8b	3735	0%	30%	1%	37%	**32%**	0%	8%	11%
WHID-3	30586	2%	46%	9%	11%	**31%**	0%	13%	30%
CAM –2	5641	0%	36%	4%	34%	**26%**	0%	13%	9%
WHID-1	20486	0%	52%	7%	21%	**20%**	0%	14%	26%
WHID-9	14405	0%	36%	18%	27%	**19%**	0%	6%	29%
CAM –3	70921	3%	33%	12%	34%	**18%**	0%	3%	22%
CAM –8	65914	5%	22%	23%	32%	**17%**	0%	5%	19%
WHID-4	12207	0%	51%	26%	6%	**17%**	0%	17%	69%
WHID-21	6963	0%	25%	49%	10%	**16%**	0%	1%	11%
CAM –4	3863	29%	8%	6%	43%	**15%**	0%	0%	29%
IS-2	5568	32%	11%	0%	42%	**15%**	0%	16%	24%
WHID-2	19630	0%	61%	2%	24%	**14%**	0%	15%	28%
WHID-27	23556	12%	32%	7%	36%	**13%**	0%	16%	23%
WHID-14	17643	0%	47%	5%	35%	**12%**	0%	13%	23%
IS-2/IS-3	11737	0%	0%	0%	31%	**11%**	58%	0%	0%
WHID-8	77985	2%	41%	19%	28%	**11%**	0%	5%	23%
IS-1	7680	2%	47%	1%	39%	**10%**	0%	17%	23%
WHID-13	21715	5%	52%	14%	22%	**8%**	0%	18%	38%
WHID-24	13623	0%	17%	50%	26%	**7%**	0%	2%	13%
WHID-15	7843	5%	30%	0%	59%	**6%**	0%	6%	19%
WHID-10	5931	0%	12%	69%	12%	**6%**	0%	3%	24%
WHID-17	24575	6%	42%	5%	42%	**5%**	0%	7%	19%
WHID-19	6157	46%	35%	0%	16%	**3%**	0%	5%	37%
WHID-22	10187	0%	28%	43%	26%	**3%**	0%	4%	12%
WHID-26	47237	18%	25%	17%	38%	**3%**	0%	34%	50%
CAM -10	22343	0%	8%	3%	87%	**3%**	0%	1%	1%
WHID-25	76904	19%	21%	8%	49%	**2%**	0%	18%	24%
IS-4	44374	18%	28%	4%	48%	**2%**	0%	18%	23%
WHID-20	43036	9%	16%	40%	33%	**2%**	0%	1%	9%
IS-6	37918	23%	22%	6%	48%	**1%**	0%	13%	25%
CAM -1	8323	0%	29%	17%	52%	**1%**	0%	0%	0%
CAM-1/CAM -13	18572	0%	0%	0%	100%	**0%**	0%	0%	0%
CAM -6	6671	0%	61%	0%	39%	**0%**	0%	7%	56%
CAM -9	2810	60%	20%	15%	5%	**0%**	0%	15%	56%
CAM -11	7680	11%	15%	12%	62%	**0%**	0%	7%	7%
CAM -12	5568	4%	35%	0%	61%	**0%**	0%	4%	10%
IS-5	12959	26%	0%	0%	74%	**0%**	0%	15%	18%
SM-1	7553	17%	0%	10%	73%	**0%**	0%	0%	0%
SM-2	8403	26%	8%	0%	66%	**0%**	0%	0%	0%
WHID-3a	731	6%	20%	0%	76%	**0%**	0%	0%	0%
WHID-3b	769	6%	16%	0%	78%	**0%**	0%	0%	0%
WHID-5	1082	0%	25%	8%	67%	**0%**	0%	7%	25%
WHID-6	2317	0%	61%	0%	39%	**0%**	0%	7%	56%
WHID-8a	3137	0%	34%	16%	50%	**0%**	0%	0%	14%
WHID-18	3889	38%	30%	0%	31%	**0%**	0%	4%	25%
WHID-23	7798	0%	31%	41%	28%	**0%**	0%	2%	13%
WHID-24/WHID-25	7875	0%	5%	73%	22%	**0%**	0%	2%	5%
WHID-28	35317	5%	50%	7%	37%	**0%**	0%	37%	54%

