Total Maximum Daily Load (TMDL)
for Wood Residues
at the Former Thorne Bay LTF Marine Area
on Prince of Wales Island, Alaska

FINAL

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Alaska Department of Environmental Conservation
555 Cordova Street
Anchorage, AK 99501

ACKNOWLEDGEMENT

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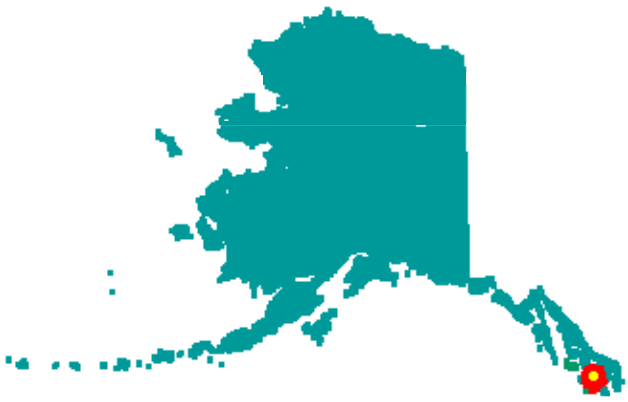

Alaska and the Location of Thorne Bay

Contents

Figures

Tables

Total Maximum Daily Load for Wood Residues at the Former Thorne Bay LTF Marine Area on Prince of Wales Island, Alaska

TMDL AT A GLANCE:

Water Quality-Limited?	Yes
Hydrologic Unit Code:	19010103
Standard of Concern:	Residues
Designated Uses Affected:	Water supply; water recreation; growth and propagation of fish, shellfish, other aquatic life and wildlife; harvesting for consumption of raw mollusks or other raw aquatic life
Environmental Indicators:	Wood residues (bark and wood debris)
Major Source:	Historical log transfer activities
Loading Capacity:	Zero m^3/acre/day
Wasteload Allocation:	Zero m^3/acre/day
Load Allocation:	Zero m^3/acre/day, except loadings from natural sources
Margin of Safety:	Implicit

1. Overview

Section 303(d)(1)(C) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) implementing regulations (40 CFR Part 130) require that a Total Maximum Daily Load (TMDL) be established to achieve state water quality standards (WQS) when a waterbody is water quality-limited for a specific pollutant and will not meet WQS with the implementation of technology-based effluent limitations and other pollution control requirements. A TMDL identifies the amount of a pollutant that a waterbody can receive while still meeting WQS, and establishes discharge limits for existing and future discharge sources of the pollutant, including an appropriate margin of safety (MOS). Discharge limits for point sources are called wasteload allocations (WLAs); discharge limits for nonpoint sources are called load allocations (LAs).

The Alaska Department of Environmental Conservation (ADEC) included Thorne Bay from 1994 through 2002 on Alaska's 303(d) list of water quality-limited waters ("impaired waters") for bark and wood debris from in-water log transfer and log storage activities that accumulated on the bottom in a portion of the northern end of Thorne Bay. These facilities ceased operation in 2000 and are not anticipated to resume operation. The State's 2004 303(d) list (issued in 2006) removed the former log storage area from the impaired list but maintained listing of the former log transfer marine area at the head of the bay (ADEC, 2006). This report presents a TMDL to address impairments associated with wood residues (bark and wood debris) at the former log transfer marine area at the head of the bay but not at the former log storage area.

The original Thorne Bay Log Transfer Facility (LTF) was located on the east side of the bay adjacent to the logging camp, which now is the City of Thorne Bay. The original LTF was constructed by Ketchikan Pulp Company (KPC) beginning in 1961 and was used until 1980. That LTF was replaced by a new and expanded LTF at the head of the bay in 1980, which KPC operated until 1999. Gateway Forest Products continued operation of the LTF in 1999-2000. The LTF since that time has been inactive, and the A-frame transfer device, rafting pens, log booms, and other facilities have been removed. In this TMDL, "log transfer" and "log storage" therefore refer to historical activities that no longer are taking place.

During KPC operation, the LTF was the largest log transfer and log storage facility in the world, handling a total of nearly 10 billion board feet of logs, composed of western hemlock, Sitka spruce, yellow cedar, and red cedar. The main purpose was to marshal logs for delivery to the KPC pulp mill in Ward Cove near Ketchikan, 47 miles to the southeast, which ceased operation in 1997. Logs also supplied a sawmill associated with the pulp mill in Ward Cove from 1989 to 2000, and supplied the Annette Cedar Mill on Annette Island south of Ketchikan.

The LTF uplands belong to the Tongass National Forest and are managed by the U.S. Forest Service. KPC operated the LTF under agreement with the Forest Service. The Forest Service does not presently plan to resume log transfer to water or log storage in water at this site. The Forest Service has indicated that, if future log transfer occurs, it will utilize transport by barge, with no logs held in water. It is expected that any future log transfer volume would be very small relative to past activities.

Dive surveys over the years have documented bark and wood debris on the ocean bottom at both the former log transfer area and the former log storage area. Detailed benthic studies at the log

storage area were carried out by the Alaska Department of Environmental Conservation (ADEC) in 2003 and 2005 to determine the extent of bark and wood debris on the bottom and the biological condition of bottom sediments. The studies determined that, while there is significant wood residues content in bottom sediments at the log storage area, wood residues are mostly decomposed to small fragments and are mixed with bottom sediments. No logs are present on the bottom. Diverse, abundant, and healthy biological communities occur throughout the log storage area. As a result, the log storage area was removed from the 303(d) list in 2006 and no longer is subject to preparation of a TMDL.

This TMDL addresses only the former log transfer marine area at the head of the bay, which was not included in the 2003-2005 detailed benthic studies. The TMDL does not address the original LTF that operated from 1962 to 1980, which is regarded as part of the former log storage area. The log transfer marine area at the head of the bay extends from the transfer site shoreline seaward to the edge of the former log storage area, encompassing an area of approximately 35 acres. For the LTF marine area, because there are no expected future discharges of wood residues from log transfer and storage activities, the TMDL establishes a wasteload allocation of zero m^3/acre/day. Because there are no anthropogenic nonpoint sources of wood residues, the TMDL establishes a load allocation for nonpoint sources of zero m^3/acre/day, except for loadings from natural sources. With these limits, no future permits to authorize discharge of bark and wood debris in the LTF marine area may be issued by EPA and ADEC, until WQS are met or the TMDL is revised. However, establishment of LTFs at other locations in Thorne Bay is not precluded by the TMDL. An LTF at another location would have to be established through required State and federal permitting processes.

2. General Background

Characteristics of Thorne Bay, the City of Thorne Bay, and the Surrounding Area.

Thorne Bay is a canal-like waterway located on the central east coast of Prince of Wales Island at the southern end of the island archipelago of Southeast Alaska. The bay lies approximately 192 air miles south of the city of Juneau, the state's capital, and 40 air miles northwest of the city of Ketchikan on Revillagigedo Island, which is the area's transportation and service hub. The bay has two major arms in an irregular "T" and is about 4.5 miles long and 0.25 to 0.75 mile wide (see Figures 1, 2, and 3). From its entrance onto Clarence Strait, a major north-south passage, the main arm of the bay angles northwest up into the island. The bay is shallow, with a maximum depth of about 66 feet at Mean Lower Low Water (MLLW) and typical depths of 20 to 50 feet. A key feature is the Thorne River, 13 miles long and the largest river on the island, which enters the bay at the northwest corner. Tides in the bay are semi-diurnal, with two low tides and two high tides each day. Average tidal range is between 10 and 13 feet, with extremes between 15 and 23 feet. Prince of Wales Island, roughly 130 miles long and 42 miles wide, is the third largest island in the U.S.

