Delineation and Function Rating of Jurisdictional Wetlands on CBJ Parcels in the Industrial Blvd and Hill 560 Areas Juneau, Alaska

by

Koren Bosworth
Bosworth Botanical Consulting
Juneau, AK
bosworth@alaska.com

and

Paul Adamus, Ph.D.
Adamus Resource Assessment, Inc.
Corvallis, OR
adamus7@comcast.net

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City and Borough of Juneau, Alaska

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Introduction

Wetland research was done in the 1980's for the Juneau Wetland Management Plan(JWMP) which was then adopted in 1992. Since that field work was done, isostatic or glacial rebound, has lifted the land over 14 inches. The City and Borough of Juneau (CBJ) would like to determine if rebound has had any effect on wetland boundaries and functions on CBJ lands in the project area. This report documents the present wetland boundaries and functions within the project areas and discusses the changes that may have taken place over the last 20 years.

This project involves the delineation, analysis and assessment of wetlands on two CBJ-owned parcels in the lower, western part of the Mendenhall Valley (Figure 1) and part of one parcel just north of there on Hill 560 (sometimes called Pederson Hill) (Figure 2) These parcels were included in the 1987 field work and the 2008 JWMP. So a comparison can be made of the earlier work and the results of this study. Maps and information from the 2008 JWMP has been included as Appendix E. Assessment of wetland functions was carried out for this project using the Adamus Methodology as it was revised for the work done on CBJ parcels in 2007 for the Community Development Department, Comprehensive Plan work.

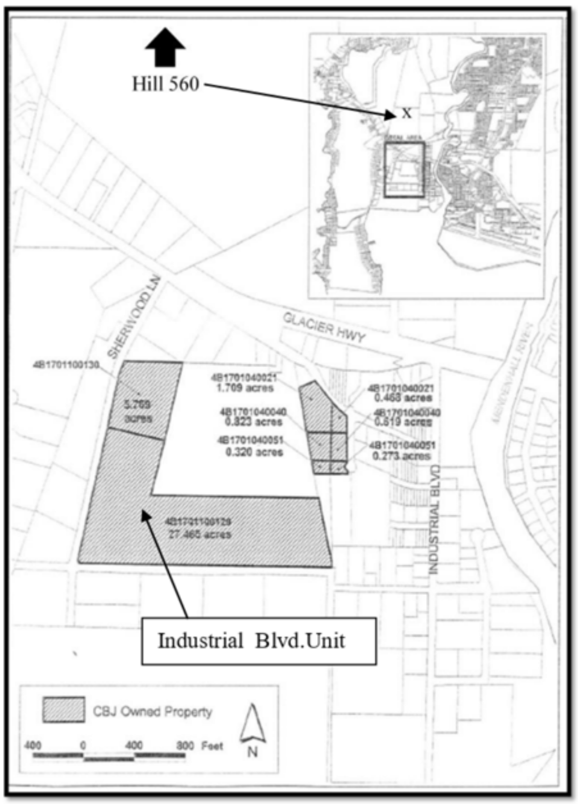

Figure 1 - Location map for project areas. The six, small, hatched parcels on the upper right side are the CBJ Public Works properties. They were dropped from the project as they have already been filled.

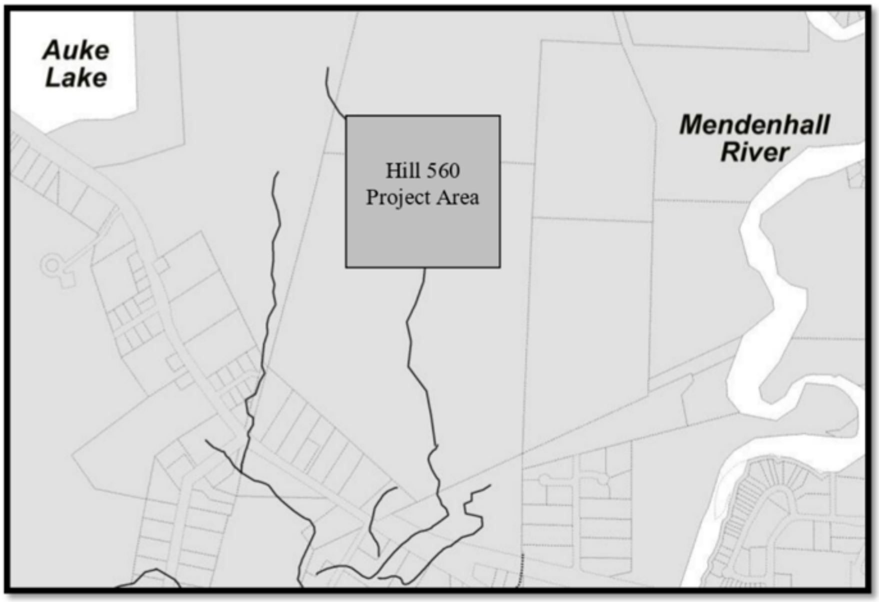

Figure 2 - Location map for the Hill 560 project area.

Previous Juneau Wetland Management Work

There are three different versions of the Juneau Wetlands Management Plan (JWMP), dated 1992, 1997, and 2008. As part of the Juneau Coastal Management Plan the JWMP required revision and re-approval with changes in the Alaska Coastal Management Plan (ACMP). The 1997 and 2008 JWMP versions addressed new ACMP requirements but added only additional text and updated parcel maps, without any additional scientific research or categorical modifications. The wetland boundaries, wetland assessment methodology, and wetland management categories have not changed since the 1992 JWMP was adopted. The 1992 JWMP was based on wetland surveys and analysis conducted in the 1980s and completed in 1987 by Dr. Paul Adamus, Koren Bosworth, and others. This report will refer to the 2008 JWMP for consistency, however the wetland methodology will be noted as the 1987 Adamus methodology. A full list and additional descriptions of the different JWMP versions and scientific reports is found in Appendix F.

Methods

Preparatory Tasks

Naming of project units, areas and wetland units was done using local landmarks and names. For the purposes of this report the two adjacent parcels in the lower Mendenhall Valley are called Unit 1 - Industrial Blvd. and the part of a parcel on Hill 560 is called Unit 2 - Hill 560. Because of significant hydrologic differences, Unit 1 is further divided into the Casa del Sol Area - the western part of the unit that is part of the Casa del Sol Creek watershed and the Sewage Sludge Area - the eastern part of Unit 1 that has been cut off from the Casa del Sol watershed by construction of ditches and dikes. Within these units and areas the wetlands were delineated and numbered from NW to SE.

- Unit 1 - Industrial Blvd - 33.24 acres
    - Casa del Sol Area - the western part of unit 1 - named after the stream (Casa del Sol Ck. - sometimes called Pederson Hill Ck.) that flows through the area.
        - Wetland units - labeled Casa and numbered 1-6.
    - Sewage Sludge Area - the eastern part of unit 1 - after its use as a sewage sludge disposal area.
        - Wetland units - labeled Sewage and numbered 1-3.
- Unit 2 - Hill 560 - 24 acres - sometimes called Pederson Hill
        - (one wetland unit)

Wetland Delineation Methodology

The project area units were visited for delineation and mapping during the period from May 30 - June 17, 2010.

The U.S. Army Corps delineation methodology was used, as outlined in the 1987 Corps of Engineers Wetland Delineation Manual, for Routine Determinations - >5 acres, and amended by the, Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region – November, 2007.
A general reconnaissance of the site was accomplished from aerial photography. Intuitive-controlled walking transects, trending east-west, were done across the Unit One project area. Representative sample points were done along the transects at any significant change in vegetation, soils or hydrology. At each sampling point the wetland status of that point was determined by observing indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. Wetland and upland areas that are big enough to be mapped separately were delineated.

Vegetation was divided into three strata and each layer was classified using the prevalence index and the dominance test. Plant species are classified by the U.S. Fish and Wildlife Service, and available on the "National List of Plant Species that Occur in Wetlands." The list was updated by the COE Alaska Plant Working Group, in Nov. 2009. Hydrology was determined using two methods: (1) visually, if the water table is at or above the surface, or (2) with a soil pit. The presence of standing water, depth to free water in the soil pit, and depth to saturated soils were recorded. Other primary and secondary hydrology indicators were recorded, such as presence of watermarks, sediment deposits, drift deposits, iron deposits, hydrogen sulfide odor, geomorphic position, and drainage patterns in wetlands. Soil pits were dug to a depth of 16-18 inches, or to bedrock refusal, to determine if indicators of hydric soils were present. Soil colors were determined from a moist sample with the Munsell Soil Color Chart.
For each sample site an Alaska Region Corps Routine Wetland Determination Data Form was filled out. A wetland delineation map was produced that includes perennial and intermittent streams, trails, property lines, roads, sample point locations and wetland boundaries. Final delineation mapping was accomplished by BBC and Richard Carstensen of Discovery Southeast,

using GPS data gathered in the field, on GIS maps using 2006 aerial photography supplied by CBJ. The GIS information was gathered with GPS's, a rented Trimble GeoXH and an owned Garmin Rino 530HCx. The Trimble GeoXH is a mapping-grade GPS that, under ideal conditions and with post processing, is advertised to have an accuracy of under 3 feet. The Garmin Rino is a WAAS-enabled, recreational grade GPS with an advertised accuracy of 5-10 feet. A field test was done to compare the GeoXH with CBJ's GIS departments Trimble. The differences in the post-processed data sets from the Trimble GeoXH and the CBJ's Trimble, was between 0 and 2.58 feet. It was found that the newer GPS system used in the GeoXH utilized a different real-time correction signal (WAAS), as opposed to the CBJ's older GPS system (which utilizes CORS). An independent opinion from an outside engineering source suggests a datum shift as a result of the two different real-time correction sources. Considering that a wetland boundary migrates seasonally due to varying rainfall and temperature and human disturbances, these differences seem acceptable for these purposes. In Unit 2 all of the wetland boundaries and some of the sample points were under the forest canopy where the Trimble GeoXH with an external antenna could not get a signal and collect data. In that area the Garmin Rino was used to mark the wetland boundary and the sample points that were under the canopy.

Averaged wetland boundaries were applied to the edges of the streams in Unit 1 using the GIS mapping program. The mainstem stream, Casa del Sol Creek, was given a seven foot wide wetland edge for 14 feet total and the tributaries were given five foot wetland edges for a total of 10 feet. The mapped ditches were not given wetland edges as they tended to be steep edged and narrow and did not have edging wetlands. These edges were added for the purpose of calculating the average streamside wetland amount and are different from the CBJ ordinance requiring a 50 foot setback from anadromous streams.

Wetland areas and stream lengths were obtained using the GIS polygon and line data gathered from Unit One with the Trimble GeoXH - GPS and from Unit 2 with the Garmin Rino GPS and the GeoXH. Wetland percentages were calculated using the total parcel acreage amounts provided by CBJ and the wetland acreages. A complete table of individual wetland areas and stream lengths can be found in Appendix A.

Assessment of Functions: Assignment to Protection Categories

The CDD requested that the "Adamus Methodology" for assessing functions of wetlands in Southeast Alaska be used, because that was the supporting document for the Juneau Wetlands Management Plan (2008 Revision). The "Adamus Methodology" is a series of standardized criteria used to assign a qualitative rating to each of 12 wetland functions or values. Those functions are defined in Adamus Resource Assessment (ARA)(1987). It is important to recognize that the Methodology by itself does not assign a wetland to a management category (A, B, C, D, EP). Rather, its ratings are used in the initial step of assigning the wetland to a category, with most of the categorization process occurring after taking into account various weights pre-assigned to the functions, as well as availability of practicable alternatives (other buildable sites) and public preferences.

The standardized procedures and weighting factors that must be used to convert function ratings to final management categories are detailed in the Juneau Wetlands Management Plan (CDD 2008). Basically, observations are made of about 30 features while visiting a wetland. Those observations are screened by a series of criteria for each wetland function and value, to arrive at a numeric score for each. Scores for related functions are summed into scores representing three broad themes: Aquatic Support, Wildlife Support, and Human Use. Each sum is then "relativized" mathematically such that each of these themes contributes equally to the final score, which is the sum of the scores for the three themes. That score is then compared to the quintile for all assessed Juneau wetlands to determine if the site is in the highest 20% of all CBJ wetlands (quintile 1), the lowest 20% of all (quintile 5), or in one of the quintiles in between. The quintile position of the wetland is then used to arrive tentatively at a choice of management categories, e.g., B/C. The final selection among those choices is made based on the average of the Public Preference and Practical Alternatives ratings assigned in 1987. If that average score is greater than 3, then the least restrictive (i.e., C in the example just given) is chosen. If less than 3, the more restrictive choice is chosen. If equal to 3, then best professional judgment may be used.

As was true for the analysis we prepared for the CDD in 2007, for this study the "Adamus Methodology" as comprised of the function criteria in the Juneau Wetlands report (Adamus Resource Assessment 1987) was not used verbatim, because using that fully would have required equipment and time not available for this effort. Rather, we used the same streamlined criteria we used in 2007, as shown in Appendix B. Also, the wetland management categories used by the Juneau Wetlands Management Plan had originally been based partly by the computed quintiles of the weighted summed function scores for Juneau wetlands assessed in 1987. In our 2007 report, we recomputed the quintile ranges after adding our data from wetlands not included in the 1987 study. We used those modified (2007) quintiles for this study. Data required to assess the levels of the 12 functions were collected by Dr. Adamus while visiting all parcel units concurrently with Ms. Bosworth, who was primarily responsible for the delineations. In addition, existing maps and aerial photographs were used to assess some features important to particular wetland functions, such as proximity to roads, general soil type, intersections with streams, and surrounding land cover.

Study Area Description

Local 2010 Weather

The weather before and during the field work for the project was warmer and drier than normal. Approximately fifty percent of the length of Casa del Sol Ck. through the project area was dry at the surface during fieldwork and all of the smaller tributaries to Casa del Sol Ck. were dry. The ditch surrounding the sewage sludge disposal site was dry. Even though there was no surface water in these drainages they and their "floodplains" were saturated within 12 inches of the surface. 2.12 inches of rain fell on the 22nd and 23rd of June, well above the average for June (daily average for June is .11 inches). After a relatively normal July in terms of temperature and precipitation, Casa del Sol Creek and its tributaries were back to normal flow.

