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Detroit District

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Buffalo Reef Alternatives Report

Department of Environmental Quality

Great Lakes RESTORATION

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Executive Summary.

Buffalo Reef is a 2200 acre whitefish and lake trout spawning habitat that is used by tribal commercial and subsistence fishermen and recreational fishermen. Buffalo Reef and the surrounding habitat in the MI-4 management unit accounts for 33% of all lake trout and 8.5% whitefish spawning habitat in the United States waters of Lake Superior. In MI-4 Buffalo Reef alone accounts for roughly one third of lake trout and whitefish spawning and is therefore a critical component of Lake Superior's fish habitat. The reef is being inundated by an estimated 15 million cubic yards of stamp sands that are migrating towards the reef through littoral drift. If the migrating stamp sands aren't abated, the reef will die and no longer be a viable spawning habitat. While other stamp sand deposits in this area have been addressed by EPA, none of those deposits approach the dynamic complexity and magnitude of this deposit in Lake Superior.

In 2017 the USEPA endorsed the formation of a Buffalo Reef Task Force (BRTF) comprised of multiple state, federal, and tribal agencies. In addition, several academic institutions and private entities have joined the team, recognizing that this issue is larger than any single entity can accomplish on its own. The USEPA proposed that a steering committee be created. The steering committee consists of members from the U.S. Army Corps of Engineers, Keweenaw Bay Indian Community, and the State of Michigan. The charge to this committee is to synchronize and prioritize the different entities within the BRTF to minimize duplication and prioritize funding efforts.

The purpose of this report is to outline the proposed alternatives that have been identified by the BRTF with enough detail to inform the public of the different alternatives that are being considered and to identify what potential risks are involved with the implementation of those alternatives and to invite public comments on these alternatives.

After public comments are received the steering committee in consultation with the BRTF, will narrow down the alternatives to three or four that both meet the objective of saving the reef and are reasonably implementable given the identified risks. These alternatives will then be further developed by the BRTF to incorporate cost estimates and environmental benefits to allow the steering committee to narrow down the alternatives to the "preferred" alternative(s). The "preferred" alternative could be a single alternative or a combination of alternatives that meet the objectives.

The Task Force will develop and circulate a method for determining which alternatives will be selected for detailed evaluation. That methodology will look at these factors:

1. Effectiveness for protecting the reef and associated juvenile fish habitat
2. Risks associated with the implementing each alternative
3. Costs, immediate and long term

1. Project Information and Background.

The Keweenaw Peninsula, located in Michigan's Upper Peninsula, became one of the largest mining regions of North America at the turn of the 20th century due to deposits of native copper. Between 1850 and 1929, the Keweenaw district was the second largest producer of copper in the world (Murdoch 1943; Benedict 1952). During that interval, 140 mines worked the central deposits and over 40 mills processed stamp rock (Figure 1). In total, 4.8 million metric tons of copper were smelted from native copper deposits producing vast amounts of tailings as a by-product of giant steam-driven stamps (Benedict 1955). The stamps crushed the amygdaloid and conglomerate ores, and mills sluiced approximately one half billion tons of copper-rich mine tailings that were dumped along rivers, waterways, lakes, and the Lake Superior shores of the Keweenaw Peninsula region. Major copper tailing dumping sites were Torch Lake, Boston wetland, Freda-Redrige, and the town of Gay (Figure 2).