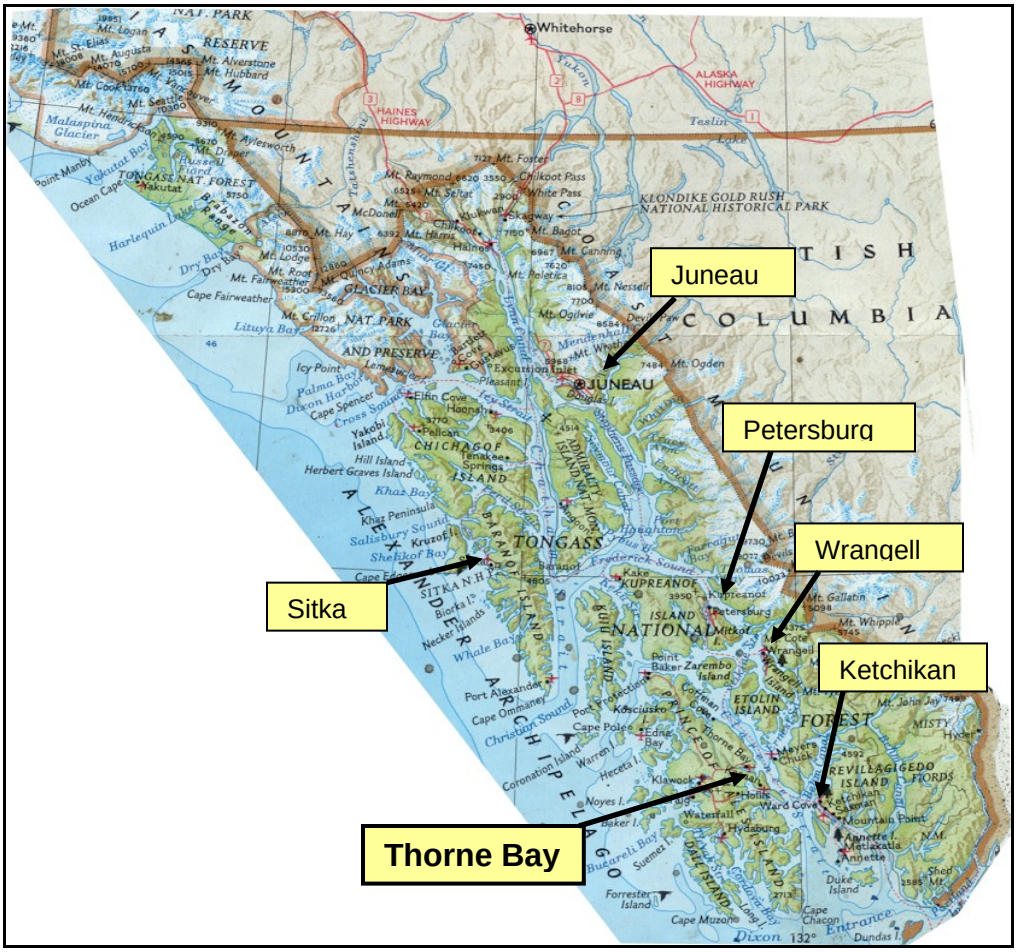

Figure 2.1. Location of Thorne Bay and Major Towns in Southeast Alaska

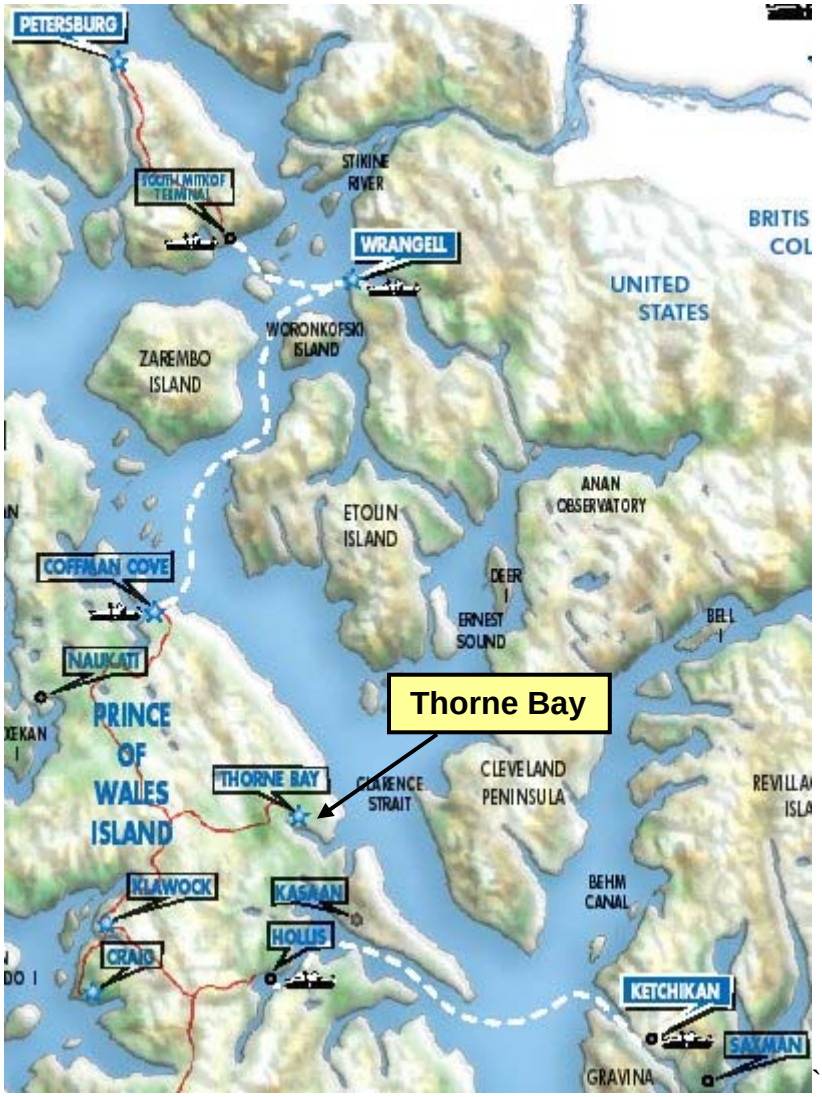

Figure 2.2. Ferry Routes to Prince of Wales Island; Roads and Towns

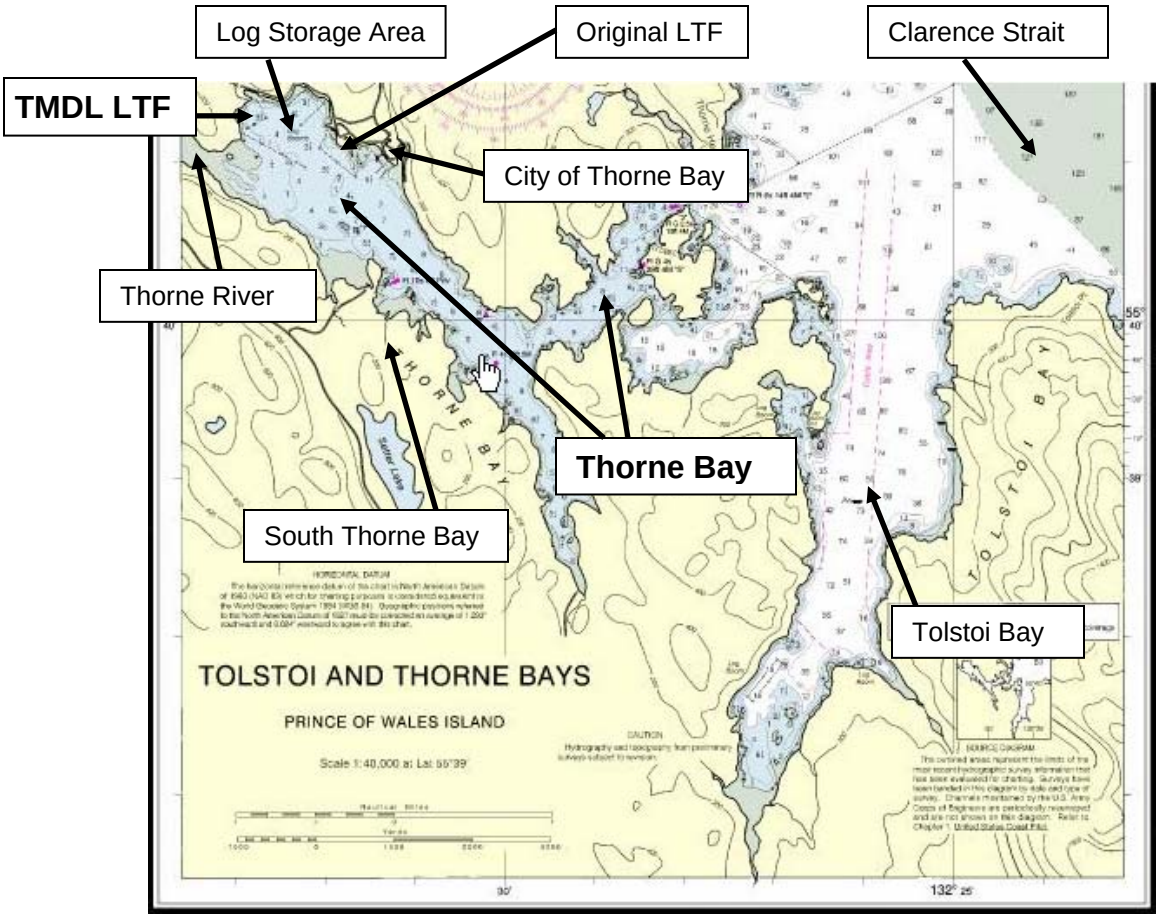

Figure 2.3. Nautical Chart of Thorne Bay with Feature Locations

Prince of Wales Island contains 12 small communities with populations from 50 to 1500, totaling about 3879 (Prince of Wales Chamber of Commerce, 2006). The City of Thorne Bay is a rustic community with a 2005 population of about 486, situated on the east side of the northern end of the bay at approximately 55.68º North Latitude and 132.56º West Longitude. The city is immediately adjacent to the former log storage area and log transfer area. The city encompasses 25.5 square miles of land and 4.8 square miles of water, and is located in the Ketchikan Recording District. The city is connected by a road system to some of the other towns on the island; a network of primitive roads also exists to past and present timber harvest areas (Figures 2.2 and 2.3). The city is accessible directly by boat and float plane, and by the island road system from the Inter-Island Ferry ports at the communities of Hollis to the south and Coffman Cove to the north, each about 60 miles by road. The only land airport on the island, servicing small airplanes, is at Klawock, 33 miles by road to the west.

The city comprises two separate areas of development. The "city" of Thorne Bay, where most of the population resides, is located on the east side of the head of the bay. The South Thorne Bay Subdivision (population 150) is located on the opposite side of the bay to the south (Figure 2.3). South Thorne Bay and businesses located in the Goose Creek commercial/industrial subdivision

are not served by city utilities. Many residents of South Thorne Bay travel to "town" by crossing the bay via skiff. Recently, the South Thorne Bay road has been significantly improved, allowing for increased vehicle travel to and from the area. By road, South Thorne Bay is approximately 12 miles from the core city. The Goose Creek subdivision, containing 27 lots, is located west of the mouth of the Thorne River. In addition, there are approximately 20 float homes scattered in coves around the bay, particularly near the mouth of the bay (City of Thorne Bay, 2005).

Most of Prince of Wales Island is included in the Tongass National Forest; considerable portions of the island are owned by Alaska Native corporations as a result of the Alaska Native Claims Settlement Act of 1971. Commercial logging occurred in the area during and after World War I. Beginning in 1954 with the opening of the Ketchikan Pulp Company pulp mill in Ketchikan, extensive timber harvest on Prince of Wales Island was carried out by the U.S. Forest Service on National Forest lands, and harvest continues at present. From 1954 until 1960, logging occurred on lands on the south side of the head of Thorne Bay. A logging camp called Davidson's Landing existed on the south shore across the bay from the present City of Thorne Bay (City of Thorne Bay, 2005).

The City of Thorne Bay began as a floating logging camp in 1961 when operations were transferred from Hollis by Ketchikan Pulp Company. Onshore camp facilities were constructed starting in 1962. In the logging heyday of the 1960s and 1970s, the community was the largest logging camp in the world (City of Thorne Bay, 2005). Connecting roads were built across the island, and the city was incorporated in 1982. The original LTF was constructed beginning in 1961 on the east side of the bay adjacent to the logging camp, and operated until 1980. The site now is within the City of Thorne Bay on the promontory west of the city harbor. The original LTF was replaced by a huge new LTF constructed on the shore at the head of the bay about 1/2 mile west of the city, which operated until 2000 (Graham, 2006). The former LTF at the head of the bay is the subject of this TMDL (see Section 5). A marine log storage area of roughly 200 acres was located between the LTF and the city. The Thorne River mouth is located just west of the log storage area; the river delta forms the southwestern boundary of the log storage area (Figures 2.3 and 4.1).