Table 12. GS Mapping Statistics by drift cell, sorted by NAD (no appreciable drift).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
IS-2/IS-3	11737	0%	0%	0%	31%	11%	**58%**	0%	0%
CAM -1	8323	0%	29%	17%	52%	1%	**0%**	0%	0%
CAM-1/CAM -13	18572	0%	0%	0%	100%	0%	**0%**	0%	0%
CAM -2	5641	0%	36%	4%	34%	26%	**0%**	13%	9%
CAM -3	70921	3%	33%	12%	34%	18%	**0%**	3%	22%
CAM -4	3863	29%	8%	6%	43%	15%	**0%**	0%	29%
CAM -5	29162	13%	29%	3%	17%	38%	**0%**	3%	20%
CAM -6	6671	0%	61%	0%	39%	0%	**0%**	7%	56%
CAM -7	7003	0%	50%	0%	8%	41%	**0%**	9%	40%
CAM -8	65914	5%	22%	23%	32%	17%	**0%**	5%	19%
CAM -9	2810	60%	20%	15%	5%	0%	**0%**	15%	56%
CAM -10	22343	0%	8%	3%	87%	3%	**0%**	1%	1%
CAM -11	7680	11%	15%	12%	62%	0%	**0%**	7%	7%
CAM -12	5568	4%	35%	0%	61%	0%	**0%**	4%	10%
IS-1	7680	2%	47%	1%	39%	10%	**0%**	17%	23%
IS-2	5568	32%	11%	0%	42%	15%	**0%**	16%	24%
IS-3	10016	0%	4%	10%	49%	36%	**0%**	0%	0%
IS-4	44374	18%	28%	4%	48%	2%	**0%**	18%	23%
IS-5	12959	26%	0%	0%	74%	0%	**0%**	15%	18%
IS-6	37918	23%	22%	6%	48%	1%	**0%**	13%	25%
SM-1	7553	17%	0%	10%	73%	0%	**0%**	0%	0%
SM-2	8403	26%	8%	0%	66%	0%	**0%**	0%	0%
WHID-1	20486	0%	52%	7%	21%	20%	**0%**	14%	26%
WHID-2	19630	0%	61%	2%	24%	14%	**0%**	15%	28%
WHID-3	30586	2%	46%	9%	11%	31%	**0%**	13%	30%
WHID-3a	731	6%	20%	0%	76%	0%	**0%**	0%	0%
WHID-3b	769	6%	16%	0%	78%	0%	**0%**	0%	0%
WHID-4	12207	0%	51%	26%	6%	17%	**0%**	17%	69%
WHID-5	1082	0%	25%	8%	67%	0%	**0%**	7%	25%
WHID-6	2317	0%	61%	0%	39%	0%	**0%**	7%	56%
WHID-7	10217	0%	50%	0%	8%	41%	**0%**	9%	40%
WHID-8	77985	2%	41%	19%	28%	11%	**0%**	5%	23%
WHID-8a	3137	0%	34%	16%	50%	0%	**0%**	0%	14%
WHID-8b	3735	0%	30%	1%	37%	32%	**0%**	8%	11%
WHID-9	14405	0%	36%	18%	27%	19%	**0%**	6%	29%
WHID-10	5931	0%	12%	69%	12%	6%	**0%**	3%	24%
WHID-11	3391	0%	25%	12%	27%	36%	**0%**	1%	18%
WHID-12	5942	0%	18%	25%	21%	37%	**0%**	3%	14%
WHID-13	21715	5%	52%	14%	22%	8%	**0%**	18%	38%
WHID-14	17643	0%	47%	5%	35%	12%	**0%**	13%	23%
WHID-15/WHID-14	9220	0%	0%	0%	25%	75%	**0%**	0%	0%
WHID-15	7843	5%	30%	0%	59%	6%	**0%**	6%	19%
WHID-16	11067	8%	43%	4%	3%	42%	**0%**	5%	29%
WHID-17	24575	6%	42%	5%	42%	5%	**0%**	7%	19%
WHID-18	3889	38%	30%	0%	31%	0%	**0%**	4%	25%
WHID-19	6157	46%	35%	0%	16%	3%	**0%**	5%	37%
WHID-20	43036	9%	16%	40%	33%	2%	**0%**	1%	9%
WHID-21	6963	0%	25%	49%	10%	16%	**0%**	1%	11%
WHID-22	10187	0%	28%	43%	26%	3%	**0%**	4%	12%
WHID-23	7798	0%	31%	41%	28%	0%	**0%**	2%	13%
WHID-24	13623	0%	17%	50%	26%	7%	**0%**	2%	13%
WHID-24/WHID-25	7875	0%	5%	73%	22%	0%	**0%**	2%	5%
WHID-25	76904	19%	21%	8%	49%	2%	**0%**	18%	24%
WHID-26	47237	18%	25%	17%	38%	3%	**0%**	34%	50%
WHID-27	23556	12%	32%	7%	36%	13%	**0%**	16%	23%
WHID-28	35317	5%	50%	7%	37%	0%	**0%**	37%	54%

Table 13. CGS Mapping Statistics by drift cell, sorted by L (landslide).