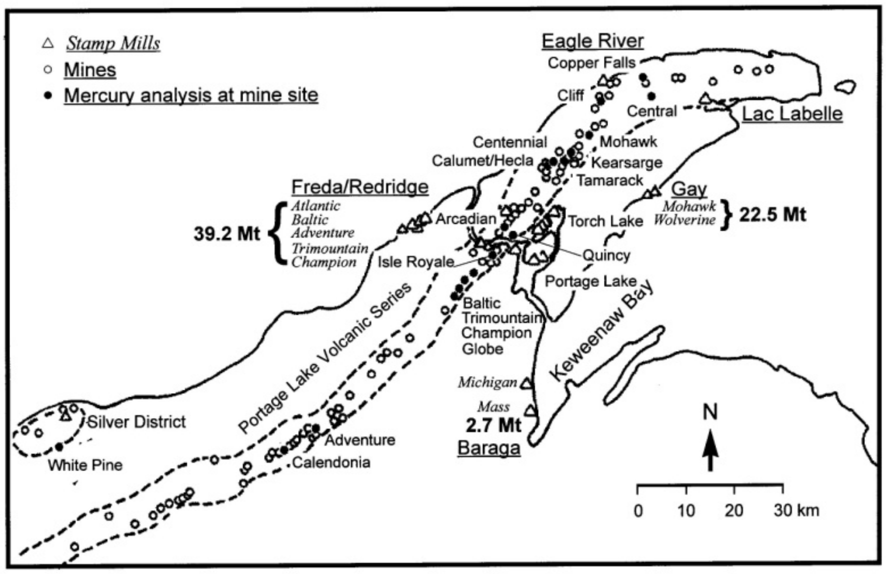

Figure 1 Native copper and silver mines along the Keweenaw Peninsula and the amounts of discharged tailings from coastline "stamp" mills.

These mines produced mainly copper from ores containing about 1% copper. The remaining crushed rock, is the mining wastes or tailings that are locally called stamp sands. These sands are generally 1-3 millimeters (mm) in diameter with 0.07-15% fines. The Michigan Department of Environmental Quality (MDEQ) hired Weston Solutions to prepare a toxicological evaluation of the stamp sands at Gay (Weston

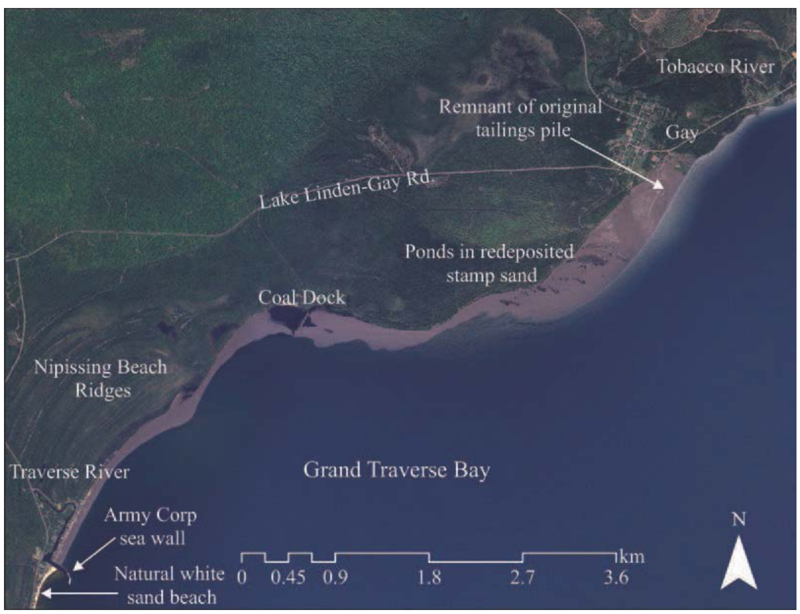

Figure 2 Stamp Sands deposit near Gay, MI.

Solutions, September 2006). They determined that human health risks were acceptable for the use of this material as road traction, as construction material and for a "sand box scenario." The only unacceptable human health risk was associated with residential drinking water. The report also identified that stamp sands in surface water sediments or in surface waters posed an unacceptable risk to aquatic organisms. MDEQ and Department of Health and Human Services (MDHHS) also evaluated the stamp sands at Gay (MI/DEQ/WRD-12/023, May, 2012).

That report only cited copper as being above the "probable effect concentration" for aquatic toxicity. Not surprisingly, bulk sediment toxicity testing showed all sediment samples in the vicinity of the Gay stamp sand deposit were acutely toxic to the aquatic organisms tested. The Michigan Department of Community Health (MDCH) ("Evaluation of Inhalation of airborne stamp sands….*September, 2014) concluded "*MDCH has determined that the estimated concentrations of metals in airborne stamp sands at the Gay tailings pile along Lake Superior are not expected to cause harm to heavy equipment operators or recreational vehicle users at the site".* MDCH has medium to high confidence in the values used for the evaluation.