The Thorne Bay LTF was the central site for marshalling logs destined for the Ketchikan Pulp Company pulp mill and sawmill in Ward Cove and the Annette Island sawmill. Most of the logs harvested from National Forest lands on the island were transported to Thorne Bay by truck or by rafts towed in the ocean. At the LTF, logs were graded and sorted, tied in bundles, placed in rafts in the water, and towed to the Ward Cove pulp mill and sawmill and the Annette Island sawmill. Timber harvest on National Forest lands has declined substantially since closure of the pulp mill in 1997. The Thorne Bay LTF was deactivated and dismantled after 2000; no facilities remain there today. Timber harvest continues on National Forest lands utilizing LTFs at other locations and transporting logs to market mainly by barge rather than by towed rafts. Substantial timber harvest also has occurred and continues on Native Corporation lands on the island; this timber has not moved through Thorne Bay facilities and does not affect wood residues in Thorne Bay.

The Thorne Bay watershed area is considerably greater than the surface area of the bay, and is dominated by the Thorne River drainage. The river discharges into the head of Thorne Bay,

providing a large input of fresh water. A substantial sand and gravel delta exists at the river mouth. The former log storage area was immediately adjacent to the river delta. The bottom substrate across the log storage area is composed largely of fine silt and sand sediment deposited by the river, with riverine wood residues intermixed at the surface near the river delta. The bottom surface is an almost level bed of sediment filling the original basin to an average water depth of approximately 22 feet MLLW.

Land Use

Thorne Bay is surrounded largely by National Forest lands that are interspersed with historic and continuing clearcut logged areas of varying age and by forest roads accessing the clearcuts. Land use in the surrounding area is restricted by its wild character and limited road access. Little structured industry and commerce are present beyond the community of Thorne Bay and outlying residences, including float homes. Commercial fishing is active in the bay and in Clarence Strait outside the bay. Commercial sportfish guiding takes place on the Thorne River, a world-class fishery for steelhead and salmon, and in the ocean for salmon, halibut, and other fish. The recreation section below discusses recreational activities. Land use within the community is a mix of light industry, commerce, and residences in proportion to the small size of the community.

Transportation

As an island community, the City of Thorne Bay is accessed directly by float plane and boat, both commercial and private; by the small-plane land airport at Klawock 33 miles away by road on the west side of the island; and by Inter-Island Ferry terminals on the island at Hollis to the south (service from Ketchikan) and Coffman Cove to the north (service from Wrangell and Petersburg), both 60 miles away by road. Road links also connect to the towns of Craig and Hydaburg on the island (Figure 2.2). Local roads allow normal vehicle transportation in and around the community of Thorne Bay. Commercial barge service reaches the community once per week. Freight and mail arrive by cargo plane, barge, ship, and truck. A breakwater, dock, small boat harbor, boat launch, boat grid, and State-owned seaplane base are available on the city's waterfront. Ketchikan is the area's transportation hub, and offers commercial jet air service to major Alaskan communities and to the continental United States.

Industry and Commerce

The economy of Thorne Bay from inception in the early 1960s was based on the timber industry. Until closure of the pulp mill in 1997, Ketchikan Pulp Company was the area's dominant employer, with 67% of the work force employed either directly or indirectly, including 57 full time employees related to timber harvest and LTF operations. The company no longer has a presence in the community (City of Thorne Bay, 2005).

With the reduction of the timber industry, the economy has become diversified among various sectors. The U.S. Forest Service continues to maintain its headquarters for the Thorne Bay Ranger District at Thorne Bay, with 41 full-time employees and 24 part-time and seasonal employees. The Southeast Island School District in Thorne Bay has 22 employees, including teachers, administration, and maintenance. The City of Thorne Bay has 9 full-time positions and

3 part-time positions. The city also employs project workers for capital improvement construction (City of Thorne Bay, 2005).

The City of Thorne Bay lists 104 businesses on its sales tax rolls, not including rental housing. Over half of these businesses are located within the owners' homes. Non-residential businesses include fuel services, groceries and supplies, lodges, laundromat, restaurant, airline offices, fishing supplies and equipment, newspaper office, video store, liquor store, vehicle and tire repair, sawmills, shake and shingle mills, drilling and blasting, recreational vehicle and car rental, boat and vehicle storage, and construction (City of Thorne Bay, 2005).

Commercial fishing boats utilize Clarence Strait to catch a variety of seafood (Foster Wheeler Environmental Corporation and Floyd Snider McCarthy, Inc. 2002). Twenty-two residents of Thorne Bay hold commercial fishing permits (Alaska Division of Community Advocacy, no date).

Several sport fishing lodges and charter boat operators are based in Thorne Bay. A few homes are established as "bed and breakfast" lodging. The town includes three churches, a public library, a medical clinic, and a U.S. Post Office.

For the last twelve years, the City of Thorne Bay has been striving to establish an industrial park and deep-water port at Tolstoi Bay, adjacent to the mouth of Thorne Bay. The Tolstoi Development Project has the potential to provide roughly 87 new jobs, including an ethanol plant, sawmill operations, wood chipping, a regional dry-kiln and planing facility, warehousing, barge operations, ferry terminal, and cruise ship operations. Secondary industries could include trucking, tug boat operations, service industries, and manufacture of finished products. (City of Thorne Bay, 2005)

City Services

The City of Thorne Bay provides law enforcement, ambulance, volunteer fire department and EMS squad, boat moorage, emergency medical, water, sewer, road maintenance, garbage collection, and RV Park services. Facilities include a City Hall, fire station, library, water treatment plant, sewer treatment plant, medical clinic, garbage bailer, landfill, drive-down boat grid, boat launch ramp, RV sewage dump station, RV Park, city float, recreational park, and 30 miles of paved road.

Residential

In 1990 there were approximately 200 residential housing units in Thorne Bay proper and approximately 30 homes in South Thorne Bay. Since that time, approximately 20 new homes have been built in South Thorne Bay, and the population was estimated at 150 in 1999. Most townsite lots are under 6,000 square feet, and many contain two residential structures. Housing includes trailers, mobile homes, single family residences, duplexes, one four-plex apartment building, and a Forest Service 26-unit housing complex (City of Thorne Bay, 2005). There is no hotel or motel in the town, but as noted there are a few "bed and breakfasts."

Recreation

Recreational activities in the Thorne Bay area include hunting, fishing, hiking, walking, sightseeing, boating, driving, wildlife viewing, beachcombing, camping, picnicking, canoeing, kayaking, mountain biking, cross-country skiing, ice skating, and other interests. Hunters seek Sitka blacktail deer, black bear, and waterfowl. Fishing pursues king salmon, silver salmon, sockeye salmon, pink salmon, chum salmon, steelhead, cutthroat trout, halibut, cod, snapper, crab, shrimp, and clams. Trapping takes place for wolf, river otter, mink, marten, and beaver. Subsistence harvest is important in the area, and includes hunting, trapping, fishing, and gathering natural resources. Recreational facilities in the City of Thorne Bay include a gymnasium and ballfield (tennis, baseball, basketball, football, soccer, track) at the school; the Pearl Nelson Community Park; and the Bay Chalet multi-use community building. (Foster Wheeler Environmental Corporation and Floyd Snider McCarthy, Inc. 2002; City of Thorne Bay, 2005).

Wildlife Resources

With forest, freshwater, and marine environments, the Thorne Bay region supports a great diversity and richness of wildlife. Predominant large land mammals are Sitka black-tailed deer, black bear, and wolves. Although habitat loss has occurred due to extensive logging activities on the island, these animals remain abundant. Other mammals present include beavers, mink, marten, river (land) otters, sea otters, short-tailed weasels, mice, voles, shrews, and bats. (City of Thorne Bay, 2005)

Anadromous fish in Thorne Bay and the Thorne River include king salmon, sockeye salmon, chum salmon, pink salmon, coho salmon, and steelhead trout. The Thorne River is classified as a "world class" steelhead stream. For anadromous fish, spawning and juvenile rearing take place in fresh water, and growth to maturity takes place in the ocean, with adults returning to freshwater to spawn. These fish are an important food source for black bears, bald eagles, sea gulls, and other wildlife. Cutthroat trout are found in streams and lakes in the region, and may be either anadromous or resident. (City of Thorne Bay, 2005)

Marine mammals occurring in the bay include harbor seals, sea lions, killer whales, and whitesided dolphins. Humpback whales are common in Clarence Strait. (City of Thorne Bay, 2005)

Common larger marine invertebrates, both intertidal and subtidal, include many species of sea cucumbers, starfish, crab, shrimp, sea urchins, jelly fish, clams, barnacles, mussels, and snails. (City of Thorne Bay, 2005)

Birds are plentiful around Thorne Bay. Resident land-based birds include the bald eagle, northern goshawk, raven, crow, spruce grouse, chestnut-backed chickadee, golden crowned kinglet, Steller's jay, winter wren, and dark-eyed junco. Migratory forest birds include rufous hummingbird; red breasted sapsucker; western flycatcher; barn, tree and violet green swallows; belted kingfisher; dipper; American robin; varied, hermit, and Swainson's thrushes; ruby-crowned kinglet; orange-crowned, yellow, yellow-rumped, Wilson's, and Townsend's warblers;

pine grosbeak; pine siskin; common redpoll; red and white-winged crossbills; and Savannah, white-crowned, golden-crowned, fox, song, and Lincoln's sparrows. (City of Thorne Bay, 2005)

The Thorne River estuary is extremely productive habitat for a variety of birds, both summer and winter; the bay and the river are major wintering areas for waterfowl. The following list indicates migratory (M) and wintering (W) species found in the Thorne River estuary (City of Thorne Bay, 2005). These birds also may be found throughout the bay as either ocean dwellers or shorebirds.