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
WHID-28	35317	5%	50%	7%	37%	0%	0%	**37%**	54%
WHID-26	47237	18%	25%	17%	38%	3%	0%	**34%**	50%
WHID-13	21715	5%	52%	14%	22%	8%	0%	**18%**	38%
WHID-25	76904	19%	21%	8%	49%	2%	0%	**18%**	24%
IS-4	44374	18%	28%	4%	48%	2%	0%	**18%**	23%
WHID-4	12207	0%	51%	26%	6%	17%	0%	**17%**	69%
IS-1	7680	2%	47%	1%	39%	10%	0%	**17%**	23%
WHID-27	23556	12%	32%	7%	36%	13%	0%	**16%**	23%
IS-2	5568	32%	11%	0%	42%	15%	0%	**16%**	24%
WHID-2	19630	0%	61%	2%	24%	14%	0%	**15%**	28%
IS-5	12959	26%	0%	0%	74%	0%	0%	**15%**	18%
CAM -9	2810	60%	20%	15%	5%	0%	0%	**15%**	56%
WHID-1	20486	0%	52%	7%	21%	20%	0%	**14%**	26%
WHID-3	30586	2%	46%	9%	11%	31%	0%	**13%**	30%
IS-6	37918	23%	22%	6%	48%	1%	0%	**13%**	25%
CAM -2	5641	0%	36%	4%	34%	26%	0%	**13%**	9%
WHID-14	17643	0%	47%	5%	35%	12%	0%	**13%**	23%
CAM -7	7003	0%	50%	0%	8%	41%	0%	**9%**	40%
WHID-7	10217	0%	50%	0%	8%	41%	0%	**9%**	40%
WHID-8b	3735	0%	30%	1%	37%	32%	0%	**8%**	11%
CAM -6	6671	0%	61%	0%	39%	0%	0%	**7%**	56%
WHID-6	2317	0%	61%	0%	39%	0%	0%	**7%**	56%
WHID-17	24575	6%	42%	5%	42%	5%	0%	**7%**	19%
WHID-5	1082	0%	25%	8%	67%	0%	0%	**7%**	25%
CAM -11	7680	11%	15%	12%	62%	0%	0%	**7%**	7%
WHID-9	14405	0%	36%	18%	27%	19%	0%	**6%**	29%
WHID-15	7843	5%	30%	0%	59%	6%	0%	**6%**	19%
WHID-19	6157	46%	35%	0%	16%	3%	0%	**5%**	37%
WHID-8	77985	2%	41%	19%	28%	11%	0%	**5%**	23%
WHID-16	11067	8%	43%	4%	3%	42%	0%	**5%**	29%
CAM -8	65914	5%	22%	23%	32%	17%	0%	**5%**	19%
WHID-18	3889	38%	30%	0%	31%	0%	0%	**4%**	25%
CAM -12	5568	4%	35%	0%	61%	0%	0%	**4%**	10%
WHID-22	10187	0%	28%	43%	26%	3%	0%	**4%**	12%
CAM -5	29162	13%	29%	3%	17%	38%	0%	**3%**	20%
CAM -3	70921	3%	33%	12%	34%	18%	0%	**3%**	22%
WHID-12	5942	0%	18%	25%	21%	37%	0%	**3%**	14%
WHID-10	5931	0%	12%	69%	12%	6%	0%	**3%**	24%
WHID-23	7798	0%	31%	41%	28%	0%	0%	**2%**	13%
WHID-24	13623	0%	17%	50%	26%	7%	0%	**2%**	13%
WHID-24/WHID-25	7875	0%	5%	73%	22%	0%	0%	**2%**	5%
WHID-20	43036	9%	16%	40%	33%	2%	0%	**1%**	9%
CAM -10	22343	0%	8%	3%	87%	3%	0%	**1%**	1%
WHID-21	6963	0%	25%	49%	10%	16%	0%	**1%**	11%
WHID-11	3391	0%	25%	12%	27%	36%	0%	**1%**	18%
CAM -1	8323	0%	29%	17%	52%	1%	0%	**0%**	0%
CAM-1/CAM -13	18572	0%	0%	0%	100%	0%	0%	**0%**	0%
CAM -4	3863	29%	8%	6%	43%	15%	0%	**0%**	29%
IS-2/IS-3	11737	0%	0%	0%	31%	11%	58%	**0%**	0%
IS-3	10016	0%	4%	10%	49%	36%	0%	**0%**	0%
SM-1	7553	17%	0%	10%	73%	0%	0%	**0%**	0%
SM-2	8403	26%	8%	0%	66%	0%	0%	**0%**	0%
WHID-3a	731	6%	20%	0%	76%	0%	0%	**0%**	0%
WHID-3b	769	6%	16%	0%	78%	0%	0%	**0%**	0%
WHID-8a	3137	0%	34%	16%	50%	0%	0%	**0%**	14%
WHID-15/WHID-14	9220	0%	0%	0%	25%	75%	0%	**0%**	0%

Table 14. CGS Mapping Statistics by drift cell, sorted by TE.

FBE = Feeder Bluff Exceptional. FB = Feeder Bluff. TZ = Transport Zone. AS = Accretion Shoreform. MOD = Modified. NAD = No Appreciable Drift. L = Landslide. TE = Toe Erosion. Statistics for drift cells that were embayments were excluded. Drift cells that had embayments landward of the shoreline excluded the embayment (NAD) from the statistics in order to prevent skewing data that was not applicable for the shoreline.