The MDEQ, the Keweenaw Bay Indian Community (KBIC), the Houghton Keweenaw Conservation District and the United States Environmental Protection Agency (USEPA) have undertaken several number of projects to lessen or eliminate ecological or public health threats posed by stamp sands in the Keweenaw Peninsula over several decades. None have involved stabilizing/removing sediments from a high energy surf zone, as is required at Gay. This project involves the restoration/protection of fish spawning/rearing areas located near the town of Gay, just east of the Peninsula and protection of Grand Traverse Harbor, which is designated as a Harbor of Refuge (Figure 3).

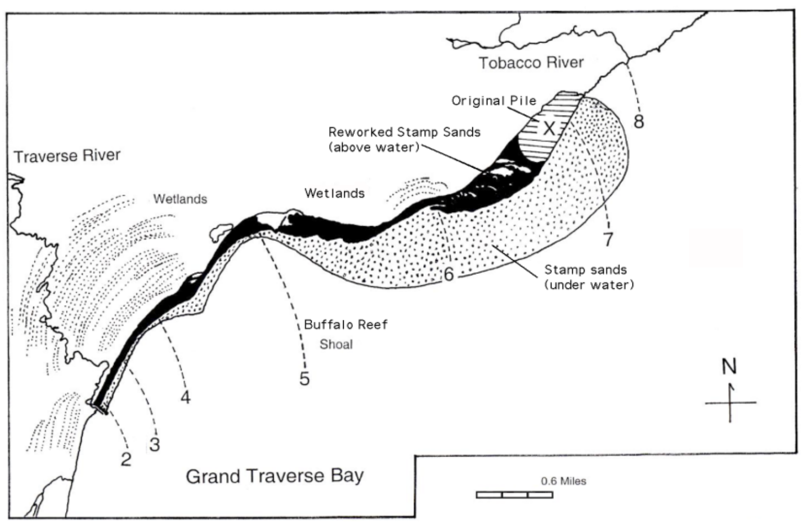

Figure 3 Above-water and underwater extent of the Stamp Sand tailings in Grand Traverse Bay, a small bay off Keweenaw Bay. A natural white sand beach occurs south of the Traverse River.

The proposed project area includes the stamp sands that were deposited off shore from the stamping mill located near the town of Gay, Michigan. Between 1890 and 1930, approximately 22.7 million metric tons (MMT) = 16 million (M) cubic yards (CY) of stamp sand material was deposited at the Gay site.

Approximately 5.3 miles of shoreline that begins at the Gay site and continues southerly to the break wall located at the Grand Traverse Bay Harbor, Schoolcraft Township, Section 4, T55N, R31W, Houghton County, Michigan has been affected by the stamp sands. Recent LiDAR/MSS studies from 2008 indicate that of the 22.7 MMT of stamp sands deposited at the Gay site, only an estimated 3.1 MMT remained on the shoreline pile, while 8.6 MMT were re-deposited on the beach stretching southwest of the pile, 1.0 MMT were removed by the Keweenaw County Road Commission for winter road treatment, and 11.5 MMT have moved into Grand Traverse Bay (Kerfoot et al. 2012). It is estimated that the original pile of stamp sand at the Gay site is eroding at a rate of about 26 feet per year.

The affected area includes: 320 acres of terrestrial stamp sands along the coast and 2,816 acres of aquatic habitat. The aquatic habitat includes: 1260 acres of near-shore coastal habitat that has already been impacted.

The migrating stamp sands which are black in color, have covered native white sand beaches and threaten important fish-spawning sites (Figure 4) and young of year nursery areas. These habitats have significant commercial and spiritual value to Native Americans and are also highly valued by sports fishermen. Fine material associated with the stamp sands are covering the lake bed out to water depths greater than 50 feet. The physical effect of smothering by stamp sands and the copper leaching from the stamp sands has impacted and continues to impact the aquatic environment.