Common loon (M,W)
Arctic loon (M,W)
Red-necked grebe (M,W)
Horned grebe (M,W)
Double-crested cormorant (M,W)
Pelagic cormorant (M,W)
Great blue heron (W)
Trumpeter swan (M,W)
Canada goose (M,W)
Brant (M)
Mallard (M,W)
Pintail (M,W)
Green-winged teal (M)
Northern shoveler (M,W)
American wigeon (M)
Greater scaup (M,W)
Common golden-eye (M,W)
Barrow's golden-eye (M,W)
Bufflehead (M,W)
Song sparrow (W)
Golden-crowned sparrow (M)
Common, red-breasted, hooded mergansers (M,W)
Bald eagle (M)
Semipalmated plover (M)
Black-bellied plover (M)
Whimbrel (M)
Greater and lesser yellowlegs (M)
Black turnstone (M,W)
Short-billed dowitcher (M)
Surf bird (M)
Western and least sandpipers (M)
Dunlin (M)
Glaucous-winged gull (W)
Herring gull (M,W)
Thayer's gull (M,W)
Mew gull (M,W)
Common raven (W)
Northwestern crow (W)
Belted kingfisher (W)
Water pipit (M)
White-winged, surf, and black scoters (M,W)
Savannah sparrow (M)

Clarence Strait to the east is a major migratory route on the Pacific Flyway from north to south and a minor migratory route from south to north. Spring migration can be intense as birds head for northern breeding grounds. Fall migration is less intense than spring because it is spread out over a longer period of time and some species by-pass the coastline altogether. Bays, coves, estuaries, shorelines, and wetlands like those of Thorne Bay provide critical resting and feeding habitat for many species. (City of Thorne Bay, 2005)

Vegetation

The thick, temperate, evergreen rain forest surrounding Thorne Bay is dominated by Sitka spruce and western hemlock, with a high proportion of western red cedar and some Alaska yellow cedar. Lodgepole pine and red alder also are common. The spruce-hemlock forest consists of an overstory canopy, understory canopy, shrub layer, and ground vegetation. Understory species throughout the area consist mainly of rusty menziesia, devil's club, skunk cabbage, blueberry, huckleberry, salmonberry, thimbleberry, and red elderberry. Riparian vegetation, muskeg bogs, and tide-influenced meadows also are common throughout the area. (City of Thorne Bay, 2005)

Common marine attached vegetation found in the area includes brown seaweed, rockweed, bull kelp, and eelgrass. (City of Thorne Bay, 2005)

Climate

Prince of Wales Island experiences a cool, wet, maritime climate, often dominated by clouds and precipitation. Based on climate data available in Hollis (60 miles away) from 1949 through 2003, average monthly temperature ranges from 32 degrees Fahrenheit in January to 58 degrees in July. Summer temperatures range from the mid 40s to 70 degrees; isolated high temperatures of up to 80 degrees occur. Average annual precipitation is 160 inches; from October through January Thorne Bay can receive up to eighteen inches of rainfall each month, with a dryer period from May through August. Precipitation during winter months falls primarily as snow, with an average annual snowfall of 40 inches (City of Thorne Bay, 2005; Alaska Division of Community Advocacy, no date).

Summer winds generally are from the southeast and southwest. Winter winds also predominate from the southeast, but can vary to north and northeast as well. Gale force winds can be common, with storms lasting for several days. Topography produces microclimate conditions by trapping wind currents and varying the amount of solar radiation received. Due to the northerly latitude, daylight hours vary from a minimum of six at the winter solstice to a maximum of 19 at the summer solstice (City of Thorne Bay, 2005).

3. Applicable Water Quality Standard

TMDLs are developed to meet applicable water quality standards (WQS). This section identifies the water quality standard for wood residues in Thorne Bay.

The Alaska Water Quality Standards regulation (18 AAC 70), for both fresh and marine waters, establishes 13 pollutant parameters, establishes designated uses of waters, and sets water quality criteria to protect the designated uses. The water quality criteria, which may be numeric or narrative expressions, serve as "pollution limits" that may not be exceeded in waters by human actions. The WQS contain an antidegradation provision requiring that "existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected." The WQS also contain various narrative provisions that govern the implementation of standards, including several exceptions to the statewide standards, notably the Zone of Deposit provision pertaining to the residues parameter.

Designated Uses

Designated uses for both fresh and marine waters are established in the WQS regulation along with water quality criteria established to protect the uses. For marine waters of the state, these designated uses include (1) water supply for aquaculture, seafood processing, and industrial uses; (2) primary and secondary contact recreation; (3) growth and propagation of fish and aquatic life; and (4) harvesting for consumption of raw mollusks or other raw aquatic life (18 AAC 70.020).

Exceedance of the residues standard at the former Thorne Bay LTF most directly affects the designated use of growth and propagation of fish, shellfish, other aquatic life, and wildlife. The most stringent standards generally apply to this designated use; therefore, this designated use is the focus of this TMDL. The accumulation and decomposition of wood residues can adversely affect benthic organisms through burial, displacement, alteration of habitat, reduction of dissolved oxygen, and production of leachates and toxic by-products. Changes in benthic populations may be reflected in other changes throughout the food chain. Effects also might occur on recreational uses such as boating and sportfishing and on the harvest for consumption of raw aquatic life.

Parameter of Concern

The 2004 303(d) list of impaired waters (issued by DEC in May 2006) identified the former Thorne Bay LTF as water quality-limited due to non-attainment of the water quality standard for the parameter "Residues" (ADEC 2006). The material of concern for the residues standard is bark and wood debris deposited by activities at the former LTF.

Applicable Water Quality Criteria

Water quality criteria are the actual numeric or narrative limits on pollutant parameters established in the Alaska Water Quality Standards (18 AAC 70.020). This section describes applicable criteria for residues in Thorne Bay.

For the designated use, "Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife," the Alaska water quality criteria state that residues "May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use, or cause acute or chronic problem levels as determined by bioassay or other appropriate methods. May not, alone or in combination with other substances, cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines." (18 AAC 70.020 (b)(2)). Table 3-1 contains the full water quality criteria for residues.

Under the Zones of Deposit provision of the WQS (18 AAC 70.210), ADEC may issue a permit that allows the deposit of substances on the bottom of marine waters within limits set by ADEC. It is important to note that the water quality criteria of 18 AAC 70.020 and the antidegradation requirement of 18 AAC 70.015 may be exceeded in a zone of deposit, but must be met at every point outside the zone of deposit and in the water column. In allowing a zone of deposit ADEC must consider several factors, including impacts on human health, impacts on aquatic life, impacts on other uses of the waterbody, alternatives to reduce adverse effects, and duration and transport of pollutants. The Zones of Deposit provision is presented in Table 3-2.

Table 3-1. Alaska's water quality criteria for Residues in marine waters (18 AAC 70.020)

Pollutant & Water Use	Criteria
(**20) RESIDUES, FOR MARINE WATER USES: Floating solids, debris, sludge, deposits, foam, scum, or other residues**	
(A) Water Supply (i) aquaculture	May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use. May not cause detrimental effects on established water supply treatment levels.
(A) Water Supply (ii) seafood processing	May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use; cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.
(A) Water Supply (iii) industrial	May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use.
(B) Water Recreation (i) contact recreation	Same as (20)(A)(ii).
(B) Water Recreation (ii) secondary recreation	Same as (20)(A)(ii).

(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use, or cause acute or chronic problem levels as determined by bioassay or other appropriate methods. May not, alone or in combination with other substances, cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.
(D) Harvesting for Consumption of Raw Mollusks or Other Raw Aquatic Life	May not make the water unfit or unsafe for the use; cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.

Table 3-2. Alaska's WQS Zones of Deposit provision (18 AAC 70.210)

18 AAC 70.210. Zones of deposit. (a) The department will, in its discretion, issue or certify a permit that allows deposit of substances on the bottom of marine waters within limits set by the department. The water quality criteria of 18 AAC 70.020(b) and the antidegradation requirement of 18 AAC 70.015 may be exceeded in a zone of deposit. However, the standards must be met at every point outside the zone of deposit. In no case may the water quality standards be violated in the water column outside the zone of deposit by any action, including leaching from, or suspension of, deposited materials. Limits of deposit will be defined in a short-term variance issued under 18 AAC 70.200 or a permit issued or certified under 18 AAC 15.

(b) In deciding whether to allow a zone of deposit, the department will consider, to the extent the department determines to be appropriate,

(1) alternatives that would eliminate, or reduce, any adverse effects of the deposit;
(2) the potential direct and indirect impacts on human health;
(3) the potential impacts on aquatic life and other wildlife, including the potential for bioaccumulation and persistence;
(4) the potential impacts on other uses of the waterbody;
(5) the expected duration of the deposit and any adverse effects; and
(6) the potential transport of pollutants by biological, physical, and chemical processes.

(c) The department will, in its discretion, require an applicant to provide information that the department considers necessary to adequately assess (b)(1)-(6) of this section. In all cases, the burden of proof for providing the required information is on the person seeking to establish a zone of deposit. (Eff. 11/1/97, Register 143)

Because the residues water quality criteria are narratives and are use-based, ADEC applies the residues criteria on a case-by-case basis. A Zone of Deposit (ZOD) may be used to implement the TMDL through a permit. ADEC's application of the narrative criteria is discussed in Appendix G of the 303(d) listing report, *Alaska's Final 2004 Integrated Water Quality Monitoring and Assessment Report*, as follows (ADEC 2006).

> The water quality criteria for residues are narrative criteria with several provisions that are subject to interpretation. As such, it is overly simplistic to characterize the residues standard as "zero discharge". The first sentence of the criteria for most uses provides that residues "[m]ay not, alone or in combination with other substances or wastes, make the water unfit or unsafe, for the use..." [emphasis added] This is a "use-based" criterion – meaning, a use impairment determination must be made to trigger a water quality violation or a significant non-compliance situation.

> The second sentence within the narrative criteria for some uses states that residues "may not cause a sludge, solid, or emulsion to be deposited" on the surface, bottom, or shoreline. This prohibition against deposits is the most restrictive provision of the residue criteria. But it is not treated as a zero discharge standard in all instances. For example, DEC permits zones of deposit under 18 AAC 70.210; mixing zones under 18 AAC 70.240-.270; and variances under 18 AAC 70.200.

ADEC has developed a residues target for the Thorne Bay TMDL as a level of residues that will support the achievement of stable benthic biological communities with balanced species composition in more than 75 percent of the area with documented coverage by wood residues on the bottom of Thorne Bay, within 40 years. This target is based on scientific findings that natural benthic communities, because of dynamic conditions, generally have no more than 75 percent of area exhibiting such mature biological communities (EVS 2001). This target also reflects the WQS residues criteria that state that residues may not make the water unfit or unsafe for biological use. Section 6.1 provides additional explanation on the TMDL target and loading capacity for residues.