NSD cell	Cell Length (ft)	FBE	FB	TZ	AS	MOD	NAD	L	TE
WHID-4	12207	0%	51%	26%	6%	17%	0%	17%	**69%**
CAM -9	2810	60%	20%	15%	5%	0%	0%	15%	**56%**
CAM -6	6671	0%	61%	0%	39%	0%	0%	7%	**56%**
WHID-6	2317	0%	61%	0%	39%	0%	0%	7%	**56%**
WHID-28	35317	5%	50%	7%	37%	0%	0%	37%	**54%**
WHID-26	47237	18%	25%	17%	38%	3%	0%	34%	**50%**
CAM -7	7003	0%	50%	0%	8%	41%	0%	9%	**40%**
WHID-7	10217	0%	50%	0%	8%	41%	0%	9%	**40%**
WHID-13	21715	5%	52%	14%	22%	8%	0%	18%	**38%**
WHID-19	6157	46%	35%	0%	16%	3%	0%	5%	**37%**
WHID-3	30586	2%	46%	9%	11%	31%	0%	13%	**30%**
WHID-16	11067	8%	43%	4%	3%	42%	0%	5%	**29%**
CAM -4	3863	29%	8%	6%	43%	15%	0%	0%	**29%**
WHID-9	14405	0%	36%	18%	27%	19%	0%	6%	**29%**
WHID-2	19630	0%	61%	2%	24%	14%	0%	15%	**28%**
WHID-1	20486	0%	52%	7%	21%	20%	0%	14%	**26%**
WHID-18	3889	38%	30%	0%	31%	0%	0%	4%	**25%**
IS-6	37918	23%	22%	6%	48%	1%	0%	13%	**25%**
WHID-5	1082	0%	25%	8%	67%	0%	0%	7%	**25%**
WHID-10	5931	0%	12%	69%	12%	6%	0%	3%	**24%**
IS-2	5568	32%	11%	0%	42%	15%	0%	16%	**24%**
WHID-25	76904	19%	21%	8%	49%	2%	0%	18%	**24%**
WHID-27	23556	12%	32%	7%	36%	13%	0%	16%	**23%**
IS-1	7680	2%	47%	1%	39%	10%	0%	17%	**23%**
WHID-14	17643	0%	47%	5%	35%	12%	0%	13%	**23%**
WHID-8	77985	2%	41%	19%	28%	11%	0%	5%	**23%**
IS-4	44374	18%	28%	4%	48%	2%	0%	18%	**23%**
CAM -3	70921	3%	33%	12%	34%	18%	0%	3%	**22%**
CAM -5	29162	13%	29%	3%	17%	38%	0%	3%	**20%**
WHID-15	7843	5%	30%	0%	59%	6%	0%	6%	**19%**
WHID-17	24575	6%	42%	5%	42%	5%	0%	7%	**19%**
CAM -8	65914	5%	22%	23%	32%	17%	0%	5%	**19%**
WHID-11	3391	0%	25%	12%	27%	36%	0%	1%	**18%**
IS-5	12959	26%	0%	0%	74%	0%	0%	15%	**18%**
WHID-8a	3137	0%	34%	16%	50%	0%	0%	0%	**14%**
WHID-12	5942	0%	18%	25%	21%	37%	0%	3%	**14%**
WHID-23	7798	0%	31%	41%	28%	0%	0%	2%	**13%**
WHID-24	13623	0%	17%	50%	26%	7%	0%	2%	**13%**
WHID-22	10187	0%	28%	43%	26%	3%	0%	4%	**12%**
WHID-21	6963	0%	25%	49%	10%	16%	0%	1%	**11%**
WHID-8b	3735	0%	30%	1%	37%	32%	0%	8%	**11%**
CAM -12	5568	4%	35%	0%	61%	0%	0%	4%	**10%**
CAM -2	5641	0%	36%	4%	34%	26%	0%	13%	**9%**
WHID-20	43036	9%	16%	40%	33%	2%	0%	1%	**9%**
CAM -11	7680	11%	15%	12%	62%	0%	0%	7%	**7%**
WHID-24/WHID-25	7875	0%	5%	73%	22%	0%	0%	2%	**5%**
CAM -10	22343	0%	8%	3%	87%	3%	0%	1%	**1%**
CAM -1	8323	0%	29%	17%	52%	1%	0%	0%	**0%**
CAM-1/CAM -13	18572	0%	0%	0%	100%	0%	0%	0%	**0%**
IS-2/IS-3	11737	0%	0%	0%	31%	11%	58%	0%	**0%**
IS-3	10016	0%	4%	10%	49%	36%	0%	0%	**0%**
SM-1	7553	17%	0%	10%	73%	0%	0%	0%	**0%**
SM-2	8403	26%	8%	0%	66%	0%	0%	0%	**0%**
WHID-3a	731	6%	20%	0%	76%	0%	0%	0%	**0%**
WHID-3b	769	6%	16%	0%	78%	0%	0%	0%	**0%**
WHID-15/WHID-14	9220	0%	0%	0%	25%	75%	0%	0%	**0%**

Examples of Feeder Bluff Exceptional from Camano Head and Double Bluff.

Examples of Feederbluff from south of Lake Hancock and west of Holmes Harbor.

Examples of Transport Zones from southeast Camano Island and southwest Penn Cove.

Figure 1. Examples of Shore Types A

Examples of Accretion Shoreforms from Sandy Hook and south of Langley.

Examples of modified segments from west Holmes Harbor and southeast Camano Island.

Example of landslide south of Fox Spit and toe erosion at southeast Camano Island.