Table 1 - NOAA monthly weather data for the Juneau area

Month - 2010	**Trend**	**Mean Temp. °F**	**Ave Mean Temp - °F**	**Precip. inches**	**Ave Precip. inches**
Feb.	Warm and dry	36.3°	28.9°	1.53	4.02
March	Warmer and wetter	36.5°	33.7°	6.16	3.51
April	Slightly higher than normal precip. and temp.	41.9°	40.8°	3.08	2.96
May	Warmer and drier	50.8°	47.9°	1.25	3.84
June (1st-17th)	Warmer and very dry	53.9°	52.9°	.81	1.87

Juneau Area Wetland Types

Bog - A bog is a peat landform where the rooting zone is unaffected by runoff waters or groundwater from the surrounding mineral soils. Precipitation and snowmelt are the primary water sources. Bogs are therefore ombrotrophic ("cloud-fed"). Given that precipitation does not contain dissolved minerals and is mildly acidic, the surface bog waters are consequently low in dissolved minerals and are acidic. Bog water acidity, usually between pH 4.0 and 4.8, is enhanced due to the organic acids that form during decomposition of the peat and the acids present within *Sphagnum* peat. Generally the water table is at or slightly below the bog surface. As the bog surface is raised by an accumulation of peat, the water table stays at the surface. Most mature bogs in the Juneau area have 5-15+ feet of stratified *Sphagnum* peat and are dominated by a variety of *Sphagnum* moss species, ericacious sub-shrubs (crowberry, Labrador tea, bog kalmia and bog rosemary), sedges and stunted shore pine and mountain hemlock. Bogs in our coastal area are found on a variety of geo-morphological landforms but most often on shallowly-sloping to flat areas underlain by bedrock or relatively impermeable glacial till or uplifted glacio-marine sediments.

Fen - A fen is peat landform where the rooting zone has ground water or surface water flow through it. These waters are rich in dissolved minerals and are called minerotrophic. Fens in the Juneau area are dominated by shrubs and small deciduous trees (alder, crabapple, mountain ash) *Sphagnum* and sedges. Fens are often found at the toe-of-slope where ground water flowing downslope is forced to the surface by impermeable layers. They are also found as a transition zone between upland areas and bogs.

Forested Wetland - The forested wetlands in SE Alaska are almost always minerotrophic or fen type wetlands with western hemlock trees dominating. They are usually found in shallowly sloping lowland areas with poorly-draining glacial till or glaciomarine sediments underlying shallow (1.5-3 feet) mucky peats. They can also be found in riparian situations.

Marsh - A marsh is a minerotrophic wetland in which the water table is above the surface and can come from either or both, surface water and groundwater flow. Most of our marshes are estuarine or tidal salt marshes dominated by *Carex lyngbyei*. Freshwater marshes in the Juneau area are almost always dominated by *Carex sitchenisis* and *Scirpus microcarpus*.

Young wetlands - The recent glacial activity in this area has created conditions conducive to wetland development. Peat is slow to build up so early wetlands usually have a groundwater influence and are often classified as poor fens.

US Army Corps of Engineers wetland definition - "Those areas that are inundated or saturated by surface or ground water (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils).

Geomorphology, Hydrology and Soils
Industrial Blvd Unit

<u>Geomorphology</u>

During the Little Ice Age the lower Mendenhall Valley, along with all of northern SE Alaska, was depressed under the weight of increased glacial ice. As a result of this, sea level was higher and in the western part of the Mendenhall Valley the tide line reached north as far as the base of Hill 560, north of Glacier Highway and west to the base of the Mendenhall Peninsula. All of the project area was subtidal. Glacial silt and clay from the Mendenhall Glacier was carried out to Gastineau Channel by the Mendenhall River and deposited over the lower Mendenhall Valley in layers up to ten feet deep.

Figure 3 - 1962 photography of the Industrial Blvd. project area. Faint dotted lines are present property boundaries, light colored areas are freshwater wetlands and the darker areas in the lower half of the photo are intertidal and supratidal wetlands. The diagonal line of trees on the east side of the photo marks the route of an early ditch in the Industrial Blvd area where water is drained from the wetlands above Glacier Hwy and rerouted into the Mendenhall River.

The Mendenhall Glacier began retreating in the late 1700's and as the weight of the ice was removed, the land began rebounding. There has been approximately 10.5 feet of rebound or uplift in the Juneau area since the late 1700's. Right now the uplift rate for the Juneau area is 0.6 inches per year. As the land rose the flat deposits of glacial silts and clays were incised by developing intertidal channels. Those channels remain today in the project area as intermittent tributaries to Casa del Sol Creek - the largest drainage through the project area. The area is no longer intertidal but the highest tides reach up Casa del Sol Creek to within 600-700 feet of the south end of the project area.

Hydrology

The headwaters of Casa del Sol Creek are on Hill 560, north of the Unit one project area and to a lesser degree, on Pederson Hill, to the west. Figure 4 shows the full extent of the watershed and identifies the major tributaries to Casa del Sol Ck. The main upper channel comes off the south flank of Hill 560, runs behind the State Department of Motor Vehicles (DMV) building and enters the project area from the west just below the Fire Training Center. Other tributaries come off the southeast flanks of Hill 560,crossing the Brotherhood meadow and into Casa del Sol Creek just below the Fire Training Center (Figure 4). Smaller tributaries, draining out of wetland areas within and just beyond the boundaries of the project area, enter Casa del Sol at four points along its length through the project area. Casa del Sol Creek enters Gastineau Channel near the south end of Mendenhall Peninsula.

Importance of Ephemeral Streams to Salmon

Headwater channels that are dry for most of the year are still of potentially great importance to mobile fish including salmon. When they contain water and are physically accessible (especially with gradients less than 20%) without blockage by poorly designed culverts or dams, they provide temporary habitat space that contains an abundance of protein-rich insect foods and refuge from strong currents. This has been documented by several studies in the Pacific Northwest, e.g., Brown & Hartman 1988, Giannico et al. 2004, Steiner et al. 2004, and Colvin et al. 2009.

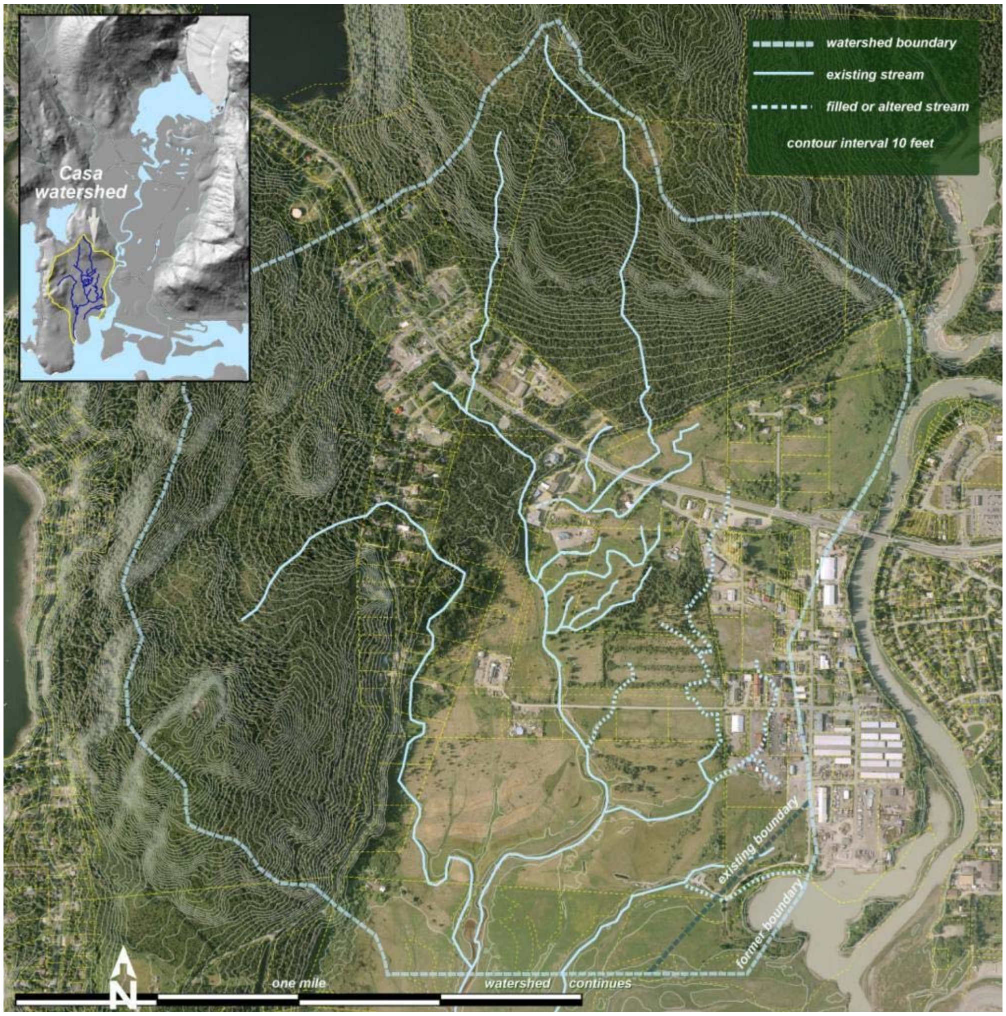

Figure 4 - Watershed map for Casa del Sol Creek showing the 3rd and 4th order streams outside of the project area and more detail within the project area. This map is meant to show the extent of the watershed not to detail all of the smaller streams within the watershed.

The Alaska Dept. of Fish and Game has catalogued all of the anadromous fish waters in the Juneau area. Casa del Sol Ck. and several of its tributaries have been catalogued as coho salmon rearing streams, dolly varden rearing streams and habitat for chum salmon (Figure 5). Fisheries reports indicate that Casa del Sol Ck. and its tributaries are very important coho rearing habitat.

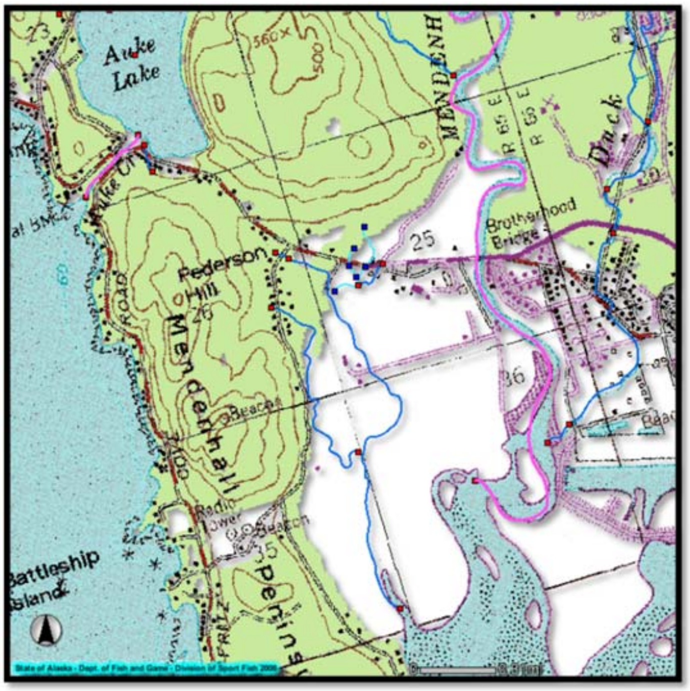

Figure 5 - ADF&G anadromous waters catalog map for the Casa del Sol watershed. Red and blue squares indicated sample points at which fish were present.

Fifteen acres of wetland at the eastern end of the project area were altered in the late 1970's by the CBJ during the construction of a sewage sludge disposal area. The site is enclosed by a dike approximately 4-5 feet high and 30-40 feet wide The dike appears to be made of sand and gravel though it is thought that the core might include other materials. This rectangle was further divided by two additional dikes, into three - 1000 foot long rectangles. A 400 foot long dike tails off the lower southwest corner of the enclosed area. Along the inside edge of these rectangles, 250-300, 9ft x 8ft. x 14ft. pits were dug and reported to have been filled with sewage sludge. A drainage ditch was dug around the perimeter of whole site. The ditch intercepts all surface and most groundwater flow upstream of the sewage sludge area and drains it south around the enclosure and then west into lower Casa del Sol Creek. This deprives the wetlands within the enclosure of a major source of water. The enclosure was also constructed across two relatively large streams and all downstream flow was cut off and the hydrology of the area was altered (Figures 3 & 4). The upper unit within the sewage sludge area has dried out considerably since construction. The lower unit still has remnants of the two stream channels and is the wettest of the three. Filling of the ditch (including restoration of the impermeable silt layer) and removal of the dikes would be the beginning of restoring the original wetland function to this area. A description and timeline of the history of the sewage sludge storage area is included as Appendix D.

Figure 6 - Remnant stream channel south of the sewage sludge disposal area.

Soils

Most of the Unit 1- Industrial Blvd. project area is underlain by a thick layer of relatively impermeable glacial/intertidal silts and clays with an occasional layer of silty sand.
The 1974 *Soils of the Juneau Area* (Figure 6), lists the soils of the Industrial Blvd unit as*:*

Poorly drained soils on very low-lying, nearly level alluvial plains. The soils consist of deep gray silty water-laid sediments that commonly contain thin strata of sandy materials and seams of peat. In most places these soils have a thick mat of partially decomposed organic material on the surface . The dominant vegetation consists of sedges and grasses, but in a few places the soils support stands of willow and alder or Sitka spruce and western hemlock. In most places it is susceptible to occasional overflow from freshwater streams, and in a few places it may be inundated by exceptionally high tides. The depth to the water table is usually less than one foot.

Figure 7 - 1974 soils map for the lower Mendenhall area

The soils are less than 100 years old and they have not developed the characteristics typical for older hydric soils, but have the minimum necessary to be called a hydric soil (8+ inches of saturated organic material or gleyed soils with redox concentrations within 12 inches of the surface).

Figure 8 - Young wetland soil typical for Industrial Blvd project area. Saturated *Sphagnum* peat over uplifted intertidal silt.

In areas along the deeply incised, steep-banked, drainages, such as Casa del Sol Creek and its upper tributaries, the silt layer has been breached and the surface drained. Hydric soil conditions are not present. In these areas a young loamy soil has developed (Figure 9).