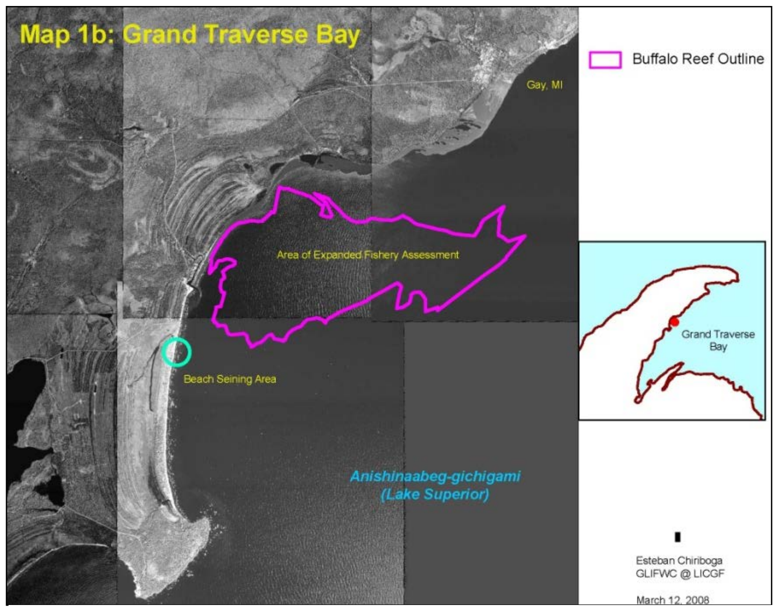

Figure 4 Buffalo Reef depicting Gay and Traverse Harbor.

2. Long Term Adaptive Management Plans.

In 2017 the USEPA endorsed the formation of a Buffalo Reef Task Force (BRTF) comprised of multiple state, federal, and tribal agencies, In addition several academic institutes and private entities joined the team recognizing that the issue is larger than any single entity can accomplish on its own. In addition, many potential alternatives for containing stamp sand erosion and protecting the reef habitat have been proposed. Some alternatives have been advanced by members of the BRTF but there have also been important contributions from the general public. The USEPA directed that a steering committee be set up to facilitate and lead the different BRTF teams. The purpose of this steering committee is to help narrow down the different adaptive management alternatives to make qualitative and quantitative recommendations to the USEPA on the best course of action moving forward.

The BRTF came together in January 2018 to conduct a risk assessment of all of the proposed alternatives and began the process of narrowing down the large pool of alternatives to those that the team felt should be considered for further evaluation. This report presents the evaluation of 13 alternatives.

Once the field of alternatives is narrowed down to three to four potential alternatives a habitat unit discriminator will be developed and applied to the remaining alternatives to further evaluate the cost to habitat benefit ratio. The following is a list of the adaptive management alternatives that are being evaluated in this report.

1. No Action Alternative.
2. Deep Water Disposal >300ft or as far offshore as can be practicably pumped during hydraulic dredging.
3. Maintenance Dredging at Harbor and Trough with a Stone Revetment.
4. Maintenance Dredging at Harbor and Trough without Revetment.
5. Dredge Everything with on Land Disposal in Nearby Wetlands.
6. Dredge Everything with Disposal in a Newly Constructed Landfill Nearby.
7. Dredge 15M CY with Disposal in the White Pine Mine Tailings Basin.
8. Dredge Everything with Disposal in a Quarry Close to the Great Lakes.
9. Dredge Everything with Disposal in an Existing Landfill.
10. Dredge Everything with Disposal in the Keweenaw Mine Shafts.
11. Beneficial Reuse in or Out of State.
12. Stocking the Fishery.
13. Build a New Reef.

All of the action alternatives will start with the baseline assumption that at least 15 million (15M) CY of stamp sands will need to be moved or contained to protect and restore the function of the Buffalo Reef area and the adjacent juvenile recruitment area south of Grand Traverse Harbor.

As more data is collected and more hydraulic modeling is conducted, the baseline equilibrium amount of 15M CY is expected to change over time. However, it is also presumed that any change in this number would not likely impact the relative ranking number or the alternatives presented in this report.

2.1 Institutional Significance

This project is recognized institutionally through a variety of laws and executive orders (EOs), including:

2.1.1 Clean Water Act

The Clean Water Act provides for the restoration of the chemical and biological integrity of the nation's waters. Protection of Buffalo Reef will maintain a resource critical for the integrity of Lake Superior and improve habitat diversity.