Figure 2. Examples of Shore Types B

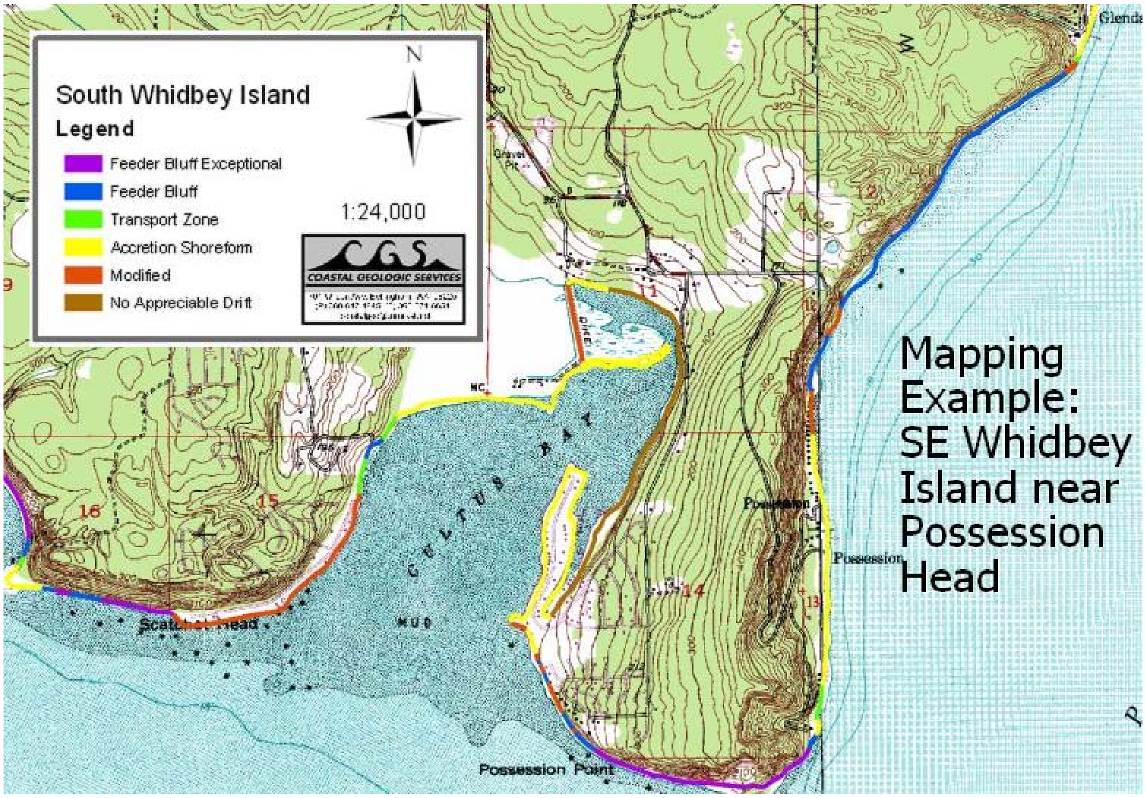

Figure 3. Mapping Example: SE Whidbey Island near Possession Head.

Figure 4. Possession Point – Feeder Bluff Exceptional and Feeder Bluff.