Figure 9 - Soil typical to upland areas in the Industrial Blvd project area. Unsaturated organic material and loamy soil over uplifted intertidal silt.

Wetland Maintenance

Because glacial silts and clays are relatively impermeable to water, in flat undrained areas this layer perches the water table creating ideal wetland conditions (Figure 8). These conditions will maintain the area's wetlands unless drainage conditions are changed by intentional or unintentional ditching and/or filling. Isostatic rebound in itself will not drain wetlands. Rebound raises all of the land surface evenly - the flat wetland areas at the top of Hill 560 are being uplifted at the same rate and the same amount as the wetlands in the lower west part of the Mendenhall Valley. The only difference is the lower areas proximity to energetic streams that are incising relatively quickly through soft sediments rather than through bedrock (these streams also got a head start incising during the time they were intertidal channels) (Figure 10). The steep banks of these streams will drain the area near them. Lower energy streams with less flow will incise less and will not drain the surrounding area (Figure 21).

Figure 10 - The incised channel of Casa del Sol Creek during a very dry month.

The 1962 aerial photography (Figure 3) shows that almost all of the lower west part of the Mendenhall Valley was wetland in 1962. The only uplands are the narrow bands along the incised streams, the old Glacier Highway, the fill for a few homesteads and along a ditch that drained the wetlands above Glacier Highway, away from Casa del Sol Creek and into the Mendenhall River. As roads were built (always with ditches alongside them) and wetlands were filled for development, the surface and shallow groundwater flow that maintains the wetlands was disrupted and channeled directly into streams, rivers or the ocean.

Hill 560 Unit

Geomorphology

The Hill 560 project area is located on a relatively flat bench at the 400 ft. level on a 560 ft. high hill just east of Auke Lake and west of Mendenhall River. The hill is bedrock cored and there are small bedrock outcrops within the project area (Figure 11). The bench was not directly affected by the Little Ice Age glacial activity and so has developed an old, fairly extensive wetland complex including forested wetlands, poor fens, bogs and streams. The project area includes the eastern 1/3rd of this complex.

Figure 11 - Bedrock exposure near center of Hill 560 area bog

Hydrology

Four perennial and several smaller intermittent streams flow through or originate within the project area (Figures 4, 12, 50). The watershed map for Casa del Sol Creek (Figure 4) shows that the watershed boundary goes through the eastern part of the Hill 560 project area. Two of the perennial steams flow south and west into Casa del Sol Creek, one southeast into Mendenhall River and one, southeast and then northeast, into Montana Creek.

Figure 12 - Stream through Hill 560 project area

Soils

The soils of the Hill 560 project area transition from deep acidic *Sphagnum* peats in the center of the bog, to less acidic peats in the fen area just outside the bog, to mucky peat in the forested wetland just outside the fen and then into upland forest soils in the well-drained spruce/hemlock forest at the outer edge of the project.

The 1974 *Soils of the Juneau Area*, lists the soils of the Hill 560 unit as*:*

Peats of fens and bogs (Figure 13) - *Kogish Series soils consist of very poorly drained nearly level to strongly sloping peat soils that occur in valleys and on broad benches The peat material are derived chiefly from sphagnum moss, which is the dominant vegetation. The peat materials are more than five feet thick. The water table is near the surface.*

Figure 13 - *Sphagnum* peat in bog on Hill 560.

Mucky peats of forested wetlands (Figure 14**)** - *Maybeso Series soils consists of very poorly drained soils of nearly level to strongly sloping seepage areas, drainage ways and benches. These soils are made up of mucky peat 16 to 50 inches thick over glacial till. They support a forest of western hemlock and scattered Sitka spruce. The water table is usually less than two feet below the surface.*

Figure 14 - Mucky peat in forested wetland in Hill 560 project area.

Vegetation

Industrial Blvd Unit

There are two basic community types within the Industrial Blvd. project area:

1. The community along Casa del Sol Ck. and its tributaries is an upland community dominated by species typical to beach meadow communities such as cow parsnip (*Heracleum lanatum*), fireweed (*Epilobium angustifolium*), bluejoint (*Calamagrostis canadensis*), Bering hairgrass (*Deschampsia beringensis*) and sweetgrass (*Hierochloe oderata*) (Figures 14 & 15) . In some places in the north part of the project area scattered Sitka spruce (*Picea sitchensis*) seedlings and saplings are springing up in this community. The dikes of the sewage sludge disposal area have a young, weedy dense upland community of Sitka spruce, cottonwood (*Populus balsamifera*), Sitka alder (*Alnus sinuata*), Sitka willow *(Salix sitchensis*) and fireweed (*Epilobium angustifolium*) (Figure 17).
2. The second community type is the wetland type found in the flat undrained parts of the project area and is dominated by *Sphagnum* spp. This community can be subdivided into two distinct types:
   - those of the northern part of the project area and the northern unit of the sewage sludge area, that have a proto-bog type of vegetation dominated by *Sphagnum* sp., bog cranberry (*Vaccinium oxycoccus*), many-flowered sedge (*Carex pluriflora*) and atypically, for a mature bog at least, Sitka spruce (*Picea sitchensis*). The presence of vigorous Sitka spruce in this wetland community, though it would be unusual for a mature bog, does not mean that these areas are not wetland. The shallow peat layer and the tendency of the trees to elevate their roots makes them able to grow in these wetland areas (Figure 18)
   - the larger areas of the southern part of the project area and the southern two units of the sewage sludge area, that are dominated by Sphagnum sp., rusty cottongrass (*Eriophorum russeolum*), marsh cinquefoil (*Potentilla palustris*), bog cranberry (*Vaccinium oxycoccus*), many-flowered sedge (*Carex pluriflora*) and <u>no</u> Sitka spruce - except along the edges (Figure 19).

   Along the drainages and in shallow wet swales there are a variety of small community types:

   - the narrow floodplain of Casa del Sol Ck. and some of its tributaries have a lush community of marsh marigold (*Caltha palustris*), horsetail (*Equisetum arvense*), creeping buttercup (*Ranunculus repens*), skunk cabbage (*Lysichiton americanum*), and spreading clones of reed canary grass (*Phalaris arundinacea*) (Figure 20).
   - the shallow swale that is the Snyder tributary in the west corner has an unusual assortment of species including water hemlock (*Cicuta douglasii*), meadow foxtail (*Alopecurus geniculatus*), giant mannagrass (*Glyceria maxima*) and marsh marigold (Figure 21).
   - the cut-off stream channels in the lower sewage units and below the sewage sludge disposal area are marsh and floating Sphagnum mat areas now and have a distinct marsh flora of Sitka sedge (*Carex sitchensis*), water hemlock, marsh cinquefoil, many-flowered sedge (*Carex pluriflora*) and rusty cottengrass (Figure 22).

Figure 15 - Upland community dominated by fireweed and bluejoint grass.

Figure 16 - Upland community dominated by bluejoint grass and chocolate lily.

Figure 17 - Upland community on sewage sludge disposal site dike. Sitka spruce and alder dominate.

Figure 18 - Young bog community with *Sphagnum* sp. bog cranberry and Sitka spruce.

Figure 19 - Young bog community with *Sphagnum* sp. rusty cottongrass and many-flowered sedge.

Figure 20 - Casa del Sol Ck. floodplain wetland with marsh marigold, creeping buttercup and skunk cabbage.

Figure 21 - Snyder tributary to Casa del Sol Ck. with giant mannagrass and Sitka sedge.

Figure 22 - Marsh community in sewage #3 with marsh cinquefoil and Sitka sedge.

Invasive species

Most populations of non-native species found in the Juneau area occur in disturbed areas and will not invade undisturbed native communities. But there are some non-native species that are very invasive and seem to be able to invade undisturbed native communities. And unfortunately there are lots of natural disturbances occurring in the area that create the opportunity for many of these species to spread beyond the human footprint such as: glacial activity, flooding on a large and small scale, isostatic rebound, avalanches, landslides, wind-throw, animal disturbances and transport of propagules, drought and changes in river and stream channels.

Within the Industrial Blvd. unit there are a number of human-caused disturbances that may have contributed to the spread of invasive species:

- disturbance of native communities by the construction of roads, trails and buildings
- pasturing and transit of domesticated animals - imported feed (hay and grain) has a lot of weed seed in it, that is spread through feeding out and dung. This area has horses pastured nearby and a trail through it that is used by riders. There was a dairy in the area back in the 1940's and 1950's and I'm sure that the cows were grazed in this area.
- intentional seeding of disturbed areas for soil stabilization - one of our worst invasive species (reed canary grass) and many other less invasive species were used for many years in seed mixes that were spread on road and construction area edges.
- lots of invasive propagules are spread from infested areas to uninfested areas on the tires and undercarriages of trucks, equipment, and ATV's.

The Alaska Natural Heritage Program , the US Forest Service and several other state and federal agencies have developed an invasive species ranking system for Alaska that is focused on impacts to the ecological functioning of natural systems and predicting negative impacts to those natural systems in Alaska. I have listed the invasive species found within or just upstream of the project area along with their invasiveness ranking.

Non-native Species	Invasiveness ranking
Mouse-eared chickweed *(Cerastium fontanum)*	39
Orchard grass *(Dactylis glomerata)*	53
Orange hawkweed *(Hieracium aurantiacum)*	79
Fox-tail barley *(Hordeum jubatum)*	63
Ox-eye daisy *(Leucanthemum vulgare)*	61
Pineapple weed *(Matricaria discoidea)*	32
Reed canary grass *(Phalaris arundineacea)*	83
Timothy *(Phleum pratense)*	56
Common plantain *(Plantago major)*	44
Annual bluegrass *(Poa annua)*	46
Kentucky bluegrass *(Poa pratensis)*	52
Creeping buttercup *(Ranunculus repens)*	54
Common chickweed *(Stellaria media)*	42
Common dandelion *(Taraxacum officinale)*	58
White clover *(Trifolium repens)*	59
Bohemian knotweed (Polygonum bohemicum)	87

There are two species found in the project area that have very high invasiveness rankings, orange hawkweed (*Hieracium aurantiacum*) - 79 and reed canary grass (*Phalaris arundineacea*) - 83. Bohemian knotweed (Polygonum bohemicum) - 87, is found just upstream of the project area and near the stream bank. It could very easily spread into the project area. Creeping buttercup (*Ranunculus repens*) has an invasiveness ranking of 54 but is very well established in the narrow floodplain along Casa del Sol Ck. and seems to have squeezed out many of the native species that would be growing along the creek, including a native buttercup, *Ranunculus occidentalis*. Further disturbance in the area of the creek will allow the spread of this invasive species.

Orange hawkweed description: A fibrous rooted perennial herb in the Aster family that grows 10-36 inches tall and branching at the top to produce flower heads. Erect stems usually do not have stem leaves, contain a milky juice and are covered with stiff hairs. The simple leaves are basal with 1 or 2 leaves measuring about 4 ½ inches in length. Both leaves and stems are covered with hairs. Conspicuous orange-red ray flowers, bloom June –September with 5 to 35 flower heads. Each flower produces 12-30 tiny seed that are dark brown or black, cylindrical, elongated, longitudinally ridged, barbed and bristled. Seeds can be dispersed by wind, water, or "hitch-hiking," and are often moved in contaminated soil associated with transplanting new plants into gardens and flowerbeds. Seeds remain viable in soil for up to 7 years. The roots are shallow and fibrous with aboveground stolons (that resemble strawberry runners) and below ground rhizomes that allow for aggressive vegetative reproduction. Stolons originate from buds in the rosette when plants flower. These runners radiate out from the original plant and form new rosettes where they touch down and take root.

Figure 23 - Orange hawkweed

Ecological impacts of orange hawkweed: Orange hawkweed reproduces and spreads through prolific seed production as well as vegetatively through stolons, and rhizomes. Under ideal conditions, one plant can spread and infest an area 2–3 feet in diameter in its first year of growth. It forms extensive mats that can compete with and completely exclude native meadow and forest understory plants. It is an aggressive competitor for space, light, and soil nutrients. It has been reported to be allelopathic, producing phytotoxic chemicals in pollen grains that inhibit seed germination, seeding emergence, or regeneration of other plants.

Description of reed canary grass: Reed canary grass is a large, coarse grass in the grass family (Poaceae) that reaches 2 to 9 feet in height. The compact panicles are erect or slightly spreading (depending on the plant's reproductive stage), and range from 3 to 16 inches long with branches 2 to 12 inches in length. Single flowers occur in dense clusters in May to mid-June. They are green to purple at first and change to beige over time. Shiny brown seeds ripen in late June and are dispersed by waterways, animals, humans and machines. Roots have short, stout rhizomes that root at the nodes forming a thick fibrous root mass. It reproduces by seeds and creeping rhizomes.

Figure 24 - Reed canary grass

Ecological Impacts of reed canary grass: It has become naturalized in much of the northern United States and southern Canada. Over time, it can form large colonies that spread throughout a wetland or floodplain. It is now invading forested sites and limiting tree regeneration. Few plants can grow in areas dominated by reed canary grass. In areas on the Kenai Peninsula, dense reed canary grass colonies have invaded stream beds and completely eliminated fish passage in those streams. There are several clonal patches of reed canary grass within the project area. These are all along Casa del Sol Ck. and in one patch the grass is growing into the creek channel (Figure 25).

Figure 25 - Spreading clump or clone of reed canary grass along in Casa del Sol Ck.