Seasonal Variation

TMDLs must be developed with consideration of seasonal variation. Seasonal variation in pollutant loadings, waterbody response, and impairment conditions can affect the development and expression of a TMDL. A TMDL should include wasteload and load allocations that ensure the waterbody will maintain water quality standards under all expected conditions.

The existing wood residues impairment in Thorne Bay is not associated with a particular season or environmental condition. The impairment is a result of years of accumulation and decomposition of wood debris occurring year-round under prevailing environmental conditions. Therefore, development of the TMDL for specific seasons and conditions is not necessary; the wasteload and load allocations of zero m^3/acre/day (except for loadings from natural sources) are established to be protective under all seasons and conditions.

4. Water Quality Analysis

This section presents an analysis of water quality with respect to the Residues standard at the former Thorne Bay LTF marine area at the head of the bay.

As described in Section 3, the key elements of the water quality standard for Residues applicable to the Thorne Bay LTF establish that Residues may not be deposited in the water or on the bottom, and may not make the water unfit or unsafe for designated uses. Through the Zone of Deposit provision, ADEC can allow the deposit of residues on the bottom in a specified area; however, no bark discharge permit or Zone of Deposit authorization was issued to the former Thorne Bay LTF.

The bottom of the log transfer marine area at the head of Thorne Bay was impacted extensively by dredging activities in both construction and operation, and by accumulation of bark and wood debris during operation, over the period from 1980 to 2000. The adjacent Thorne River was depositing silt and sand sediment continually during that period; while the rate of deposition is not known, the natural substrate clearly is composed of deposited sediments. In addition, deposited bark and wood go through a natural process of decomposition with time that causes continuing physical, chemical, and biological changes in sediments. It is presumed that infaunal communities in and on bottom substrates in this area were in a continual state of flux throughout the period because of the interplay of these conditions.

As indicated previously, the accumulation and decomposition of wood residues can adversely affect benthic organisms and communities through burial, displacement, alteration of habitat, reduction of dissolved oxygen, and production of leachates and toxic by-products such as sulfides and ammonia. Changes in benthic populations may be reflected in other changes throughout the food chain. Effects also might occur on recreational uses such as boating and sportfishing and on the harvest for consumption of raw aquatic life.

At the same time, once accumulation of bark and wood debris ceases, and in the absence of additional disturbance, ocean substrates typically undergo a fairly rapid process of biological recovery. Benthic studies conducted by ADEC in 2003 and 2005 illustrate that this biological recovery process has taken place within the log storage area, including the original LTF marine area. The question of the present condition of bark and wood debris and biological communities on the bottom within the log transfer area is addressed below.

In 1994, both the Thorne Bay log storage area and log transfer area were placed on the 303(d) "impaired water" list based on knowledge of the transfer and storage of large volumes of logs at the site, and on dive surveys conducted in 1988 and 1990 that documented bark accumulation in the log storage area but did not include the LTF marine area at the head of the bay. No specific documentation of the condition of the bottom of the LTF marine area was available until dive surveys were conducted there in 2001, 2002, and 2004. Table 4-1 presents a summary of the three LTF dive surveys.

Table 4.1 Dive Surveys Conducted at the Thorne Bay LTF marine area

Date	Dive Contractor	Continuous Bark Cover, Acres	Discontinuous Bark Cover, Acres
June 2001	Alaska Commercial Divers[1]	2.6	0.6
June 2002	Haggitt Consulting[2]	1.1	2.8
April 2004	Alaska Commercial Divers[3]	6.5	2.3

1. Alaska Commercial Divers, Inc., July 18, 2001. Thorne Bay Bark Monitoring Survey. P.O. Box 9351, Ketchikan, AK 99901.
2. Haggitt Consulting, Inc., July 15, 2002. Thorne Bay Log Transfer Facility Bark Monitoring Survey, Survey Date June 7, 2002. 6991 Highway 112, Sekiu, WA 98381.
3. Alaska Commercial Divers, Inc., April 18, 2004. Thorne Bay Permit Dive Contract # 53-0116-4-00658. P.O. Box 9351, Ketchikan, AK 99901.

In 1988 and 1990, Ketchikan Pulp Company conducted dive surveys to measure bark accumulation in the three main portions of the log storage area where logs were stored. The 1988 dive survey estimated approximately 55 acres of bark on the bottom, mostly varying from 6 to 24 inches in thickness, with some lesser and some greater thicknesses, and a maximum of 30 inches. The 1990 dive survey showed similar results, though the pattern of bark thickness varied somewhat from the 1988 dive survey, and the maximum thickness was 36 inches. The surviving dive reports present only maps and data in hand-drawn graphic form, with no discussion of dive method, bark thickness measurement method, bark area calculation, or bark and substrate condition. The calculation of bark area (present only in the 1988 report) is shown in handwritten annotation (author unknown) with no explanation of calculation method. In addition, substantial bottom area between the three main areas of log storage, at least 60 acres, was not measured in these dive surveys, so the actual area of "continuous bark cover" on the bottom at the time is not known, and may have been greater than 55 acres. (Ketchikan Pulp Company, 1988; 1990)

In 2003 and 2005, ADEC carried out detailed benthic studies at the former log storage area, including the original LTF marine area, but not at the former log transfer marine area at the head of the bay, to determine the present extent of bark and wood debris on the bottom and the biological condition of bottom sediments. The studies employed Sediment Profile Imaging (SPI), core sampling, physical analysis, chemical analysis, biological analysis, and diver analysis. SPI is a powerful technique that drops a wedge-shaped housing containing a camera into soft bottom substrates and takes a clear picture of a vertical slice of the substrate to a depth of roughly eight inches. SPI thus provides a view into bottom sediments that can identify chemical, physical, and biological features. The SPI camera was deployed at 109 log storage area stations and four reference sites. Using grab samples of bottom material, biological analysis counted and identified the species of all organisms present (greater than 0.5 mm in size) at 12 intensive study sites and four reference sites. The studies determined that, while there is significant wood residues content in bottom sediments at the log storage area, wood residues are mostly decomposed to small fragments and are mixed with bottom sediments, and further that diverse, abundant, and healthy benthic biological communities occurred throughout the former log storage area. Following are some of the key scientific findings (Germano and Associates, Inc., 2006).

- At 82 of the 109 bottom stations sampled using the SPI camera, wood content was less than 15 percent, with an additional 21 stations less than 30 percent wood content (as estimated by SPI cross section images).
- Bark coverage on the sediment surface was less than 20 percent at 49 stations measured by SPI images and at 55 stations measured by surface photos. Bark coverage was less than 50 percent at an additional 30 stations measured by SPI images and at 26 stations measured by surface photos.
- In grab samples with area of 12 inches square and depth of 6 inches, Total Organic Carbon (TOC) at 12 intensive study sites averaged 8.15 percent, compared to 6.97 at four reference sites.
- Total Volatile Solids (TVS) in grab samples at the 12 sites averaged 19.14 percent, compared to 16.7 at the reference sites.
- An average of 255 organisms was found in grab samples at the 12 sites, compared to 372 at reference sites. Numbers of species per sample were 50 and 64, respectively.
- The Organism-Sediment Index, a combined measure of benthic community health, was very high over the entire study area.

As a result of these findings, the former log storage area, including the original LTF marine area, was determined to be "an extremely healthy coastal embayment" (Germano and Associates, Inc., 2006). In April 2006, ADEC removed the former log storage area from the 303(d) list; the log storage area no longer is subject to preparation of a TMDL (ADEC, 2006).

This TMDL addresses only the former log transfer marine area at the head of the bay, which was not included in the 2003-2005 detailed benthic studies. Removal of the log storage area serves to define the remaining former log transfer marine area as the area between the LTF shoreline at the head of the bay and the boundary of the log storage area, as shown in Figure 4.1. This area, approximately 35 acres, remains on the 303(d) impaired water list.

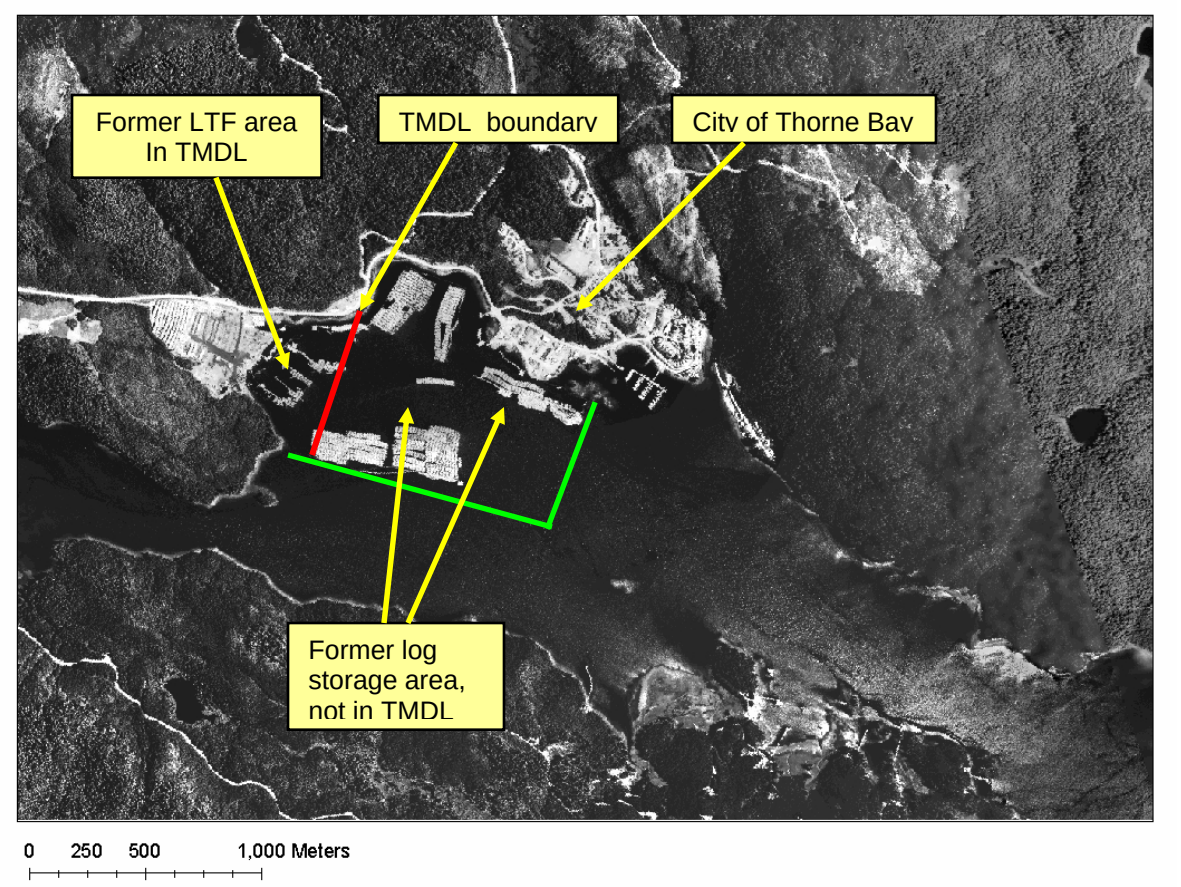

Figure 4.1. TMDL boundary, former LTF area addressed in TMDL, former log storage area not addressed in TMDL, and City of Thorne Bay