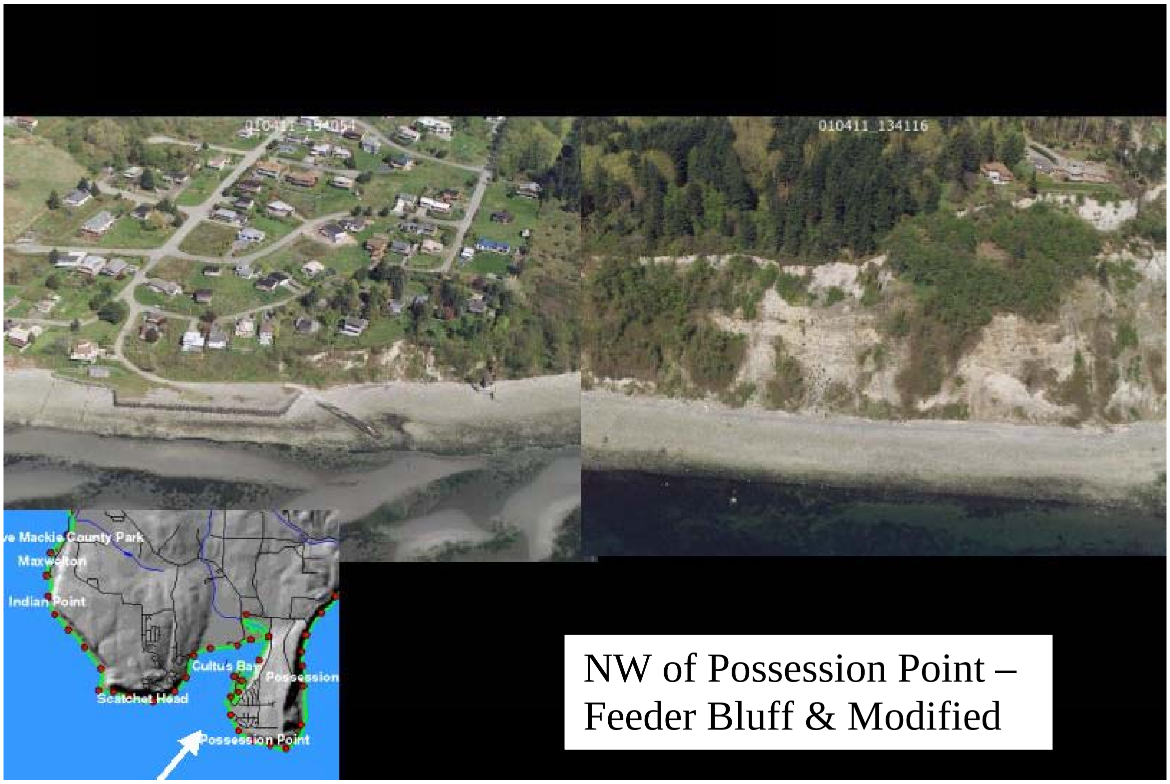

Figure 5. NW of Possession Head - Feeder Bluff & Modified.

Figure 6. Sandy Hook - Accretion Shoreform.

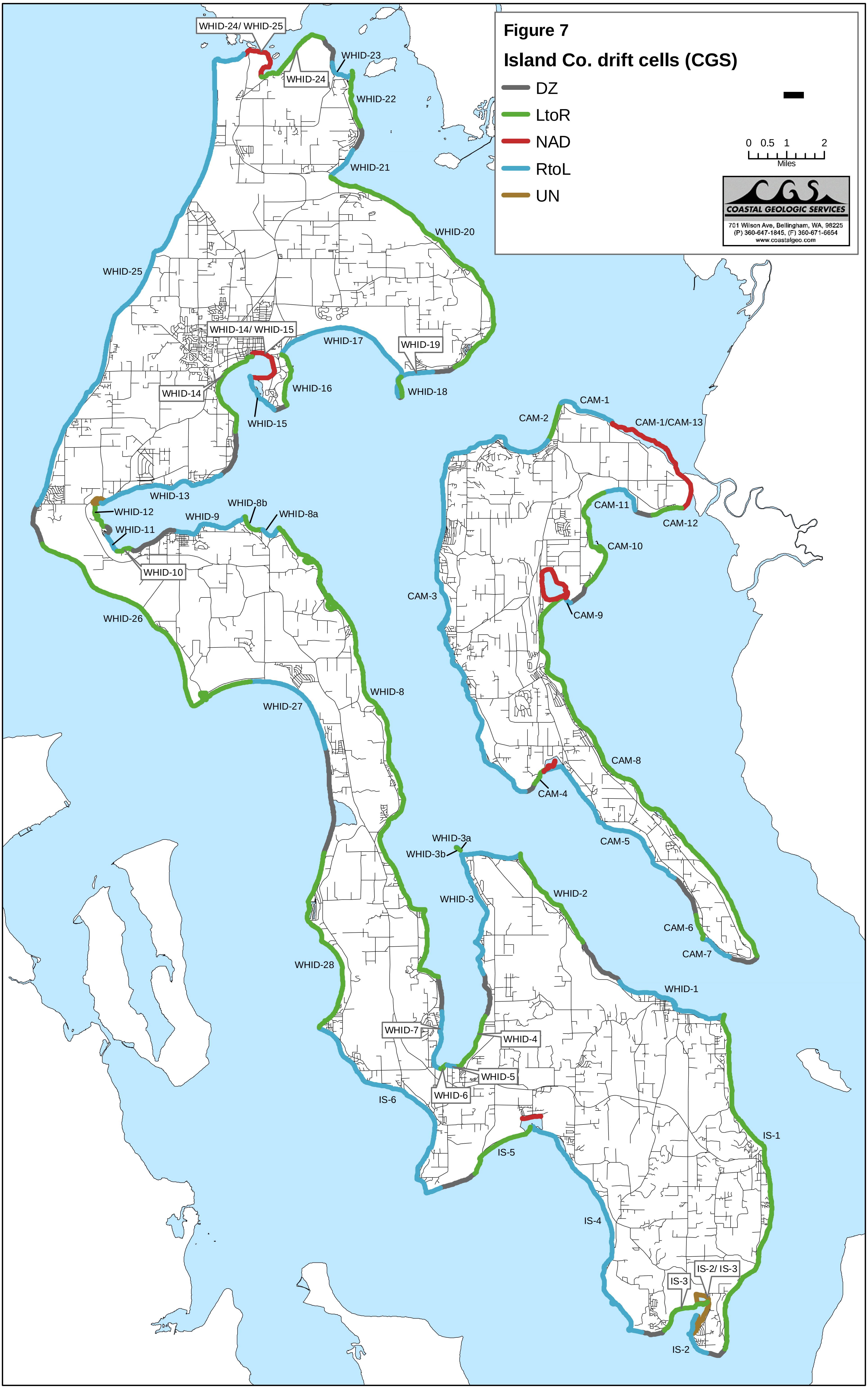
Figure 7
Island Co. drift cells (CGS)
DZ
LtoR
NAD
RtoL
UN
0 0.5 1 2
Miles
COASTAL GEOLOGIC SERVICES
701 Wilson Ave, Bellingham, WA, 98225
(P) 360-647-1845, (F) 360-671-6654
www.coastalgeo.com
WHID-24/ WHID-25
WHID-24
WHID-23
WHID-22
WHID-21
WHID-20
WHID-25
WHID-14/ WHID-15
WHID-17
WHID-19
WHID-18
WHID-14
WHID-16
WHID-15
WHID-13
WHID-12
WHID-11
WHID-10
WHID-9
WHID-8b
WHID-8a
WHID-26
WHID-27
WHID-8
CAM-1
CAM-2
CAM-1/CAM-13
CAM-11
CAM-12
CAM-10
CAM-3
CAM-9
CAM-8
CAM-4
CAM-5
CAM-6
CAM-7
WHID-3a
WHID-3b
WHID-3
WHID-2
WHID-1
WHID-28
WHID-7
WHID-4
WHID-5
WHID-6
IS-6
IS-5
IS-1
IS-4
IS-2/ IS-3
IS-3
IS-2