PLANT SPECIES LIST

Scientific name/common name/wetland indicator status
Achillea millefolium/yarrow/FACU
Alnus sinuata/Sitka alder/FAC
Angelica genuflexa/kneeling angelica/FACW
Athyrium felix-femina/lady fern/FAC
Calamagrostis canadensis/bluejoint/FAC
Caltha palustris/marsh marigold/OBL
Carex kelloggii/Kelloggs sedge/OBL
Carex lyngbyei/Lyngbye's sedge/ OBL
Carex macrochaeta/long-awned sedge/OBL
Carex pauciflora/few-flowered sedge/ OBL
Carex pluriflora/many-flowered sedge/OBL
Carex sitchensis/Sitka sedge/OBL
Cicuta douglasii/water hemlock/OBL
Cornus canadensis/ dwarf dogwood/FACU
Deschampsia beringensis/Bering hairgrass/FAC
Equisetum arvense/ horsetail/ FAC
Eriophorum russeolum/rusty cottongrass/OBL
Fritillaria camschatcensis/chocolate lily/FAC
Geum macrophyllum/big-leafed avens/FACW
Glyceria maxima/giant mannagrass/OBL
Heracleum lanatum/cow parsnip/FACU
Hierochloe oderata/holygrass/FACW
Iris setosa/Alaska iris/FAC
Ledum groenlandicum/Laborador tea/FACW
Luzula parviflora/ woodrush/FAC
Lysichiton americanum/ skunk cabbage/OBL
Maianthemum dilatatum/deer berry/NI
Menyanthes trifoliatum/buck bean/OBL
Menzisia ferruginea/false azalea/NI
Malus fusca/crabapple/FACU
Picea sitchensis/Sitka spruce/FACU
Phalaris arundinacea/reed canary grass/OBL
Phleum pratense/timothy/FACU
*Plantago macrocarpa/*Alaskan plantain/FACW
Platanthera dilatata/white bog orchid/FACW
Polygonum bohemicum / Bohemium knotweed/NI
Potentilla palustris/marsh cinquefoil/OBL
Ranunculus occidentalis/western buttercup/FACW
Ranunculus repens/creeping buttercup/FAC
Rubus arcticus/nagoonberry/FAC
Rubus pedatus/ trailing raspberry/FAC
Rubus spectabilis/ salmonberry*/FACU*
Salix sitchensis/ Sitka willow/FAC
Salix barclayi/Barclay's willow/FAC
Sanguisorba canadensis/Canada burnet/FACW
Taraxacum officianale/dandelion/FACU
Trientalis arctica/ starflower/FAC
Tiarella trifoliata/foamflower/FAC
Tsuga heterophylla /Western hemlock/FAC
Vaccinium ovalifolium/ early blueberry/FAC
Vaccinium oxycoccus/bog cranberry/OBL
Viola langsdorffii/Alaska violet/FACW

Wetland Indicator Status Key

Indicator Code	Wetland Type	Comment
OBL	Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW	Facultative Wetland	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FACU	Facultative Upland	Usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).
UPL	Obligate Upland	Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified. If a species does not occur in wetlands in any region, it is not on the National List.
NI	No indicator	Insufficient information was available to determine an indicator status.

Hill 560 Unit

As with the soils, the vegetation on the Hill 560 project area transitions outward from the bog to the fen to the forested wetland to the upland forest.

- **Bog** - The Hill 560 bog varies from open and acidic, dominated by *Sphagnum* species with small amounts of tufted clubrush (*Trichophorum cespitosum*), livid sedge (*Carex livida*) and stunted shore pine (*Pinus contorta*)(Figure 26) to a less acidic bog with a variety of *Sphagnum* species, more trees - shore pine and mountain hemlock (*Tsuga mertensiana*) and dominated by ericaceous subshrubs - Labrador tea (*Ledum groenlandicum*), crowberry (*Empetrum nigrum*), bog laurel (*Kalmia polifolia*) and few-flowered sedge(*Carex pauciflora*) (Figure 27).
- **Fen** - The narrow ring of fen that surrounds the bog has a dense cover of shrubs, mostly blueberry (*Vaccinium ovalifolium*) and a small amount of rusty menziesia (*Menziesia ferruginea*). There is less than 10% cover of western and mountain hemlock and shore pine and an herbaceous layer of goldthread (*Coptis asplenifolia*), cloudberry(*Rubus chamemorus*), bracken fern (*Pteridium aqualinum*) and skunk cabbage (*Lysichiton americanum*) (Figure 28).
- **Forested wetland** - This community is just outside and downhill of the fen community. The overstory is dominated by western hemlock and the understory is made up of blueberry and skunk cabbage (Figure 29).
- **Upland forest** - Because of the way the boundary was drawn there is very little of this within the project area - just the outer edges where the hillside gets steeper. The overstory trees are western hemlock and Sitka spruce and the understory is blueberry, rusty menziesia, trailing raspberry (*Rubus pedatus*) and dwarf dogwood.

Figure 26- Acidic bog dominated by *Sphagnum* and tufted clubrush.

Figure 27 - Hill 560 bog dominated by shore pine, mountain hemlock, Labrador tea and crowberry.

Figure 28 - Shrubby fen with mountain hemlock, blueberry and bracken fern.

Figure 29 - Forested wetland dominated by western hemlock, blueberry and skunk cabbage.

Plant Species List

Scientific name/ common name/ indicator status
Picea sitchensis/Sitka spruce/FACU
Tsuga heterophylla /western hemlock/FAC
Tsuga mertensiana/ mountain hemlock/ FAC
Pinus contorta/shore pine/FAC
Vaccinium ovalifolium/ early blueberry/FAC
Menziesia ferruginea/false azalea/NI
Alnus sinuata/Sitka alder/FAC
Oplopanax horridum / devils club/FACU
Sambucus racemosa/elderberry/FACU
Malus fusca/crabapple/FACU
Gymnocarpium dryopteris/ oak fern/ FACU
Dryopteris dilatata/spiny wood fern/FACU
Lysichiton americanum/ skunk cabbage/OBL
Coptis asplenifolius/ goldthread/FAC
Cornus canadensis/ dwarf dogwood/FACU
Rubus pedatus/ trailing raspberry/FAC
Athyrium felix-femina/lady fern/FAC
Streptopus streptopoides/ twisted stalk/FAC
Equisetum arvense/ horsetail/ FACU

Vaccinium caespitosum/ dwarf blueberry/FACW
Vaccinium vitis idea/cranberry/FAC
Ledum groenlandicum/Laborador tea/FACW
Maianthemum dilatatum/deer berry/NI
Tiarella trifoliata/foamflower/FAC
Circeae alpina/enchanters nightshade/FACW
Fauria crista-galli/deer cabbage/FACW
Carex pauciflora/small-flowered sedge/OBL
Carex livida/livid sedge/OBL
Rubus chamaemorus/cloudberry/FACW
Gentiana douglasiana/Douglas gentian/FACW
Menyanthes trifoliata/buckbean/OBL
Empetrum nigrum/crowberry/FAC
Carex pluriflora/many-flowered sedge/OBL
Pteridium aqualinum/bracken fern/FACU
Kalmia polifolia/bog laurel/FACW
Rubus pedatus/trailing raspberry/FAC
Vaccinium oxycoccus/bog cranberry/OBL
Drosera rotundifolia/round-leafed sundew/OBL

Findings: Delineation

Jurisdictional wetlands and waters of the US were found in both the Industrial Blvd. Unit and the Hill 560 Unit. In the Industrial Blvd. Unit, 16.1 acres out of 36.5 acres total were found to be wetland or 44% (Figure 30). In the Hill 560 unit 17.1 acres out of a surveyed total of 24 acres was found to be wetland or 71% (Figure 50). Appendix A contains a table of individual wetland acreages and stream lengths.

Industrial Blvd. Unit
Casa del Sol Area

A comparison of the wetlands depicted in the Industrial Blvd. unit in the 2008 Juneau Wetlands Management Plan (Appendix E) and those mapped in this project indicates a considerable reduction in wetland amount in the 30+ years since the earlier plan was written - approximately 93% wetland in 1980's (based on Google Earth calculation of FTC fill and sewage sludge area dike fill) and 44% wetland in 2010. It is tempting to hypothesize that isostatic rebound is the major cause of this reduction but it is likely that most of the difference is due to lack of field wetland delineation during the earlier project. The wetland mapping units used for that project were obtained from U.S. Army Corp of Engineers and U.S. Fish and Wildlife Service - National Wetland Inventory maps. The wetland units for these maps were done from black and white aerial photography and not field checked. It is often difficult to distinguish well -drained meadow vegetation and young bog vegetation from these aerial photographs. Another difficulty can be in distinguishing upland forest from forested wetland and shrub wetlands and young shrubby alluvial forests . The fringing forested wetland in the Hill 560 area was probably not included in the earlier report. Since field wetland delineations were not done during the 1987 work it would be difficult to document the change in wetland amounts between the 1980's and now. But now that we have carefully delineated wetlands in this project area and in other CBJ parcels it will be possible to monitor for changes in wetland amounts:

- *Delineation and Function Rating of Jurisdictional Wetlands on Potentially Developable City-owned Parcels*, Adamus and Bosworth, 2007
- *Hill 560 Wetland Delineation* , Bosworth, 2009
- *Vanderbilt Creek Wetland Delineation*, Bosworth, 2008
- *Fish Creek Quarry Wetland Delineation*, Bosworth, 2007
- Eight Eaglecrest development project wetland delineations, 2006-2009
- Five CBJ - Engineering Dept. delineations, 2006-2009

The U.S. Army Corps of Engineers requires that to maintain a wetland permit, wetlands be redelineated every five years. This would be a reasonable interval to use for planning further study of the effects of isostatic rebound on wetlands in the present project area and in the Juneau area as a whole.

Although it would take a geomorphologist or hydrologist to accurately predict the long term stability of the uplifted intertidal wetlands of the lower west Mendenhall Valley, it is possible for most of us to infer the trend for this type of wetland from other wetlands in the Juneau area. There are only a few places in the CBJ where this community type survives undeveloped and even in these areas much of the watershed above the wetland area has been developed and the conditions needed to maintain the wetland in the long term are gone.

- In the Lemon Creek area, the Vanderbilt Creek wetlands are an example of a very productive wetland complex developing partly on uplifted intertidal sediments. The northwestern part of this wetland complex and the watershed that supports these wetlands has been reduced considerably by development in the Home Depot, Costco, commercial park area. Just above the young wetlands on uplifted intertidal sediments, is a small, deep-peated, old bog. Its presence indicates that geomorphic conditions are such that undisturbed wetlands can be maintained there for the long term.
- A very similar suite of wetlands occurred in the Switzer Creek area - young wetlands on uplifted intertidal sediments with older bogs on similarly flat land just above them. Most of the young wetlands have been developed and only the well-drained creek-edge meadows remain.
- Only small, isolated examples of this wetland type still occur in the lower Mendenhall Valley, and most of these are along the protected and usually well-drained edges of Jordan Creek and Duck Creek.
- The best undeveloped, examples, of these young, uplifted intertidal sediment wetlands and the closely associated old bogs occur out Glacier Highway in the Pederson Creek/ Saga Valley, Strawberry Creek Valley, the Herbert/Eagle River/Eagle Beach area and further out the road at the Cowee Creek meadows. These valleys and their richness and importance as fish and wildlife habitat is well documented in a 2003 report for the Southeast Alaska Land Trust, *Risen Valleys Wildlife Habitats of Juneau's Premier Natural Area - 24- to 29-mile, Glacier Highway* by Richard Carstensen.

Figure 30 - Wetland Delineation Map for Industrial Blvd Unit

Fire Training Center Area Wetlands

Figure 31 - Fire training center wetland detail.

Wetland: Casa #1 - Casa #1 is a small, .02 acre remnant of an old tidal slough and stream that originally drained a now filled wetland that was just east of Sherwood Lane. It now drains the upper part of the paved Fire Training Center (FTC) by way of a ditch. It is culverted under the FTC driveway and under the Miller construction yard access road and then flows into Casa del Sol northwest of the project boundary. It is dominated by Sitka sedge.

Figure 32 - Wetland casa #1

Wetland: Casa #2- Casa #2 is a .03 acre, cement- lined settling pond with shallow-edge vegetation dominated by water hemlock. A small stream whose headwaters are northeast of the FTC comes through the pond and joins Casa del Sol Ck. just south of the FTC.

Figure 33 - Wetland casa #2.

Figure 34 - Outfall for the casa #2 settling pond.

Wetland: Casa #3 - Casa #3 is a .33 acre, young, shallow-peated bog with open-grown Sitka spruce.

Figure 35 - Wetland casa #3

Wetland: Casa #4 - Casa #4 has the same character as Casa #2 though it is larger. The part of this wetland that is within the project area is .66 acres. It extends east of the project area boundary by the same acreage. It is a young, shallow-peated bog with *Sphagnum*, bog cranberry and open-grown Sitka spruce.

Figure 36 - Casa #3 under large Sitka spruce.

Southwest Corner Wetlands

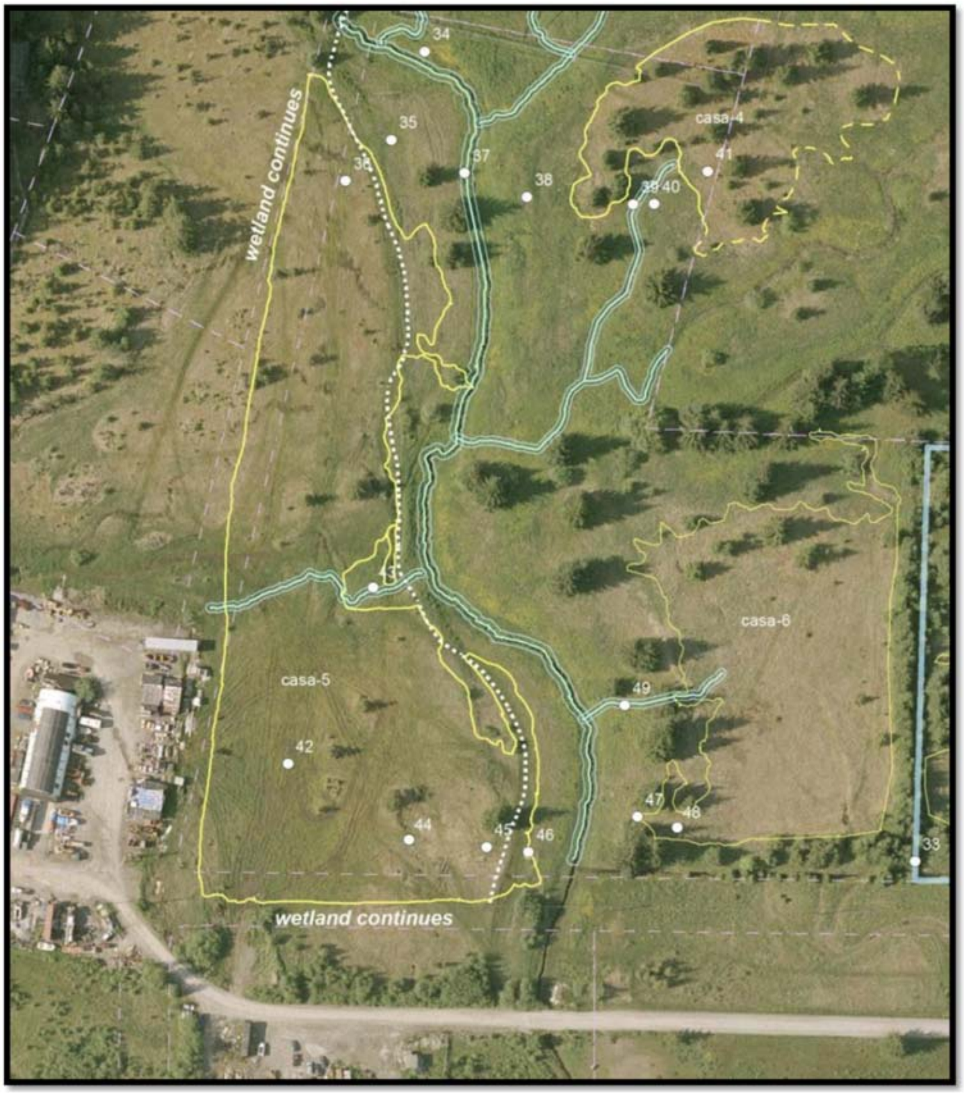

Figure 37 - Detail for southwest corner wetlands.