2.1.2 Fish and Wildlife Conservation Act of 1980

The Fish and Wildlife Conservation Act provides that all Federal departments and agencies to the extent practicable and consistent with their respective authorities, should conserve and promote conservation of non-game fish and wildlife, and their habitats.

2.1.3 Executive Order-13340

Executive Order 13340 designates the resource issues of the Great Lakes as nationally significant and defined a federal policy to support local and regional efforts to restore and protect the Great Lakes ecosystem through the establishment of a regional collaboration. The Great Lakes Regional Collaboration (GLRC) was convened with the objective of Federal agencies working in partnership with state, tribal and local governments to meet the intent of this Executive Order. The U.S. Army Corps of Engineers (USACE) Great Lakes and Ohio River Division (LRD) and its three Great Lakes Districts, Buffalo (LRB), Detroit (LRE), and Chicago (LRC), have been participants in these activities.

2.1.4 Executive Order -11514 Protection and Enhancement of Environmental Quality

Executive Order 11514 states that the Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life.

2.2 No Action Alternative

If No Action is taken to prevent further migration of stamp sands, the beach and littoral zone located south of the harbor will become covered with stamp sands and the quality and importance of this habitat will diminish to levels similar to the area impacted by stamp sands north of the harbor. In addition, the deposition of stamp sands affects coastal wetlands by increasing wave action during storms. Stamp sand deposition has changed the bathymetry of the nearshore which has had the effect of reducing natural wave attenuation. Coastal wetlands are receiving greater amounts of water and sediment from the lake during storms, which will reduce their functions and values.

Continued migration of the stamp sands onto Buffalo Reef will greatly affect the quality of the reef and its importance as this critical habitat is compromised and made unsuitable for spawning by lake trout and white fish.

2.2.1 Loss of Buffalo Reef.

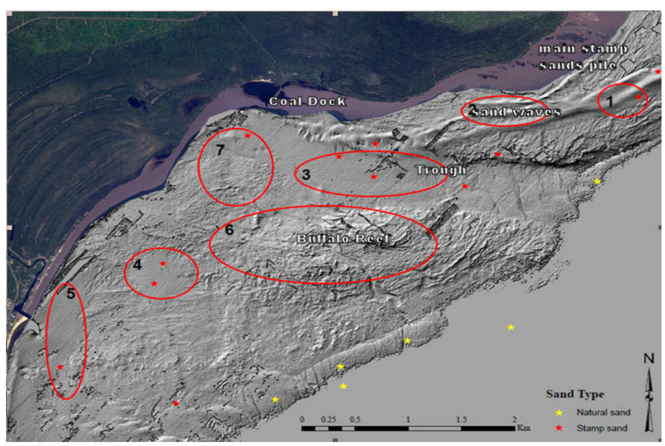

Figure 5 Buffalo Reef labeled 6 and trough north of reef labeled 3

<u>Habitat Description:</u> Buffalo Reef is a 2200 acre cobble reef located approximately three miles southwest of the original stamp sand pile at Gay, Michigan. A deep crevice (fault scarp) bisects the reef, and a relict riverbed "trough" runs along its northern margin (Figure 5, Kerfoot et al. in press). Cobble and bedrock with interstitial spaces cover the reef flanks, making it ideal for spawning activities. The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) conducted fisheries assessments on the reef between 1986-2002, documenting that it is an important spawning reef for whitefish and lake trout (Chiriboga and Mattes 2008). The importance of Buffalo Reef is recognized in

the "Atlas of the Spawning and Nursery Areas of the Great Lakes, Volume 2" (Goodyear et al. 1982).

Buffalo Reef is bounded by a deep water trough on the north that has been filled with stamp sands to approximately half capacity. The outer portion of the trough has insufficient capacity to contain the remainder of the migrating stamp sands.

<u>Impacts on Fish Habitat:</u> Ojibwe commercial fishermen, possessing generations of Traditional Ecological Knowledge of the Lake Superior fishery and the habitats utilized by lake trout and whitefish, first reported witnessing stamp sands moving towards Buffalo Reef to GLIFWC staff and expressed concern that the spawning habitat maybe jeopardized in the future.