Figure 4.2. View of the Thorne Bay LTF after operation ceased, showing the A-frame crane (Foster Wheeler Environmental Corporation and Floyd Snider McCarthy, Inc. 2002)

As indicated in Table 4.1, three dive surveys were conducted in the main activity portion of the log transfer area at the head of the bay in 2001, 2002, and 2004 by the U.S. Forest Service. The dive surveys were done in conjunction with the Forest Service's application in 2000 to ADEC and EPA for authorization under the agencies' Wastewater Discharge General Permit for discharge and accumulation of bark at a Log Transfer Facility in anticipation of resumption of operation of the Thorne Bay LTF. However, the application was denied by ADEC in 2003 because a separate appeal process determined that the General Permit cannot authorize bark discharge and accumulation in a waterbody that is on the ADEC 303(d) list as impaired. ADEC notified the Forest Service that it must apply for an individual permit to authorize bark discharge and accumulation at this facility. The Forest Service has not applied for an individual permit, and has indicated that, if log transfer occurs in the future, it will be done by barges, with no logs placed in water. No bark discharge permit will be required in that circumstance.

The dive survey method was similar for the three surveys. From an origin point on the shoreline, an array of transects was set to radiate seaward on compass bearings 30 degrees apart, and sample points were established at 15-foot intervals along each transect. By visual estimate within a three-foot square at each sample point, the diver recorded "percentage of continuous cover" or "100 percent cover" by bark and wood debris on the bottom (and also recorded "percentage of discontinuous cover," or cover that is 10 percent or greater, but less than 100 percent). The diver also recorded thickness of bark and wood debris with a ruler; water depth (corrected to MLLW); and substrate type. The diver took a surface photograph of each sample point. Sampling continued along each transect until the end of continuous bark cover was reached.

Each dive survey report presents the dive data in tabular form for each transect, and portrays the data on a graphic map of the dive transect array. The area of continuous bark cover is calculated as the area within a polygon boundary that connects the outermost points enclosing an area of continuous bark cover.

The calculation of area of continuous bark cover from a dive survey is an estimate. Accuracy of the dive survey method has not been evaluated. Factors that may affect the accuracy of a dive survey include the following.

1. Location of the transect point of origin.
2. Configuration of transects and sample points.
3. Following transects as compass bearings underwater.
4. Measuring distance between sample points underwater.
5. Judgment of "continuous bark cover" and "thickness of bark cover."
6. Calculation of "continuous bark cover" when points of "discontinuous bark cover" are mixed in among points of continuous cover.

A different diver conducted each of the three Thorne Bay LTF dive surveys. In the three dive surveys, the points of origin, as recorded by GPS coordinates, differed somewhat, and therefore the configurations of transects and sample points also differed.

An important consideration is the nature of bark and substrate on the bottom as it relates to determination of percent cover by bark and thickness of bark. At an active LTF, typically much smaller than the former Thorne Bay facility, it is common to find a layer of intact bark pieces on top of the bottom substrate from a few to several centimeters thick (and occasionally thicker). The area of "continuous coverage" by bark at an active LTF typically is 0.25 to 0.5 acre, but may be either more or less. Bark pieces generally are small pieces from one to 10 centimeters in length. It also is common to find bark mixed with sediments in varying proportions. The sediment is fine-grained silty material that may be both organic and inorganic in origin, presumed to be the natural fallout of suspended silt and detritus in the ocean.

As bark debris decomposes on the bottom, it tends to disintegrate into small fragments and mix with the natural substrate to form a soft sediment. This process is shown clearly in benthic assessments done both at the former Thorne Bay log storage area (Germano and Associates, Inc., 2006) and in Ward Cove (Exponent, 1999; Exponent, 2005).

Each of the three dive survey reports described the bark and substrate conditions encountered. The 2001 report in this regard stated only that, "The substrate type at this site mostly consisted of bark and silt."

The 2002 dive survey report stated:

> The bottom had been excavated into four foot by eight-foot swales as a result of remediation efforts using a clamshell type bucket. This area extended for several thousand square meters. The effect as measured during the survey was to create pockets of exposed debris in the valleys of the swales. The swales themselves contained an estimated (by volume) 70 % bark debris and 30 % colluvial mix. The swales appeared to

> be of a low density as the ruler encountered little resistance penetrating them to a depth of 48" before contacting the dense native layer. Each swale and much of the bark debris in the valleys were covered with a layer of *Beggiatoa*. In the southern portion of the LTF evidence of Alluvium deposits of up to 6" deep quilted the substrate and shrouded some of the larger log debris.

The 2004 dive survey report stated:

> Upon entering the water it was found that most of the bark debris was in an advanced state of decay. The Debris has mostly decomposed into a black sludge substance with the appearance of silt. On the 105 degree heading there was a bit more resistance while probing the sediment as to suggest that the bark in this area may be less decomposed. Some less decomposed patches of bark were observed on the surface and representative pictures taken. At the end of the transects, the substrate consisted of a rich brown mud where many star fish and Sun stars were present. Sea life observed around the survey area included Spider crab, Dungeness crab, Tanner crab, Star Fish, Sun Stars, a small Eel, a Sculpin, white and orange growth and numerous small fish (less than 1 inch).

When fine-grained bark is present primarily as an admixture with sediment, it is extremely difficult to determine both percentage of continuous bark coverage and bark thickness. The resulting area of continuous bark cover is largely a reflection of the diver's judgment of what constitutes "continuous bark cover." It is presumed that this factor is largely responsible for the differences in results among the three dive surveys. The 2004 survey found 6.5 acres of continuous bark cover, compared to 1.1 acres in 2002 and 2.6 acres in 2001. Given the absence of log transfer activity and bark discharge at this LTF after 2000, it is apparent that the prevailing dive survey method does not necessarily provide accurate measure of continuous bark cover. Further, the visual dive survey method may lose relevance as a measure of whether there is exceedance of the Residues standard in terms of both deposit on the bottom and impairment of designated uses. Benthic biological assessment may be required, as conducted for the Thorne Bay log storage area, in order to determine biological condition.

Two environmental factors affect the bottom of the LTF area in addition to bark deposits. One factor is that the adjacent Thorne River deposits a substantial silt and sand sediment load in the area, presumably on a continuing basis. While the rate of sediment accumulation in the LTF area is not known, this sediment clearly dominates the natural bottom substrate. Intermixture of decomposing bark with sediment is a major factor in promoting biological recovery.

As an interesting sidelight, the 2005 study found that the bottom of the log storage area on the southwest side immediately adjacent to the river delta contained a considerable amount of wood debris deposited by the river in the form of sticks, twigs, and leaves. Although not quantified by the study, relatively little bark from logs was evident in this area, and the quantity of river-derived woody material was similar to the amount of bark-derived woody material found on the bottom away from the delta toward the north side of the log storage area (Sturdevant 2006). The amount of river-derived woody material that may be present in the LTF area is not known. The LTF area is in proximity to the river delta, but is not directly adjacent. However, because the river-derived woody material is a natural source, it is <u>not</u> considered to contribute to impairment, but is simply a natural phenomenon.

The second environmental factor is that extensive dredging occurred during operation of the LTF in order to remove bark waste and sediment and maintain navigational water depths. The amount of bark waste removed, and the amount remaining, are not known. The description in the LTF dive reports of the advanced decomposition of bark debris in a black, sludge-like substrate with "low density" to a depth of 48 inches is consistent with the nature of substrate found throughout the log storage area in 2005. The descriptions in the dive reports are all that is known about the present condition of the bottom at the LTF area.

It is likely that a biological recovery process has been taking place in the six years since cessation of operation at the LTF area, but the status of biological recovery is not known. While the 2004 dive survey observed spider crab, Dungeness crab, tanner crab, star fish, sun stars, an eel, a sculpin, and numerous small fish, the condition of infaunal communities has not been assessed. It is possible that biological recovery has been achieved in infaunal communities in a substantial portion of the area, as it has been in the log storage area. It also is possible that biological recovery has not advanced to a similar extent. The TMDL target described in Section 6 requires that biological recovery be achieved over at least 75 percent of the area. If it were demonstrated that this target has been achieved, the LTF area (or a portion it) could be removed from the 303(d) list, obviating the need for a TMDL to be prepared. However, because adequate information is not available to remove the LTF area from the 303(d) list, a TMDL must be prepared.

ADEC is planning further studies in 2007 to assess the condition of wood waste and biological recovery of the bottom in the former log transfer marine area. The TMDL might be modified subsequently in correspondence with results of that assessment. Depending on the degree of biological recovery that is found, results might indicate that the LTF impaired area should be either redefined or delisted.

5. Pollutant Sources

Point Sources

The source of residues impairment at the former Thorne Bay LTF marine area at the head of the bay is bark and wood debris discharged into the ocean by log transfer operation from 1980 through 2000. Log transfer included the transfer of logs from water to land and from land to water, and the temporary holding of logs in water to make up log rafts, which then were moved to the adjacent former log storage area. The former log transfer area and log storage area are depicted in Figures 4.1 and 4.2

The discharge of bark from logs in marine water is regulated by EPA and ADEC as a point source discharge. Bark is discharged from logs particularly when log bundles are placed into water using a crane, log loader, or slide ramp. The amount of bark discharged depends on factors such as speed of bundle entry into the water, species and age of tree, time of harvest, and time since harvest. Bark is discharged from logs held in the water, though to a lesser degree. Bark discharge also may occur when bark residues on land are washed into the water.