Wetland: Casa #5 - Casa #5 is a five acre, young bog, dominated by *Sphagnum* sp. and rusty cotton grass. The boundaries of this wetland extend beyond the project area boundaries on the west and the south.

Figure 38 - Wetland Casa #5

Wetland: Casa #6 - Casa #6 is a 2.3 acre young, bog w/ *Sphagnum* sp. and rusty cottongrass.

Figure 39 - Wetland Casa #6.

Sewage Sludge Disposal Area

Figure 40 - Detail for sewage sludge disposal area. The blue-grey lines around the outside of the dikes indicate the ditch.

Figure 41 - Wetland Sewage #1, Human-altered young bog. 1.5 acres

Figure 42 -Upland western end of sewage #1.

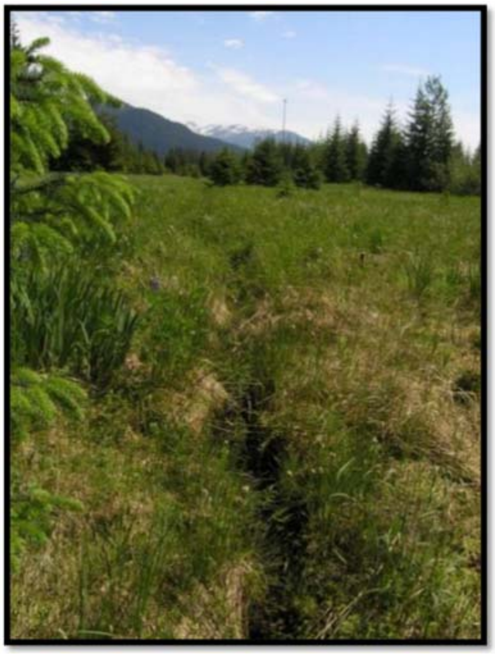

Figure 43 - Wetland sewage #2 is a human-altered young bog. 2.8 acres

Figure 44 - An typical example of the 200-300 sewage disposal pits in the area.

Figure 45 - Some of the sewage pits have more vegetation growing around them.

Figure 46 - The dike between sewage #2 and #3.

Wetland: Sewage #3 -Sewage #3 is 2.7 acre, human-altered, young bog dominated by Sitka sedge and rusty cotton grass. Marsh conditions occur where old stream channels have been dammed by the dike.

Figure 47 - Wetland sewage #3 - young bog

Figure 48 - Wetland sewage #3 - marsh.

Figure 49 - Ditch surrounding sewage sludge disposal area during dry spell.

Hill 560 Area

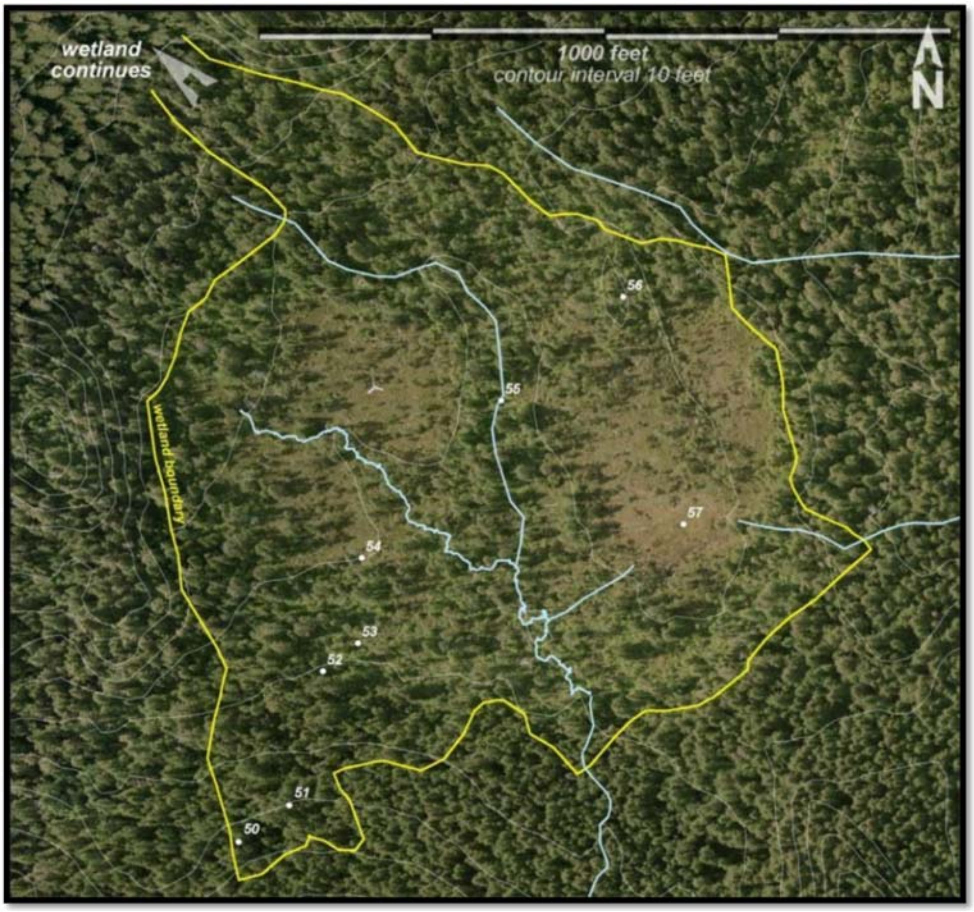

Figure 50 - Hill 560 project area wetland delineation map.

Wetland: #1 - Bog with fringing fen and forested wetland.

Figure 51 - Forested wetland dominated by western hemlock, blueberry and skunk cabbage.

Figure 52 - Shrubby fen community dominated by blueberry bracken fern and mt. hemlock.

Figure 53 - Fen-bog ecotone

Figure 54 - Bog

Findings - Assessment of Functions

Casa del Sol Area

This wetland is intersected by a few small non-tidal channels comprising the upper reaches of "Casa del Sol Creek." also known as Pederson Hill Creek. A short distance downstream from the wetland the channels become tidal and flow year-round, and decades ago this was probably true also of the channels within the site, but due to glacial rebound they are no longer tidal. Portions of the wetland closest to the intersecting ephemeral channels are sloping and have silty soils, whereas most of the wetland is flat and has organic soils and scattered large Sitka spruce trees. Most of this wetland overlaps a wetland labeled as MW3 in the 2008 Juneau Wetlands Management Plan, and the Plan assigned that to category B. Our re-assessment changes that rating to category C. Its moderately low rating is due mainly to low scores for groundwater discharge and salmonid habitat. Although coho have recently been spotted in channels very near this site, use is ephemeral so habitat is rated slightly lower than for perennial streams according to the 1987 criteria.

Sewage Sludge Disposal Area

This wetland adjoins the one described above, but is not intersected by any channels. A short distance off-site from the wetland the channels are tidal and flow year-round. Up until about 30 years ago this site, which is surrounded by dikes and ditches, was built to be used as a disposal area for sewage. No evidence of that is now overtly apparent. Wetland vegetation within the dikes is mostly *Sphagnum* moss, which in places seems to be floating in shallow water or on a high water table. Most of this wetland overlaps a wetland labeled as MW4 in the 2008 Juneau Wetlands Management Plan, and the Plan assigned that to category B. Our re-assessment changed that rating to D. Its low rating is due mainly to low scores for salmonid habitat and wildlife support. The latter function was rated low partly due to lack of trees or extensive ponded water within the wetland, lack of salmon access, and lack of connectivity to large forested tracts.

Hill 560 Area

This very large hilltop wetland is on a hilltop east of Auke Lake. Part of this wetland overlaps a wetland labeled as A1 in the 2008 Juneau Wetlands Management Plan, and the Plan assigned that part to category C. The quintile score resulting from our re-assessment places it in category B/C, and because the average of its Public Preference and Practical Alternatives scores is 3, a final rating is not assigned automatically but must be chosen based on best professional judgment. We recommend it be placed in category B, due to its unusual character (only hilltop bog this close to Juneau), likely importance as headwaters for several anadromous fish streams, a groundwater recharge area, and potential source of dissolved organic carbon to channels farther downslope. The reasons for its being assigned to category C in the 2008 Juneau Wetlands Management Plan are unclear, but may be due partly to slightly different criteria used for the wildlife habitat function, which scored lower then than during this assessment. For the 2008

JWMP (which again is based on the 1987 analysis and 1992 plan) the wetland was not visited and criteria were applied based only on assumed conditions, and it thus may be expected that our 2010 assessment provides a more accurate rating.

The wetland's rating is constrained mainly by lack of fish access, low recreational use, and low capacity for riparian support. The flatter central part of the wetland is an ombrogenous bog dominated by *Sphagnum* moss and stunted shore pine and with many small pools. The more rolling edges are parklands dominated by shore pine and ericaceous subshrubs. The spur off the southern end of the wetland is a forested wetland dominated by western hemlock and skunk cabbage. The soils are all hydric, mostly of the Kogish and Wadleigh Series, and the water table was at or within 12 inches of the surface during June.

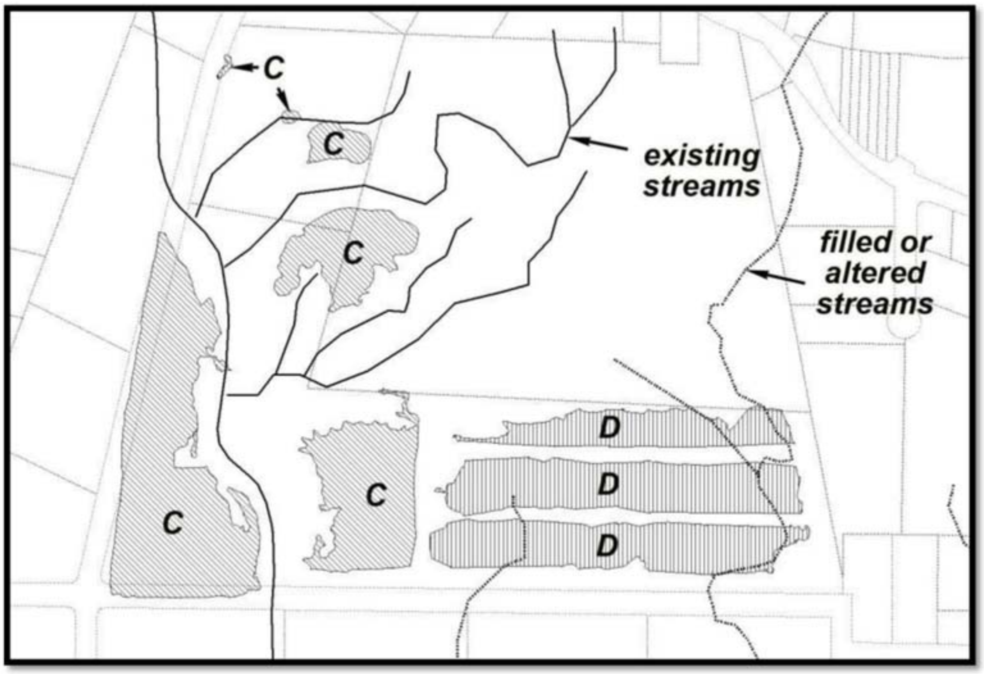

Figure 55 - 2010 wetland ratings for the Casa del Sol and sewage sludge areas.

<u>Wetland Management Categories and Management Policies</u>

A - Maintain all individual functional values in the wetland unit. One environmental function cannot be substituted for another.
B - Maintain all aggregate functional values in the wetland unit. One environmental function can be substituted for another.
C - Maintain overall functional value on roaded system. No net loss of aggregate value to region.
D - Minimize adverse impacts to functional values.

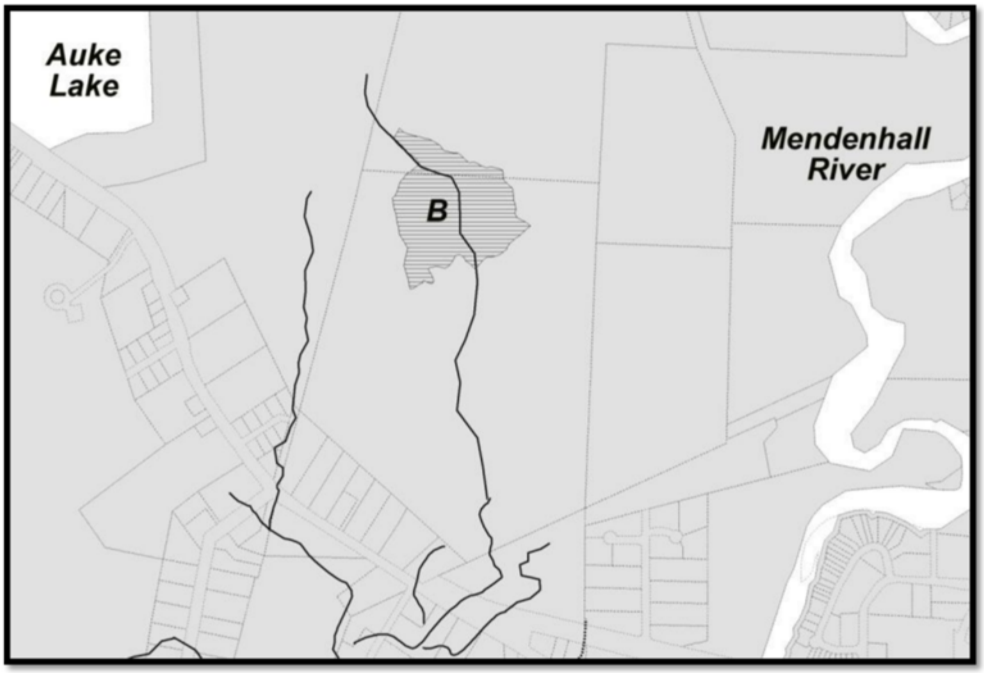

Figure 56 - Wetland rating for the Hill 560 wetland area.