In response to these concerns, GLIFWC obtained funding from USEPA's Great Lakes National Program Office to begin research in 2005 to: 1) map the extent of the stamp sands in relation to the reef to provide a baseline of the spatial relationship between stamps sands and spawning areas on the reef; 2) confirm the importance of Buffalo Reef as a spawning area; and 3) provide a preliminary assessment of the vulnerability of the reef to contamination by the stamp sands.

In 2008, GLIFWC reported, "*results of GLIFWC's fishery assessments confirmed that Buffalo Reef is an important spawning area for lake trout and whitefish and that the area adjacent to the reef may be an important nursery area. Data collected by the National Water Research Institute (NWRI) of Environment Canada provided a detailed classification of Buffalo Reef and the surrounding area*". The report also acknowledged, "*Migration of stamp sands may pose significant environmental hazards. Leaching of trace metals from stamp sands has been well documented" (Jeong et al. 1999, Cusack 1999).* Both of these statements on the importance of fishery habitat and the hazards of stamp sand migration have been confirmed by independent work by tribal, state, and federal agencies as well as by academic work at Michigan Technological University. Research has shown that many areas of stamp sands are unable to support vegetation. In addition, lakes into which stamp sands have been dumped have been found to be nearly devoid of benthic animals and concentrations of mercury and copper in sediments are high compared to uncontaminated areas of the lake (Kerfoot et al. 1999). Concentrations of metals in water have been found above toxicity thresholds for many animal and plant species and mining wastes have been identified in the Lake Superior Lakewide Management Plan 2000 (LaMP) as a principal stress to aquatic habitat in Lake Superior (LaMP 2000, p.8-10). In addition, the habitat objective for Lake Superior established in the Fish Community Objectives calls for *"no net loss of the productive capacity of habitat supporting Lake Superior fishes" (Horns et al. 2003). "Of equal concern are the effects that the addition of large amounts of fine material may have on the habitat of the region. Fish species often depend on interstitial spaces and small openings in the rock to provide shelter for eggs and young fish. The filling of these spaces by an influx of stamp sands could drastically reduce suitable habitat"* (Chiriboga and Mattes, 2008).

Since 2005, research has documented the nearshore portion of Buffalo Reef has been impacted by the stamp sands migrating along the shoreline, which poses a threat to the fishery from direct smothering through the infilling of the interstitial spaces in the rocks of the reef and the toxic nature of the stamp sands to the aquatic community (Figure 6) (Kerfoot el al. 1999, Kerfoot et al 2012). Though other rock reefs are located offshore, efforts to establish spawning stocks on those reefs have not been successful.

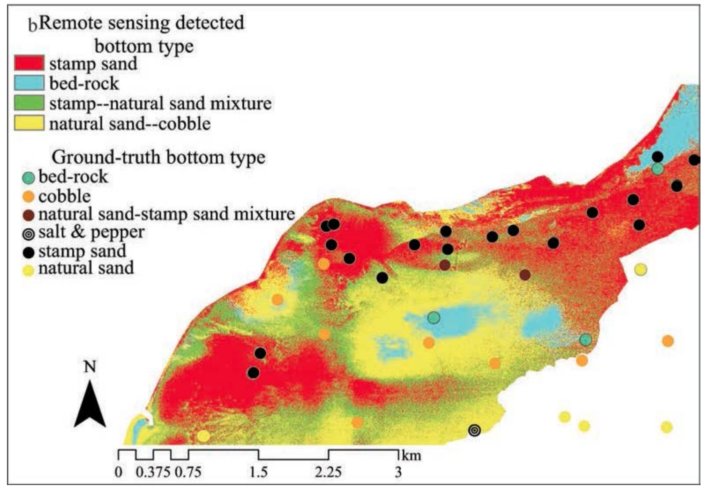

Figure 6 Bottom types surrounding Buffalo Reef. Note stamp sands north, west and south of the reef.

Stamp sand movement is of concern to the Keweenaw Bay tribal council, as tribal members maintain a subsistence and commercial fishery for whitefish and lake trout in Keweenaw Bay. In addition, GLIFWC's 1842 treaty signatory tribes also are concerned that the loss of spawning habitat will reduce lake trout and whitefish stocks that currently sustain a tribal commercial fishery in these waters.