The LTF uplands belong to the Tongass National Forest and are managed by the U.S. Forest Service. Ketchikan Pulp Company operated the LTF and log storage area under agreement with the Forest Service until 1999, following closure of the Ketchikan pulp mill in 1997. Gateway Forest Products acquired most of the pulp mill facilities at Ward Cove in 1999 and briefly operated the associated sawmill and constructed and operated a veneer mill on the site. In 1999 and 2000, Gateway used the Thorne Bay facilities to transfer and store a relatively small log volume to supply the sawmill and veneer mill.

As described in Section 2, Ketchikan Pulp Company moved a floating logging camp from Hollis to Thorne Bay by in 1961; onshore camp facilities were constructed starting in 1962; and the city was incorporated in 1982. The original LTF was constructed beginning in 1961 on the east side adjacent to the logging camp, and was replaced by a new LTF at the head of the bay in 1980. In the logging heyday of the 1960s and 1970s, the community was the largest logging camp in the world (City of Thorne Bay, 2005).

The new LTF was located on the shore about 1/2 mile west of the City of Thorne Bay (Figure 4.1). The marine log storage area of roughly 200 acres was located between the LTF area and the city. The Thorne River mouth is located adjacent to the log storage area. The river delta forms the southwestern boundary of the log storage area, and the bottom of the log storage and log transfer area is dominated by silt and sand sediments deposited by the river, with bark and wood debris intermixed, as described. The river also deposits a considerable amount of sticks, twigs, and leaves on the bottom in the area immediately adjacent to the delta.

Timber harvest on National Forest lands has declined substantially since closure of the Ketchikan pulp mill in 1997 (following closure of a pulp mill at Sitka in 1993). The Thorne Bay LTF and log storage area were deactivated and dismantled after 2000; no facilities remain there today except the ocean-front bulkhead. Timber harvest continues on National Forest lands utilizing LTFs at other locations and transporting logs to market mainly by barge rather than by towed rafts. However, the U.S. Forest Services' administrative headquarters for the Thorne Bay

Ranger District remain at the City of Thorne Bay. Substantial timber harvest also has occurred and continues on Native Corporation lands on the island; this timber has not moved through Thorne Bay facilities and does not affect wood residues in Thorne Bay.

About 1985, EPA determined that log transfer facilities (but not separate log storage facilities) would be regulated as point source discharges. From that time until 1996, EPA issued Wastewater Discharge Individual Permits for discharge of bark and wood debris to new LTFs in Alaska; these permits were certified by ADEC, including issuance of Zones of Deposit, and adopted as State permits. However, LTFs constructed before 1985 were exempted from discharge permitting. Therefore, no individual bark discharge permit or Zone of Deposit ever was issued to the Thorne Bay LTF. EPA and ADEC Wastewater Discharge General Permits for bark discharge went into effect in 2000; these General Permits applied to facilities constructed before 1985 as well as after 1985, and included log storage as well as log transfer. The U.S. Forest Service applied to ADEC in 2000 for authorization to operate the Thorne Bay LTF and log storage under the General Permits. In 2002, an appeal decision denied coverage under the General Permits for LTFs in 303(d)-listed waterbodies. The Thorne Bay LTF therefore was not eligible and did not receive authorization under the General Permits. The U.S. Forest Service later stated that log transport in the future, if any, would be done by barges, with no logs placed in the water. With no apparent prospect for transferring or storing logs in water, this TMDL for wood residues in the Thorne Bay log transfer marine area establishes a wasteload allocation of zero m^3/acre/day for future discharge and accumulation of wood residues (see Section 6).

The Thorne Bay LTF was the central site for marshalling logs destined for the Ketchikan pulp mill and sawmill in Ward Cove and the Annette Cedar Mill on Annette Island south of Ketchikan. Most of the logs harvested from National Forest lands on Prince of Wales Island were transported to Thorne Bay by truck or by rafts towed in the ocean. During the LTF's life, an estimated 908 million board feet of logs arrived by truck. Up to an estimated 10 times that volume arrived by raft and were processed at the LTF, yielding a total volume close to 10 billon board feet (Foster Wheeler Environmental Corporation and Floyd Snider McCarthy, Inc. 2002).

The Thorne Bay LTF land site was about 28 acres, with 13 acres formerly tidelands. Most of the area was built up with fill material dredged from the adjacent ocean bottom. Logs arriving at the site by truck were unloaded on land, remanufactured (trimmed), graded, sorted, bundled, and placed into the water to form log rafts. Logs arriving in rafts towed from other locations were lifted by A-frame crane from water to land, similarly handled, returned to water in bundles using a continuous-chain let-down ramp, and again formed into rafts and towed to destinations. The site was able to process up to an estimated 1 million board feet of logs per day. (Foster Wheeler Environmental Corporation and Floyd Snider McCarthy, Inc. 2002; Graham, 2006).

The huge A-frame crane was constructed at the south end of the site, and sat on top of a large concrete pad. The continuous-chain ramp was located just to the north of the A-frame. A waterfront bulkhead containing the site consisted of a large rock wall and steel sheetpiles. Floating log booms anchored just offshore formed six rafting pens in which log rafts were made up (Figure 4.1). Floating log bundles were moved into the rafting pens by small tug boats called "boom boats." A raft, contained by a perimeter chain of logs, was either 64 feet wide and 512 feet long, or 72 feet wide and 576 feet long. (Foster Wheeler Environmental Corporation and Floyd Snider McCarthy, Inc. 2002; Graham, 2006).

Log storage included both incoming and outgoing log rafts. Incoming log rafts were held in the cove on the north side of the log storage area adjacent to the highway. Outgoing log rafts were held on the northeast side of the storage area adjacent to the City of Thorne Bay promontory and on the south side of the storage area adjacent to the river delta (Figure 4.1). While varying with time, roughly 30 percent of the logs were sent to the Ketchikan Pulp Company pulp mill in Ward Cove, 20 percent to the Ward Cove sawmill, 35 percent to the Annette Cedar Mill on Annette Island south of Ketchikan, and the remainder to export destinations (Graham, 2006).

Nonpoint and Natural Sources

The ADEC 2004 303(d) list identifies the source of impairment in Thorne Bay as "excess debris from former log transfer facility activities" (ADEC, 2006). There are no significant anthropogenic nonpoint sources contributing wood residues to this portion of Thorne Bay. The Thorne River is a natural source of wood debris in the form of sticks, twigs, and leaves. In the former log storage area immediately adjacent to the river delta, a considerable amount of this river-derived wood debris exists on the bottom. River debris also likely reaches the LTF area and settles to the bottom; the amount is not known. A small natural stream entering the ocean on the north side of the LTF shoreline, and the general shoreline of Thorne Bay, may contribute incidental wood debris to the bottom of the LTF area.

6. Analytical Approach and TMDL

This section presents the TMDL for wood residues at the Thorne Bay LTF, including the following individual TMDL elements.

- **Target.** The water quality target for a given pollutant in a TMDL is a numeric or narrative expression that serves as the goal for the TMDL, which equates to attainment of the WQS. The target also is the basis for establishing the loading capacity.

- **Loading Capacity (LC).** The LC is the greatest amount of a pollutant that a waterbody can receive without violating the applicable WQS, as reflected by the target. The LC is the pollutant quantity that is available to divide up to establish WLA, LA, and MOS.

- **Wasteload Allocation (WLA).** A WLA is the portion of the LC allocated to an existing or future point source discharge.

- **Load Allocation (LA).** An LA is the portion of the LC allocated to an existing or future nonpoint source discharge or natural source.

- **Margin of Safety (MOS).** An MOS is the portion of the LC that is set aside to account for any uncertainty or lack of knowledge concerning the relationship between LAs and WLAs and water quality. An MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loading capacity) or a combination.

- **Seasonal Variation.** A TMDL must consider seasonal variation in the analysis. Seasonal variation in pollutant loadings, waterbody response, or impairment conditions can affect the development and expression of the TMDL.

- **Future Sources**. A TMDL must establish allocations for both existing and future point sources and nonpoint sources of the listed pollutant.

Target

The water quality target serves as the goal for the TMDL, which equates to attainment of the applicable WQS. The target also is the basis for establishing the loading capacity. Although a specific target and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether the targets and allocations are met but whether designated uses are supported and WQS are achieved.

Where appropriate, a target is simply the applicable numeric water quality criterion for the pollutant. The water quality criterion for residues is a narrative expression that prohibits the deposit of residues in the water or on the bottom. Given that wood residues in Thorne Bay will persist for a substantial but unknown period, it is not feasible to establish a TMDL target that is the absence of introduced wood residues or that achieves recovery to a "natural condition." In

this TMDL, the target is a narrative expression directed to biological recovery that will support designated uses and achieve WQS in the Thorne Bay LTF marine area at the head of the bay.

Benthic biological condition is highly variable in natural marine systems. Changes in benthic communities occur continually due to disturbances and varying natural conditions. Monitoring of the seafloor shows a patchwork of different stages of succession, often over a scale of tens of meters. In a recovering benthic situation, it is generally expected that not more than 75 percent of the affected bottom simultaneously will exhibit a mature (Stage 3) infaunal community (EVS 2001). "Stable, balanced communities" are viewed as "mature equilibrium communities of burrowing, deep-dwelling, head-down, deposit-feeding organisms, or other 'Stage 3' communities."

Because of the dynamic nature of the biological recovery process, the following TMDL target for residues is established for the Thorne Bay LTF: Achievement of stable, balanced benthic communities through natural biological succession, in more than 75 percent of the area with documented accumulation of wood wastes, within 40 years.

Loading Capacity

An LC is the greatest amount of a pollutant that a waterbody can receive without violating the applicable WQS, as reflected by the target.

If the target is a numeric criterion and discharge sources are present, the LC can be calculated as the greatest pollutant load that will not cause the criterion to be exceeded, expressed as kilograms per day or another suitable time-based measure. For the Thorne Bay LTF, given the narrative target and no current or apparent future sources of wood waste residues, the LC is directed to biological recovery, with no allowance for future discharge of wood residues.