Results of WESPUS Assessment of These Wetlands

Although not previously used in Alaska, a draft of a new standardized protocol for assessing wetland functions and values, which has not yet been modified for Southeast Alaska, was applied to these wetlands by its primary author (Adamus et al. 2010). Called WESPUS (Wetland Ecosystem Services Protocol for the United States), it generated the scores shown in Appendix C. Use of WESPUS was not required by this contract.

Impacts of Off-road Vehicles on Wetlands

In Alaska, environmental damage caused by ORVs has been documented in the literature since the early 1970's (Loomis & Liebermann 2006). Wetlands are the land cover type which is most easily affected by all-terrain vehicles (ATVs), a type of off-road vehicle (ORV). Wetlands with peaty or fine-textured soils are most sensitive and slowest to recover, whereas gravelly soils are affected the least. The compaction of wetland soils and vegetation by ATVs potentially impacts several wetland functions:

- Crushing kills vegetation directly and it then ceases to provide effective wildlife habitat.
- Additional plants are killed when their roots cannot get enough oxygen because air spaces within soils have been eliminated by compaction, or when ruts caused by ATVs fill with

water that drowns plants, or when plants are coated with dust or mud from adjoining ATV trails.
- Even the plants that survive tend to be less productive when growing on compacted soils, partly because they are less able to take up nitrogen essential to their growth.
- Killing of vegetation exposes underlying soils to increased erosion.
- ATV trails also tend to channel runoff rather than allowing it to pass evenly as sheet flow across a wetland. This reduces water residence time in a wetland. That tends to dry out a wetland and decrease its capacity to function as a pollution filter, while increasing its contribution to global warming and decreasing its capacity to accumulate carbon.
- Channeling of runoff by ATV trails increases the transport of eroded sediment into streams, thus potentially harming fish spawning areas.
- Soil compaction and channeling of runoff by ATV trails reduces the amount of water that can infiltrate and recharge aquifers.
- Plants crushed by ATVs sometimes represent the only populations of a particular species in a local area, thus leading to regional loss of biodiversity.
- ATVs incidentally transport invasive plants into new areas, which eventually reduce plant community diversity and simplifies the vegetation structure which is important to wildlife.

Paraphrasing from the review by Loomis & Liebermann (2006):
- Even a single ATV pass through a wetland can cause long-lasting damage (40 years or more), particularly to soil structure.
- The majority of impacts occur during the first 20 passes, and damage continues to occur up to 50 passes per year (Ahlstrand & Racine 1990).
- A single track trail of a 4-wheeler (no braids) disturbs about 1 acre of vegetation per mile, while a braided track disturbs an average of 4 acres per mile (Meyer, 2002).
- Mosses and lichens are the most sensitive plants to compaction by ATVs, and may not return to a denuded area for decades or longer.
- More damage is caused when ATV use is spread across a season as opposed to being concentrated during a shorter period encompassing the driest time of year.
- Recognizing the severity of ecological damage from ATVs, most federal and state resource agencies have adopted rules that confine ATVs to designated trails. In October 2004, the Chief of the U.S. Forest Service named unmanaged motorized recreation as one of the four key threats to public lands.

Figure 57 - Truck and four wheeler tracks in wetland casa #5.

Figure 58 - Truck tracks through small drainage in wetland casa #5.

Figure 59 - Four-wheeler wheelie spot in wetland casa #6.

Figure 60 - Four-wheeler trail in wetland casa #4 near fire training center fence.

Figure 61 - Hardened trail along east edge of wetland casa #5 and west bank of Casa del Sol Ck.

References

Adamus, P.R., J. Morlan, and K. Verble. 2010. *Wetland Ecosystem Services Protocol for the United States (WESPUS) Calculator Spreadsheet*. Beta Test Version 1.0. Internet: http://people.oregonstate.edu/~adamusp/WESPUS/

Adamus Resource Assessment, Inc.(ARA) 1987. *Juneau Wetlands: Functions and Values*. Report to the Community Development Department, City and Borough of Juneau, AK.

Adamus, Paul and Koren Bosworth 2007. *Delineation and Function Rating of Jurisdictional Wetlands on Potentially Developable City-owned Parcels In Juneau, Alaska.* Report to the Community Development Department, City and Borough of Juneau, AK.

Ahlstrand, G.M. and C.H. Racine. 1990. *Response of an Alaskan shrub-tussock community to selected all-terrain vehicle use*. Natural Resources Management Report AR-19. National Park Service, Alaska Region.

Alaska Natural Heritage Program - April 19, 2010. *Weed Ranking Project* http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm

Brown, T.G. and G.F. Hartman. 1988. *Contribution of seasonally flooded lands and minor tributaries to the production of Coho Salmon in Carnation Creek, British Columbi*a. Transactions of the American Fisheries Society. 117: 546-551.

Carstensen, Richard. July, 2003. *Risen Valleys, Wildlife Habitats of Juneau's Premier Natural Area - 24- to 29-mile, Glacier Highway*. for Southeast Alaska Land Trust.

Colvin, R.W., G. Giannico, J.L. Li, K.L. Boyer, and W.J. Gerth. 2009. *Fish use of intermittent watercourses draining agricultural lands in the Upper Willamette River Valley, Oregon*. Trans. Am. Fish Soc. 138: 1302-1313.

Community Development Department (CDD), City and Borough of Juneau. 1992. *City and Borough of Juneau Wetlands Management Plan*. CDD, Juneau, AK.

Community Development Department (CDD), City and Borough of Juneau. 1997. *Revised City and Borough of Juneau Wetlands Management Plan*. CDD, Juneau, AK.

Community Development Department (CDD), City and Borough of Juneau. Feb. 2008. *Juneau Coastal Management Plan Volume 2 - Revised City and Borough of Juneau Wetlands Management Plan*. CDD, Juneau, AK.

City and Borough of Juneau Engineering Dept. - Michele Elfers. *Snow Storage Disposal Site - Wetland Delineation Report*. October 10, 2008.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. Office of Biological Services, USDI Fish and Wildlife Service. Washington, D.C. FES/OBS-79-31. 131pp.

Douglas, George W., Del Meidinger, and Jim Pojar - editors. March 1999. *Illustrated Flora of British Columbia. Volumes 1-7.* British Columbia Ministry of Environment, Lands and Parks, Ministry of Forests

Hulten, E. 1968. *Flora of Alaska and Neighboring Territories*. Stanford University Press, Stanford, California. 1008 pp.

Giannico, J.L. Li, K.L. Boyer, R.W. Colvin, W.J. Gerth, M.E. Mellbye, S.M. Griffith, and J.J. Steiner. 2004. *Fish and amphibian use of intermittent agricultural waterways in the south Willamette Valley, Oregon*. Dept. of Fisheries & Wildlife, Oregon State University, Corvallis, OR.

Loomis, P. and R. Liebermann. 2006. *Biological Impacts of Off-Road Vehicles in Alaska: A Literature Review*. Denali National Park and Preserve, Alaska.

Meyer, K. 2002. *Managing degraded off-highway vehicle trails in wet, unstable, and sensitive environments*. USDA Forest Service, Technology & Development Program.

National Wetlands Working Group/ edited by: B.G. Warner and C.D.A. Rubec, 1997. *The Canadian Wetland Classification System, Second Edition*. Wetland Research Centre, University of Waterloo, Waterloo, Ontario.

National Weather Service Forcast Office, Juneau, Alaska. 2010. "Local Monthly Weather Summary" http://www.nws.noaa.gov/climate/index.php?wfo=pajk

Reed Jr., Porter B., 1988. *National List of Plant Species That Occur in Wetlands: Alaska (Region A)*. U.S.D.I, Fish and Wildlife Service, Research and Development, Washington, DC. 79 pp.

Steiner, J.J., G.R. Giannico, S.M. Griffith, M.E. Mellbye, J.L. Li, K.S. Boyer, S.H. Schoenholtz, G.W. Whittaker, G.W. Mueller-Warrant, and G.M. Banowetz. 2004. Grass seed fields, seasonal winter drainages, and native fish habitat in the south Willamette Valley, Oregon. Dept. of Fisheries & Wildlife, Oregon State University, Corvallis, OR.

U.S. Army Corps of Engineers, *U.S. Army Corp of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

US Army Corps of Engineers,Oct. 2007. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region*, Environmental Laboratory, ERDC/EL TR-06-x, US Army Engineer Research and Development Center, Vicksburg, MS.

US Army Corps of Engineers, September, 2006. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region* US Army Engineer Research and Development Center, Vicksburg, MS.

USDA Soil Conservation Service (NRCS). 1974. Soils of the Juneau Area, Alaska.

Viereck, L.A., C. T. Dyrness, A. R. Batten and K.J. Wenzlick. 1992. General Technical Report PNW-GTR-286, Pacific NW Research Station, USFS, USDA.

Appendix A - Wetland Statistics and Classification

stream lengths		**feet**		**Wetland Assessment Category**	**Cowardin* classification (ecologic)**	**Canadian classification (hydrologic)**	**Viereck/Alaska classification (vegetation)**
Casa del Sol Creek	upper tribs	130			R4UB3/4	Stream channel	
	mainstem	111			R2UB3/4	Stream channel	
	east tribs	136			R4UB3/4	Stream channel	
	Snyder trib				R4UB3/4	Stream channel	
	total	**377**					
ditches	FTC	37			R4UB3/4	Ditch	
	sewage	276			R4UB3/4	Ditch	
Stream buffer areas		**ft2**	**acres**	**Wetland Assessment Category**			
Casa del Sol Creek	upper tribs	108	0.002	C	PEM1	Riparian stream channel wetland	Mixed wet graminoid /forb herbaceous
	mainstem	125	0.003	C	PEM1	Riparian stream channel wetland	Mixed wet graminoid /forb herbaceous
	east tribs	93	0.002	C	PEM1	Riparian stream channel wetland	Mixed wet graminoid /forb herbaceous
	Snyder trib			C	PEM1	Riparian	Mixed wet

						stream channel wetland	graminoid /forb herbaceous
	total	**326**	**0.007**				
	Wetland areas	**ft2**	**acres**				
	casa 1	972	0.022	C	PEM1	Riparian channel marsh/Tidal channel marsh	Mixed wet graminoid /forb herbaceous
	casa 2	1,342	0.031	C	PEM1	Linked basin marsh	Fresh herb marsh
	casa 3	14,287	0.328	C	PEM1/PFO4	Young Flat Bog	Young open Sitka spruce bog
	casa 4	60,810	1.396	C	PEM1/PFO4	Young Flat Bog	Young open Sitka spruce bog
	casa 5	219,063	5.029	C	PEM1/PFO4	Young Flat Bog	Young subarctic lowland sedge bog meadow
	casa 6	99,665	2.288	C	PEM1/PFO4	Young Flat Bog	Young subarctic lowland sedge bog meadow
	sewage 1	65,950	1.514	D	PEM1/PFO4	Young Flat Bog	Young subarctic lowland sedge bog meadow
	sewage 2	122,709	2.817	D	PEM1/PFO4	Young Flat Bog	Young subarctic lowland sedge bog meadow

	sewage 3	115,870	2.660	D	PEM1/PFO4	Young Flat Bog	Young subarctic lowland sedge bog meadow
	Unit total	**987,094**	**16.092**				
	Hill 560	745,268	17.109	B	PEM1/PFO4	Domed Bog w/ slope fen edges	Subarctic lowland sedge-moss bog meadow
	Project total	**1,446,236**	**33.201**				

*****
PEM1 - palustrine emergent persistent
PFO4 - palustrine forested needle leaved evergreen
R4UB3/4 - Riverine intermittent unconsolidated shore mud/organic
R2UB3/4 - Riverine lower perennial unconsolidated shore mud/organic

Appendix B. "Adamus Methodology" criteria used for assessing relative level of each function

Ratings in column 2 are VH (very high, 7), H (high, 6), MH (moderately high, 5), M (moderate, 4), ML (moderately low, 3), L (low, 2), or VL (very low). C1, C5, etc. refer to cell addresses in the accompanying spreadsheet where the data can be found (see Appendix A for data categories). The weight shown for each function is the one recommended by the CDD (1997) report.
Important Note: When scoring each function, begin with its top row and then proceed downward row by row only if the criteria in the row being examined are not met. Only one rating (the highest applicable one) should be assigned per function per wetland.