Concern for Lake Superior's fishery and the habitat that sustains fish stocks is also shared by members of the Council of Lake Committees (CLC)[1]. The CLC was established under the Great Lakes Fishery Commission's framework and is comprised of senior-level managers from state, tribal, and provincial fishery management agencies on the Great Lakes[2]. The CLC has gone on record identifying both the scientific importance of Buffalo Reef's fishery habitat and impacts of stamp sands upon the Lake Superior fishery resource.

In 2009, the Great Lakes Fishery and Ecosystem Restoration Project Review Committee recommended, and the CLC approved, the Keweenaw Bay Stamp Sands Project as a high priority. This project is critical to protect and restore fisheries habitat in Lake Superior, which is threatened by copper mine waste. Two copper stamp mills, operating between 1898 and 1932, dumped more than 25 million tons of waste (i.e., stamp sands) into the Lake Superior Basin. These stamp sands contain high amounts of copper and arsenic and cover 1,426 acres of shoreline and lakebed to date. The stamp sands have been migrating along the southeast shoreline of the Keweenaw Peninsula from near Gay, Michigan to Grand Traverse Bay Harbor in Lake Superior and

[1] The Council of Lakes Committee was established under the Great Lakes Fishery Commission's framework with the purposes of: 1) considering issues pertinent to, or referred by, the Great Lakes Fishery Commission; 2) considering issues and problems of common concern to member agencies; 3) developing and coordinating joint programs and research projects; 4) serving as a forum for state, provincial, tribal, and federal agencies; and 5) responding to requests made to it by any of the Lake Committees.

[2] 1854 Treaty Authority, Chippewa-Ottawa Resource Authority, Great Lakes Indian Fish and Wildlife Commission, Illinois DNR, Indiana DNR, Michigan DNR, Minnesota DNR, New York DEC, Ohio DNR, Ontario MNR, Pennsylvania F&BC and Wisconsin DNR.

are threatening to cover nearby Buffalo Reef. Buffalo Reef is one of the most productive lake trout and whitefish spawning areas in Keweenaw Bay. As a part of a lakewide plan to restore Lake Trout in Lake Superior, more than 1.6 million lake trout were stocked on Buffalo Reef to re-establish this population. Successful rehabilitation has occurred, but continued degradation of the reef could undo the success that was only accomplished by more than 30 years of stocking.

<u>Loss of Genetic Diversity:</u> Buffalo Reef is one of three major spawning reefs in management unit MI-4 (Figure 7). Lake Trout spawning abundance averages about 10,000 with a range of 7,000 to 36,000 annually. Lake trout are reef specific spawning fish and return to the same reef to spawn year after year.

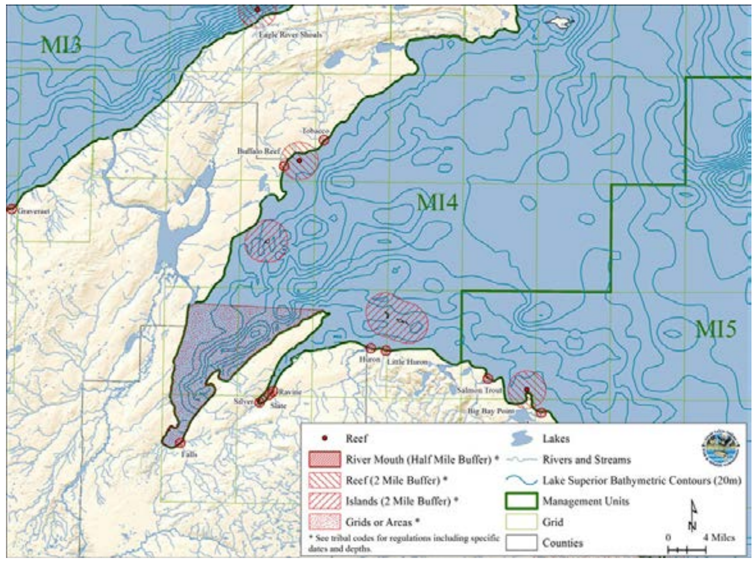

Figure 7 Michigan Management Unit 4

There is occasional straying of lake trout to other reefs mainly by young male fish. This behavioral trait of lake trout provides a means to genetically diversify lake trout stocks and increase the long-term viability of their spawning populations. The loss of Buffalo Reef would be a loss of genetic diversity for the Lake Superior fisheries and would impact both the fisheries of Keweenaw Bay and the whole of Lake Superior as documented by the location and number of lake trout tagged during spawning at Buffalo reef and then subsequently recaptured in sport and commercial fisheries (Figure 8).