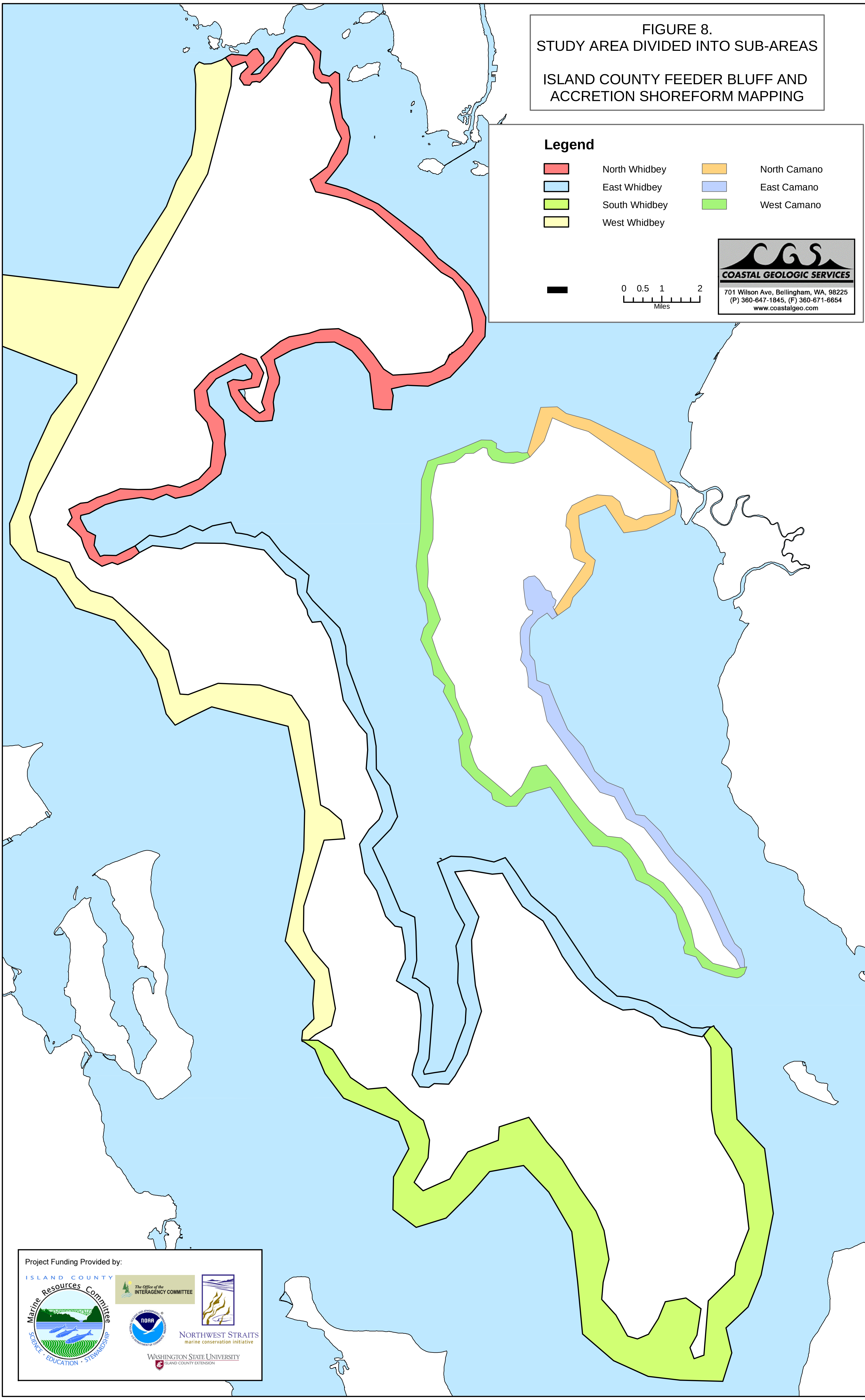

FIGURE 8.
STUDY AREA DIVIDED INTO SUB-AREAS

ISLAND COUNTY FEEDER BLUFF AND ACCRETION SHOREFORM MAPPING

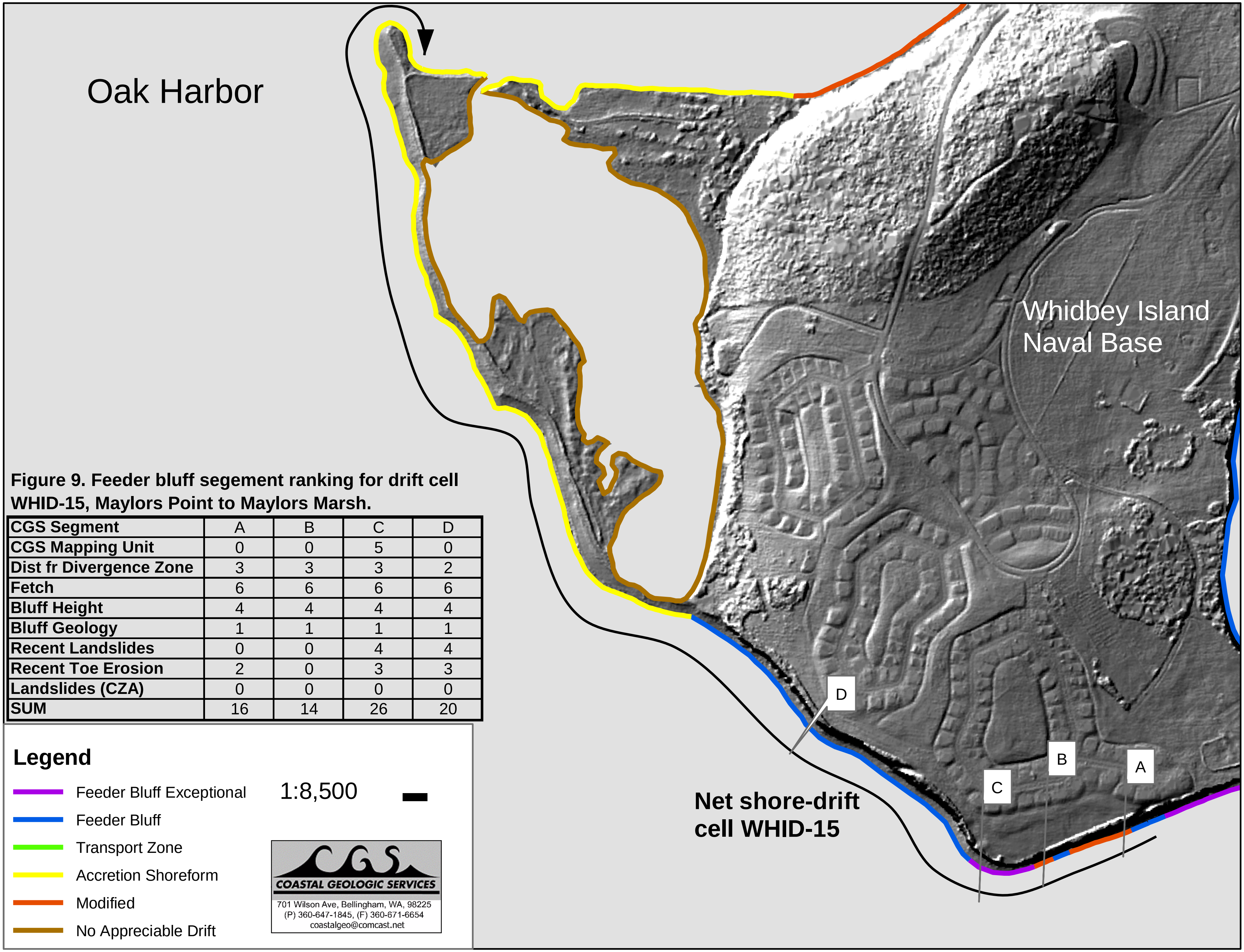

Figure 9. Feeder bluff segement ranking for drift cell WHID-15, Maylors Point to Maylors Marsh.

CGS Segment	A	B	C	D
CGS Mapping Unit	0	0	5	0
Dist fr Divergence Zone	3	3	3	2
Fetch	6	6	6	6
Bluff Height	4	4	4	4
Bluff Geology	1	1	1	1
Recent Landslides	0	0	4	4
Recent Toe Erosion	2	0	3	3
Landslides (CZA)	0	0	0	0
SUM	16	14	26	20

Figure 10. Segment Ranking for Drift Cell IS-2, Possession Head to Sandy Hook

CGS Segment	A	B	C	D	E
CGS Mapping Unit	5	0	0	0	0
Dist fr Divergence Zone	3	1	1	0	0
Fetch	6	6	6	6	6
Bluff Height	12	6	6	1	1
Bluff Geology	2	2	2	2	2
Recent Landslides	7	4	4	0	0
Recent Toe Erosion	3	3	3	0	3
Landslides (CZA)	6	0	0	0	0
SUM	44	22	22	9	12