Function	**Rating**	**Criteria**
Groundwater Discharge	H (6) if	1) Wetland is non-tidal (C9=0) AND 2) either is at the toe of a steep slope (C5= TS) or is on a slope of greater than 15% (C6= H) or in an alluvial fan or avalanche chute (C4= AC) or is intersected by a perennial stream or is within 50 ft of one (C11= PI).
	L if	Wetland is tidal (C9= Y) and is not intersected by a perennial stream or within 50 ft of one (C11= not PI & not P50) and is not at toe of a steep slope (C5= not TS) and not in alluvial fan (C4= not AF) and is on a slope of less than 7% (C6= L)
	M if	not H and not L
Sediment/ Toxicant Retention	H (6) if	1) Wetland is at toe of a steep slope or on a flat (C5= TS or F) and has a slope of less than 15% (C6= M or L) and its soil is predominantly peat (C7= Y), OR 2) Wetland is not intersected by a perennial or ephemeral stream (C11= not PI & not Ei) and is on a slope of less than 7% (C6= L)
(weight= 6)	MH (5) if	Wetland is not intersected by a perennial or ephemeral stream (C11= not PI & not Ei) and its gradient is less than 15% (C6= not H) and its soil is predominantly peat (C7=Y)
	L (2) if	Wetland gradient is greater than 15% (C6= H) and pit-mound topographic variation is not extensive or great (C17= 0 or T1L)
	ML (3) if	not H and not MH and not L

Function	Rating	Criteria
Nutrient Export (weight= 7)	H (6) if	1) Wetland is tidal (C9= Y) OR
		2) Wetland is intersected by a perennial stream (C11= PI) AND ANY of 2a, 2b, or 2c
		2a) its surface water levels experience large fluctuation (C13= H) or
		2b) its area covered only seasonally by surface water is extensive (C15= H)
		2c) it is dominated by trees (C18= T50) or deciduous shrubs (C19= D50)
	L (2) if	1) There is no perennial stream within 200 ft of the wetland and not intersected by ephemeral stream (C11= not PI & not P50 & not P200 & not Ei), and any of the following:
		2a) is mostly covered by wetland moss (C21= M50) or
		2b) the wetland's surface water levels experience little or no fluctuation (C13= L) or
		2c) the area covered only seasonally by surface water is very limited (C15= S)
	M (4) if	not H and not L
Riparian Support (weight= 10)	H (6) if	1) Wetland is intersected by a perennial stream (C11= PI) or is within an annual floodplain (C12= FP) AND EITHER
		1a) alder shrub covers at least half of the wetland's vegetated area or stream bank (C19= A50 or A90), or
		1b) deciduous shrubs/trees cover more than 90% of the wetland's vegetated area or stream bank (C20= D90).
		OR
		2) Wetland is intersected by an ephemeral stream (C11= Ei) and
		2a) alder shrub covers more than 90% of the wetland's vegetated area or stream bank (C19= A90) or
		2b) deciduous shrubs/trees cover more than 50% of the wetland's vegetated area or stream bank (C20= D50).

	MH (5) if	1) Wetland is intersected by a perennial stream (C11= PI) or is within its annual floodplain (C12= FP) AND EITHER
		1a) alder shrub covers at least 1% of the wetland's vegetated area or stream bank (C19= A1), or
		1b) deciduous shrubs/trees cover more than 50% of the wetland's vegetated area or stream bank (C20= D50).
		OR
		2) Wetland is intersected by an ephemeral stream (C11= Ei) or is within 50 ft of a perennial stream (C11= PI) AND
		2a) alder shrub covers more than 50% of the wetland's vegetated area or stream bank (C19= A50) or
		2b) deciduous shrubs/trees cover more than 1% of the wetland's vegetated area or stream bank (C20= D1).
	L (2) if	There is no perennial or ephemeral stream within 50 ft of the wetland (C11= not PI & not Ei & not P50 & not Ei), and the wetland contains less than 1% deciduous shrubs/trees (C20= 0)
	ML (3) if	not H and not L and not MH

Function	Rating	Criteria
Salmonid Habitat	VH (7) if	1) Wetland is tidal (C9= Y), OR
		2) salmonid fish can access part of the wetland year-round (C10=P) and habitat quality (pools, undercut banks, wood, etc.) is good (C14= H)
(weight= 11)	H (6) if	Salmonid fish can access part of the wetland year-round (C10= P) and habitat quality is moderate (C14=H)
	MH(5) if	Salmonid fish can access part of the wetland year-round (C10= P) and habitat quality is low (C14= M or L).
	ML (3) if	Salmonid fish can access part of the wetland seasonally (C10= S) and habitat quality is moderate or high (C14= M or H).
	L (2) if	Salmonid fish can access part of the wetland seasonally (C10= S) and habitat quality is low (C14=L).
	VL (1) if	Salmonid fish cannot access the wetland at any time (C10= 0)
Erosion Sensitivity	H (6) if	Wetland is on a slope of greater than 15% (C6= H) and its predominant soil is peat (C7= Y)
	MH(5) if	Wetland is on a slope of greater than 15% (C6= H) and its predominant soil is not peat (C7= 0)
(weight= 7)	ML (3) if	Wetland is on a slope of greater than 7% (C6= M or H) and its predominant soil is peat (C7= Y)
	L (2) if	Not H and not ML and not MH
Groundwater Recharge	H (6) if	Wetland is not in an alluvial fan or avalanche chute (C4= not AF & not AC) or tidal area (C9= 0) AND
		Wetland is not intersected by a perennial stream or within 50 ft of one (C11= not PI & not P50) and is either on a plateau (C5= P) or has a slope of mostly less than 7% (C6= L)
(weight= 7)	L (2) if	Wetland is tidal (C9= Y) or is intersected by a perennial stream (C11= PI)
	M (4) if	Not H and not L

Function	Rating	Criteria
Hydrologic Control (weight= 9)	H (6) if	1) Wetland non-tidal (C9= 0) and is on a slope of less than 7% (C6= L) and is not intersected by a stream (either perennial or ephemeral) (C11= not PI & not Ei) OR
		2) Wetland is not in a mid-slope or toe-slope position (C5= not TS & not MS) and is in a floodplain (C12= FP) or has extensive seasonal ponding of surface water (C15= H) or has extensive and large pit-mound topography (C17= T25H)
	MH(5) if	Wetland is non-tidal (C9= 0) and has moderate-extensive seasonal ponding of surface water (C15= M) or moderate water level fluctuations (C13= M) or extensive but mild pit-mound topography (C17= T25L)
	L (2) if	Wetland is tidal (C9= Y)
	ML (3) if	Not H and not MH and not L
Detention Value* (weight= 9)	H (6) if L(2) if	Wetland is non-tidal (C9= 0) and uphill areas have peat soils (C8= Y) and relatively extensive development (C26= H)
		Wetland is tidal (C9= Y) and uphill areas have little or no development (C26= L)
	M (4) if	Not H and not L
Recreational Use Potential (weight= 5)	H (6) if	Developed hiking trails go to or near (within 100 ft of) wetland and wetland is within 0.5 mile of trailhead (C30= H) and wetland is on public land (C31= C)
	MH (5) if	Developed hiking trails go to or near the wetland but wetland is farther than 0.5 mile from trailhead (C30= M) and wetland is on public land (C31= C)
	L (2) if	No hiking trails go to or near the wetland and wetland is more than 0.5 mile from road (C30= 0) and wetland is on private land (C31= P)

	ML (3) if	No trails are within 100 ft of wetland but the wetland is within 0.5 mile of a road (C30= L) and wetland is on public land (C31= C)
Recreational Use Actual	H (6) if	Results of a 1987 recreational survey indicated relatively high use of this wetland or the closest one (C32= H)
	MH (5) if	Results of a 1987 recreational survey indicated moderately high use of this wetland or the closest one (C32= MH)
(weight= 6)	L (2) if	Results of a 1987 recreational survey indicated relatively low use of this wetland or the closest one (C32= L)
	ML (3) if	Results of a 1987 recreational survey indicated relatively moderately low use of this wetland or the closest one (C32= ML)

Function	**Rating**	**Criteria**
Wildlife Support* (weight= 11.5)	H (6) if	1) Wetland is tidal (C9= Y) or contains or adjoins at least 1 acre of perennially ponded non-tidal water (C16= PW) OR
		2) Wetland is contiguous to a large forested tract and not separated from it by roads (C25= C) and has little or no uphill development (C26= L), and has not been altered by nearby ditches or roads (C28= 0), and has less than 10% cover of non-native plants (C29= 0), and 2a or 2b:
		2a) creates a gap in the canopy of an extensive surrounding forest (C23= CC) and is not primarily wetland moss (C21= 0 or M1) and is (2a1) distant from the nearest residence (C27= F) or (2a2) has many vegetation structural forms (C22= H), OR
		2b) does not create such a gap (C25= 0) and is not within 100 ft of a residence (C27= M or F), and has more than 90% total tree cover (C18=T90) or more than 50% deciduous tree/shrub cover (C20= D50), or has salmonid access (C10= S or P), or at least one large-diameter tree (C24= BT), or extensive pit-mound topography (C17= T25L or T25H), or many vegetation forms (C22= H)
	MH (5) if	Wetland is contiguous to a large forested tract and not separated from it by roads (C25= C) and has less than 10% cover of non-native plants (C29= 0), and EITHER
		a) creates a gap in the canopy of an extensive surrounding forest (C23= CC) and is not within 100 ft of a residence (C27= M or F) and has some diversity of vegetation structural forms (C22= not L) OR
		b) has more than 50% deciduous tree/shrub cover (C18= T50 or C20= D50) or is intersected by or within 50 ft of a perennial stream (C11= PI or P50) or is more than 0.5 mile from a road and lacks developed trails (C30= 0)
	L (2) if	1) Wetland does not create a gap in the canopy of an extensive surrounding forest (C23= 0), and is not tidal (C9= 0), and is not within 500 ft of perennially ponded non-tidal water (C16= 0), and does not have salmonid access (C10= 0), and has no large-diameter trees (C24= not BT & not MT), and has little or no pit-mound topography (C17= 0 or T1L), and has 1a or 1b:
		1a) >90% moss cover (C21= M90) or more than 10% cover of non-native plants (C29= Y) or only a few vegetation structural forms (C22= L), OR
		1b) is not contiguous to a large forested tract (C25= 0) and has any of the following: extensive development in uphill areas (C26= H) or is close to a residence (C27= N) or has been altered by nearby ditches or roads (C28= Y) or has developed trails and a trailhead nearby (C30= H).
	ML (3) if	Not H and not ML and not L

* Detention Value was termed “Downslope Beneficiary Sites” in the ARA (1987) and CDD (1997) reports. Wildlife Support is the merger of “Disturbance-sensitive Wildlife” and “Regional Ecological Diversity” in those reports; their respective weights were averaged.

Appendix C. Scores from applying WESPUS to these wetlands

The maximum score theoretically possible for any function is 1.00 and the minimum is 0.

	Sherwood Lane North		Sherwood Lane South		Hill 560	
Specific Functions or Values:	Relative Effectiveness of the Function	Relative Value	Relative Effectiveness of the Function	Relative Value	Relative Effectiveness of the Function	Relative Value
Water Storage & Delay (WS)	1.97	1.75	0.00	2.50	2.40	3.75
Sediment Retention & Stabilization (SR)	4.10	3.88	10.00	4.06	6.40	2.50
Phosphorus Retention (PR)	5.51	4.75	10.00	4.63	5.94	2.50
Nitrate Removal & Retention (NR)	3.03	2.85	10.00	2.78	4.69	3.33
Thermoregulation (T)	0.00	5.00	0.00	0.00	0.00	0.00
Carbon Sequestration (CS)	2.78	n/a	2.46	n/a	2.82	n/a
Organic Matter Export (OE)	7.53	n/a	0.00	n/a	6.54	n/a
Aquatic Invertebrate Habitat (INV)	4.30	5.69	5.43	6.07	7.08	7.93
Anadromous Fish Habitat (FA)	4.50	10.00	0.00	4.07	0.00	3.67
Non-anadromous Fish Habitat (FR)	1.39	10.00	1.78	2.03	0.80	1.83
Amphibian & Reptile Habitat (AM)	3.04	2.33	6.07	4.00	7.93	7.33
Waterbird Feeding Habitat (WBF)	3.33	2.33	4.07	4.00	3.67	4.00
Waterbird Nesting Habitat (WBN)	0.00	1.75	0.00	3.00	4.02	3.00
Songbird, Raptor, & Mammal Habitat	5.69	2.33	4.44	4.00	7.75	4.00
Pollinator Habitat (POL)	5.88	0.83	4.49	0.00	7.83	5.00
Native Plant Diversity (PD)	5.35	3.72	5.28	6.00	6.01	7.31
Wetland Ecological Condition	n/a	4.18	n/a	3.38	n/a	4.63
Wetland Stressors	n/a	4.77	n/a	3.66	n/a	2.23
Wetland Sensitivity	n/a	5.14	n/a	10.00	n/a	10.00

Appendix D - Background and Timeline for CBJ Sewage Sludge Disposal Site

Fifteen acres of wetland in the lower, western Mendenhall Valley at the western end of Crazy Horse Drive, were altered in the late 1970's through the early 1980's by CBJ during the construction of a sewage sludge disposal area The site is enclosed by a constructed berm approximately 4-5 feet high and 30-40 feet wide. The berm appears to be made of sand and gravel though it is thought the core might include other materials. This rectangle was further divided by two more berms into three - 1000ft. long rectangles. A drainage ditch was dug around the whole site. This ditch drains south into lower Casa del Sol Creek.

Along the inside edge of these rectangles, 250-300 9ft x 8ft. x 14ft. pits were dug and filled with 1,500 cubic yards of dewatered sewage sludge. This facility was constructed across two relatively large streams, all downstream flow was cut off and the hydrology of the area was altered. The upper unit within the sewage sludge area has dried out considerably since construction. The lower unit still has remnants of the 2 stream channels and is the wettest of the three.

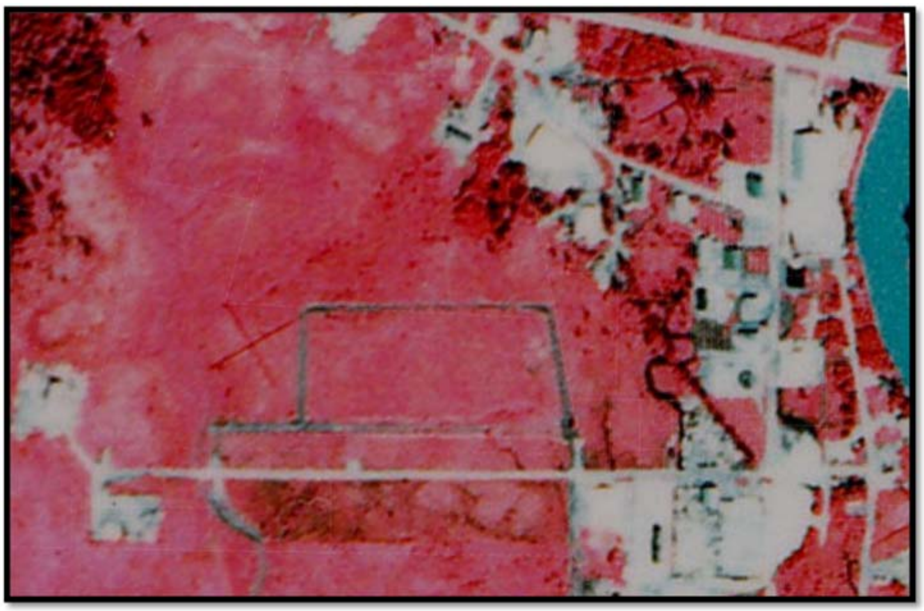

Figure 62 - A 1979 infra-red aerial photo showing the beginning of construction of the sewage sludge disposal area.