For the Thorne Bay LTF, because there are no current or apparent future sources of wood waste residues to discharge into Thorne Bay, the loading capacity is established as zero m^3/acre/day.

Wasteload Allocation

A WLA is the portion of the LC allocated to an existing or future point source discharge. In Thorne Bay, the WLA must be consistent with the LC of zero m^3/acre/day.

For the Thorne Bay LTF, because there are no current or apparent future sources of wood waste residues to discharge into Thorne Bay, the wasteload allocation is established as zero m^3/acre/day.

With this wasteload allocation, no future permits to authorize discharge of bark and wood debris in the LTF marine area may be issued by EPA and ADEC, until WQS are met or the TMDL is revised. Revision of the TMDL to include modified WLAs may be considered if activity is proposed at the Thorne Bay LTF that will entail discharge of wood waste residues. However, establishment of LTFs at other locations in Thorne Bay is not precluded by the TMDL.

Load Allocation

An LA is the portion of the LC allocated to existing or future nonpoint source or natural source discharges.

No discharge of substances contributing to the residues impairment in Thorne Bay is expected from nonpoint sources. No significant anthropogenic nonpoint sources of wood residues are present in the vicinity. Natural sources present include the Thorne River, a small stream within the former LTF site, and vegetative litter from the general shoreline.

The LA for nonpoint source wood residues at the Thorne Bay LTF is established as zero m^3/acre/day, except for loadings from natural sources.

Margin of Safety

An MOS must be included in a TMDL to account for any uncertainty or lack of knowledge regarding the pollutant loads (WLAs, LAs) and the response of the receiving water. The MOS can be implicit (incorporated into the TMDL through conservative assumptions) or explicit (expressed as an allocation of the loading capacity) or a combination.

The MOS for this TMDL is implicit in establishing the LC, WLA, and LA as zero m^3/acre/day (except for loadings from natural sources). Because no further residues inputs are allowed, the load and wasteload allocations are as conservative as possible in protecting current water quality and allowing achievement of WQS.

Seasonal Variation

TMDLs must be developed with consideration of seasonal variation. Seasonal variation in pollutant loadings, waterbody response, and impairment conditions can affect the development and expression of a TMDL. A TMDL should include wasteload and load allocations that ensure the waterbody will maintain water quality standards under all expected conditions.

The existing wood residues impairment in Thorne Bay is not associated with a particular season or environmental condition. The impairment is a result of years of accumulation and decomposition of wood debris occurring year-round under prevailing environmental conditions. Therefore, development of the TMDL for specific seasons and conditions is not necessary; the wasteload and load allocations of zero m^3/acre/day (except for loadings from natural sources) are established to be protective under all seasons and conditions.

Future Growth

There are no current or apparent future sources of wood waste residues to discharge into marine water at the Thorne Bay LTF. The U.S. Forest Service has indicated that future log transfer at the Thorne Bay LTF, if any, will use barge transport of logs, with no logs placed in the water. Nonetheless, the future of the timber industry and use of the Thorne Bay LTF could change. As indicated, if future activity is proposed at the Thorne Bay LTF that will entail discharge of wood waste residues, the TMDL may be revised to include modified WLAs. Possible revision of the

WLA in this TMDL will depend on analysis of relevant factors at that time. As indicated, establishment of LTFs at other locations in Thorne Bay is not precluded by the TMDL. An LTF at another location would have to be established through required State and federal permitting processes.

7. Monitoring

This section presents information on planned monitoring activities associated with the TMDL for wood residues at the Thorne Bay LTF. EPA encourages developing TMDLs using available information and data with the expectation that a commitment to additional monitoring will accompany the TMDL (USEPA, 1991).

EPA and ADEC support appropriate additional monitoring of wood residues to determine the status of biological recovery at the Thorne Bay LTF. ADEC is planning to conduct further assessment of wood waste and biological conditions at the Thorne Bay LTF in 2007. If results of the assessment determine that the TMDL target is not met, the TMDL may be maintained or modified in accordance with findings. If results determine that the TMDL target is met, the TMDL may be rescinded and the Thorne Bay LTF area may be removed from the 303(d) list of impaired waterbodies. Additional monitoring will be considered as warranted.

8. Possible Future Actions

This section discusses future actions to manage the wood residues impairment to the former Thorne Bay LTF area.

As described, there are no current or apparent future sources of wood waste residues to discharge into water at the Thorne Bay LTF. The U.S. Forest Service has indicated that future log transfer at the Thorne Bay LTF, if any, will use barge transport of logs, with no logs placed in the water.

The TMDL wasteload allocation and load allocation are set at zero m^3/acre/day (except for loadings from natural sources). Under these controls, no future discharge of wood waste residues into water will be permitted at the Thorne Bay LTF until WQS are met or the TMDL is revised. It is expected that these controls will lead to meeting the TMDL target within the stated time frame of 40 years, and perhaps sooner.

No active restoration is proposed for the Thorne Bay LTF. As shown by assessment in 2005, biological recovery has been achieved at the adjacent log storage area. Limited observational information from dive surveys (Section 4) indicates that biological recovery is underway at the Thorne Bay LTF. The bark that is present is mixed with sediment and is described as being in an advanced state of decay. Fish, shellfish, and starfish were observed in the area.

Additional monitoring is planned in 2007 to determine the status of biological recovery at the LTF marine area. As mentioned, it is possible that biological recovery has been achieved in a substantial portion of the LTF area, but also possible that biological recovery has not advanced widely, as it has at the log storage area. The results of further assessment will determine whether the TMDL should be maintained, modified, or rescinded.

As mentioned, the TMDL may be revised to include modified wasteload allocations if future activity is proposed at the Thorne Bay LTF that will entail discharge of wood waste residues. The TMDL can be revised in conjunction with the process to issue a wastewater discharge permit. Possible revision of the TMDL will depend on analysis of relevant factors at that time.

9. Public Review and Comment

A Draft TMDL for Wood Residues at the Former Thorne Bay LTF Marine Area, along with a Fact Sheet, was available for public review and comment from December 18, 2006, through January 31, 2007. Notice of the public review was published in the Ketchikan Daily News and in the Island News (Prince of Wales Island). Notice was posted on the State of Alaska public notice website at http://www.dec.state.ak.us/public_notices.htm and on the ADEC website at http://www.dec.state.ak.us/water/wnpspc/forestry/thornebay.htm. Links to download the Draft TMDL, Fact Sheet, and public notice were available on the ADEC website.

The public notice stated that DEC would hold a public information meeting by teleconference to discuss the proposed TMDL on January 17, 2007. The teleconference was held; four individuals representing one environmental services firm participated in the teleconference.

No public comments were received.

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Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
BMP	Best Management Practice
CFR	Code of Federal Regulations
EPA	U.S. Environmental Protection Agency
KPC	Ketchikan Pulp Company
LA	Load Allocation
LC	Loading Capacity
LTF	Log Transfer Facility
MLLW	Mean Lower Low Water
MOS	Margin of Safety
mmbf	million board feet
NPDES	National Pollutant Discharge Elimination System
RAO	Remedial Action Objective
TMDL	Total Maximum Daily Load
WQS	Water Quality Standards
WLA	Wasteload Allocation
ZOD	Zone of Deposit

Glossary

Benthic. Refers to material, especially sediment, at the bottom of an aquatic ecosystem. It can be used to describe the organisms that live on or in the bottom of a waterbody.

Best management practice (BMP). A practice or combination of practices that is determined to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.

Clean Water Act. The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.

Decomposition. The breakdown or decay of organic materials; the decomposition process releases energy and creates simple organic and inorganic compounds.

Designated uses. Those beneficial uses specified in water quality standards for all waters, whether or not the uses are being attained.

Dissolved oxygen. Oxygen dissolved in water. The term also refers to a measure of the amount of oxygen available for biochemical activity in a waterbody.

Load Allocation (LA). The portion of a receiving water's Loading Capacity that is allocated to an existing or future nonpoint source discharge or natural source. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished. (40 CFR 130.2(g))

Loading Capacity (LC). The greatest amount of a pollutant that a waterbody can receive without violating applicable water quality standards. The LC is the pollutant quantity that is available to divide up to establish WLA, LA, and MOS. (40 CFR 130.2(f))

Margin of Safety (MOS). The portion of the Loading Capacity that is set aside to account for any uncertainty or lack of knowledge concerning the relationship between pollutant loads or allocations (WLAs and LAs) and water quality. A MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the LC) or a combination. (CWA §303(d)(1)(C))

National Pollutant Discharge Elimination System (NPDES). The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing wastewater discharge permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Nonpoint source pollution. Pollution that is not released through a discernible, confined, and discrete pipe or conveyance, but rather originates from broad or multiple sources over relatively large areas. Nonpoint sources can include such things as agriculture, forest practices, and urban runoff.

Point source pollution. Pollution that is released from a discernible, confined, and discrete conveyance, including a pipe, ditch, channel, tunnel, conduit, well, container, rolling stock, or vessel or other floating craft.

Residues. Floating solids, debris, sludge, deposits, foam, scum, or any other material or substance remaining in a waterbody as a result of direct or nearby human activity (18 AAC 70.990).

Seasonal Variation. Variation in pollutant loadings, waterbody responses, impairment conditions or other factors that is of a seasonal nature that can affect the development and expression of a TMDL.

Total Maximum Daily Load (TMDL). The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural sources, and a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard. (40 CFR 130.2(i))

Wasteload Allocation. The portion of a receiving water's Loading Capacity that is allocated to an existing or future point source discharge. WLAs constitute a type of water quality-based effluent limitation. (40 CFR 130.2(h))

Water quality criteria. Numeric or narrative criteria established in water quality standards that serve as pollution limits to protect designated uses of waters. Numeric criteria are scientifically-derived ambient concentrations or other measures developed by EPA or states for various pollutants of concern to protect designated uses such as human health and aquatic life. Narrative criteria are descriptive statements to establish allowable pollutant levels that similarly protect uses such as human health and aquatic life.

Water quality standards. Provisions of state or federal law or regulation required by the Clean Water Act, consisting of designated uses for waters of the United States, water quality criteria necessary to protect designated uses, and an antidegradation policy and implementation procedures.

Watershed. A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, lake, or ocean at a lower elevation.