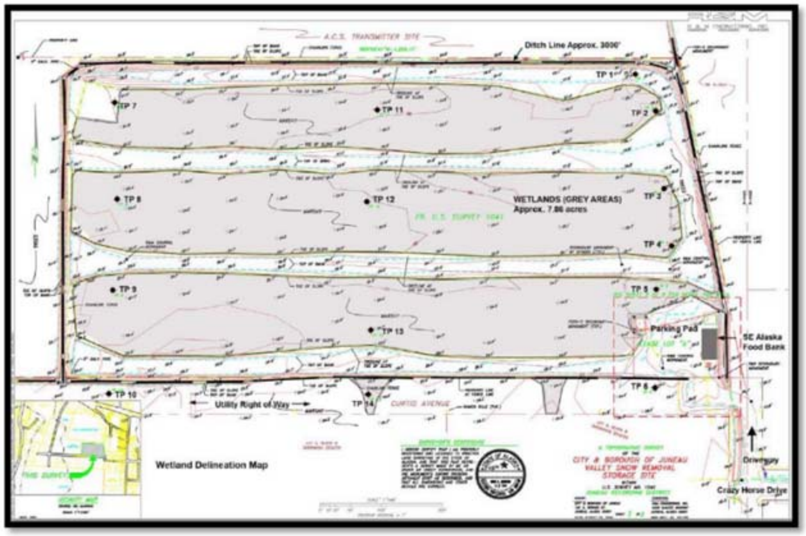

Figure 63 -- 2008 wetland delineation map of sewage area produced by CBJ engineering - Michelle Elfers.

Figure 64- 2006 aerial photograph of sewage sludge disposal area

The following timeline was constructed using CBJ Lands Department Archive documents. The documents include correspondence between CBJ Lands Dept. and the US Army Corps of Engineers, the CBJ School District and the State of Alaska, Dept. of Governmental Coordination.

- Construction of the sewage sludge facility began in 1978. In the summer of 1979 the outer perimeter berm was completed. The inner berms were completed sometime before 1982 but probably by 1980.
- In October of 1982, CBJ submitted an after-the-fact permit application to the US Army COE to place 27,000 tons of gravel fill in wetlands at the end of Crazy Horse Drive in conjunction with excavating 9' x 8' x 14' deep pits for disposal of 1,500 cubic yards of dewatered sewage sludge. (There is no documentation in the CBJ archival material I received on the actual dumping of the sewage sludge. It is assumed that sewage sludge was dumped but there is no record of it happening.)
- The COE denied the application because the city was unable to obtain a water quality certification from DEC and because it was not in compliance with Section 404(b)(1) of the Clean Water Act
- At that time the COE required that the CBJ remove all fill from the wetland and restore the area to preconstruction status by December of that year (1982).
- At the end of that October, the city replied that it would cost too much to remove the fill and sludge and restore the site.
- The COE requested that at least the metal building and the concrete pad be removed, the ditch around the perimeter of the site be filled in and the area leveled off and seeded by the following spring.
- The city agreed at that time but in April of 1983 they had not complied and they said they were going to submit a new application to use the site as a junk car storage site.
- In August of 1983 the request was turned down by the COE, ADEC, ADF&G, USFWS ADGC and NOAA.
- In November of 1983 the city told the COE that restoration of the site would be completed by September 1985.
- In April of 1985 the COE received an application from the city to utilize a portion of the site as a greenhouse and nursery but the application could not be processed while the there was still an outstanding violation.
- After consultation with ADF&G, , ADEC, ADF&G, USFWS, EPA, ADGC and NOAA, on August 27, 1985 it was determined that the area under violation should not be disturbed therefore the only restorative measures required were removal of the metal building and the concrete pad and testing of the sludge. The restoration was to be completed by mid- November, 1985.
- On November 12, 1985 the city reported having completed restoration of the disposal site and they were planning on submitting a new greenhouse application.
- The site was inspected by the COE at the end of December, 1985 and the restoration work was found to be satisfactory and they closed the file on the violation.
- On January 6, 1986 the city sent an application to the COE for the construction of a greenhouse. The structure would be located entirely with the confines of the existing pad and will not involve any additional wetland filling.

- The COE informed the city that because the previous violation had been resolved and no additional fill was to be discharged into the wetland, then the proposed work does not require a COE permit.
- The city decided in April of 1986 to build the greenhouse at a different site and confirmed with the COE that the sludge disposal site could be used for anything as long as no more wetland was filled and no activities would degrade the ecological values or affect areas of public interest on adjacent land under COE jurisdiction.
- In December of 1986 the school district requested temporary use of the site for storage and maintenance of school district snow removal equipment and gravel and in September of 1986 the CBJ Planning Commission approved the application for temporary use with some stipulations.
- In 2007 the CBJ Public Works Department began exploring placing a snow removal storage and mass wasting storage site on the sewage sludge storage area.
- In the summer of 2008 CBJ Engineering did a wetland delineation and surveyed the site.

Appendix E - 2008 Juneau Wetland Management Plan - Mendenhall West Maps

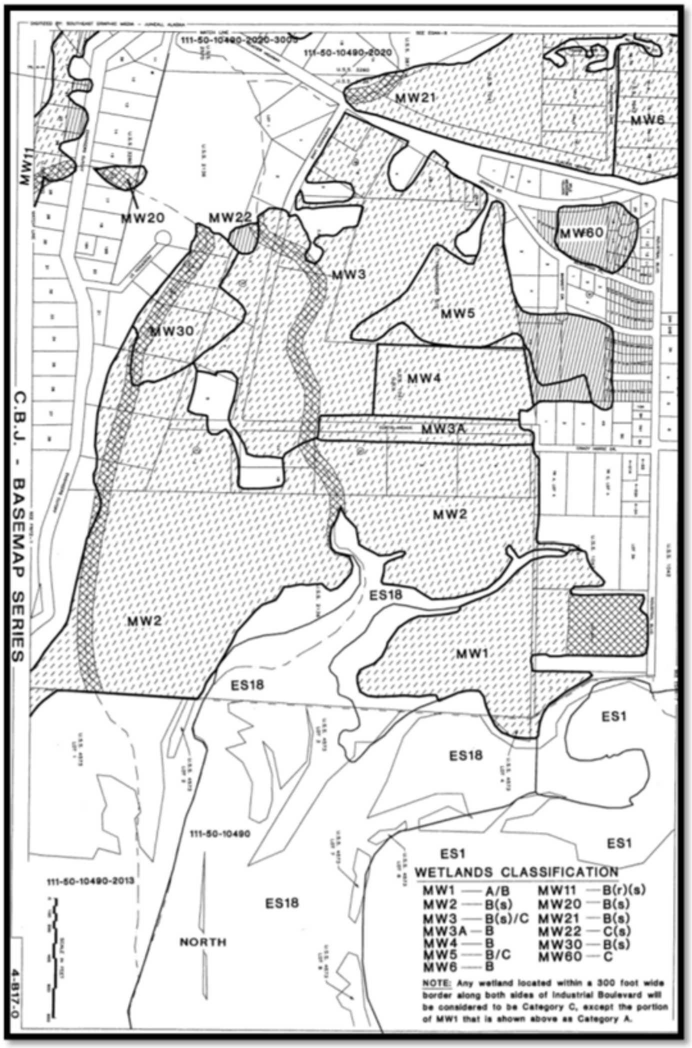

Figure 65 - 1994 Juneau Wetland Management Plan Atlas map of the southwest Mendenhall valley area including the 2010 Industrial Blvd unit, project area. The part of MW3 that is classified as C (as per the note on the map above) is a difficult-to-identify, small piece of property east of MW4, the main part of MW3 is classified as B with a category A stream category going through it.

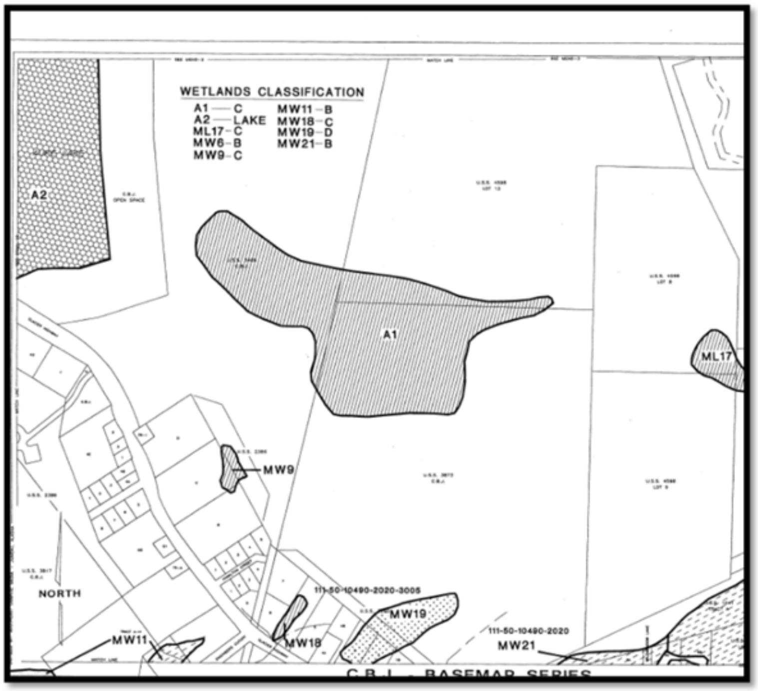

Figure 66- 2008 Juneau Wetland Management Plan map of the Hill 560 area including the Hill 560 unit, project area.

<u>**Wetland Management Categories and Management Policies**</u>

A - Maintain all individual functional values in the wetland unit. One environmental function cannot be substituted for another.
B - Maintain all aggregate functional values in the wetland unit. One environmental function can be substituted for another.
C - Maintain overall functional value on roaded system. Not net loss of aggregate value to region.
D - Minimize adverse impacts to functional values.
(s) - Indicates that a more restrictive, category A, stream corridor designation applies to a portion of the wetland unit.
(r) - Indicates that a less restrictive, category C, residential road corridor designation applies to a portion of the wetland unit.

Wetland documentation for 2008 Juneau Wetland Management Plan wetland areas corresponding with 2010 project area wetlands

MW3 – Management category B - "23 acres of emergent vegetation in a north south orientation as far north as Old Glacier Highway. An unnamed creek (Casa del Sol) meanders in the wetland.

The creek corridor is A because the MW2 segment is A. There are small C road corridors on the north and northwest portions.” (Corresponds with the Casa del Sol Area)

MW3A– Management category B - “8 acres of emergent vegetation in a relatively narrow rectangle oriented in an east west direction adjacent to industrially developed land. The west portion is in an A stream buffer.”(Corresponds with the right of way land below the Sewage Area)

MW4 – “Management category B – 13 acres of emergent vegetation in a rectangular shape occupying the old sludge disposal site adjacent to industrially developed land.” (Corresponds with Sewage Area)

A1 – Management category C – “40 inaccessible forested acres in undeveloped part of east valley about midway between Mendenhall River and Auke Lake and about midway between old Glacier Highway and Back Loop Road. It is C by best professional judgment , primarily due to a low WET score.” (Corresponds with the Hill 560 Unit)

Appendix F - Juneau Wetland Management Plan Revisions and Supporting Scientific Materials (from Laroche+Associates, 2008)

In 1985, the City and Borough of Juneau initiated the planning process by forming a Wetlands Interagency Advisory Committee. The committee selected the "Adamus Wetland Evaluation Technique (WET)" for the environmental assessment. Paul Adamus was retained to evaluate each of the study area wetlands that had been previously identified and mapped by the Corps of Engineers and the U. S. Fish and Wildlife Service. The field work for the environmental evaluation lasted one year, and the study team included researchers from Syracuse University, the State University of New York at Syracuse, and the University of Minnesota. A number of Juneau habitat biologists were employed to conduct the field work, including bird surveys and fish counts. Professionals associated with the National Marine Fisheries Service Auke Bay Laboratory, and a variety of State and federal agencies and independent experts, made voluntary contributions. The result was a scientifically based evaluation of functions that eventually led to the classification system and wetland management policies. Scientific documentation for the classification system can be found in the following studies that were produced specifically for the Juneau Wetland Management Plan.

> 1987, *Juneau Wetlands Functions and Values*, Adamus Resource Assessment, Inc
>
> 1987, *Juneau Wetlands Functions and Values Map Appendix*, Adamus Resource Assessment, Inc
>
> 1987, *Juneau Wetlands Functions and Values Appendix D - Rapid Assessment Method for Southeast Alaska*, Adamus Resource Assessment, Inc

The Juneau Wetland Management Plan was prepared as a Special Area Management Plan. It was adopted by the former Coastal Policy Council as an amendment to the Juneau Coastal Management Plan. It was adopted by the city in 1992 and went into effect in 1993. It was revised to incorporate changes that were required during the approval process and reprinted in 1997. The

1997 revision did not alter the assumptions or methodology that led to the original wetland classifications, nor modify the enforceable polices that were approved by the former Alaska Coastal Policy Council. In 2003, the Alaska Legislature changed the rules for the plans. LaRoche + Associates was hired to assist the City and Borough of Juneau (CBJ) in updating these plans to comply with State mandates. This revision was finished and printed in 2008. As with the 1997 revision, it did not alter the assumptions or methodology that led to the original wetland classifications, nor modify the enforceable polices that were approved by the former Alaska Coastal Policy Council.

1992, *Juneau Wetlands Management Plan*, City and Borough of Juneau

1994, *Juneau Wetland Management Plan Atlas*, City and Borough of Juneau

1997, *Juneau Coastal Management Plan Volume II: Revised Juneau Wetlands Management Plan*, City and Borough of Juneau.

2008, *Juneau Coastal Management Plan Volume II: Revised Juneau Wetlands Management Plan*, City and Borough of Juneau.