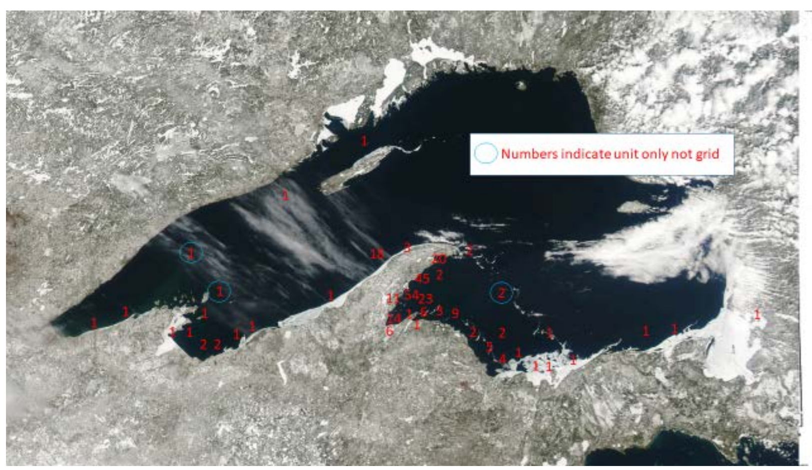

Figure 8 Location and number of lake trout tagged during spawning at Buffalo reef and then subsequently recaptured in sport and commercial fisheries.

The Bay Mills Indian Community, located in the eastern portion of Lake Superior, has court affirmed treaty fishing rights in the 1836 ceded waters. The loss of genetic diversity due to the destruction of Buffalo Reef could have impacts on the long term viability of lake trout stocks in 1836 ceded waters (Figure 9).

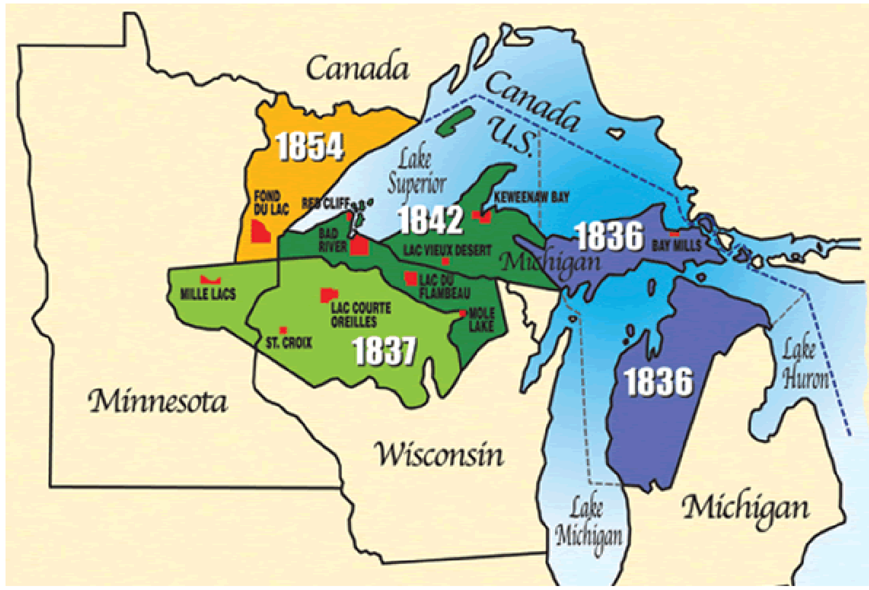

Figure 9 Location of GLIFWC member tribes and ceded territories.

2.2.2 Loss of Grand Traverse Harbor.

Grand Traverse Harbor, Michigan is a recreational harbor maintained by the USACE that is located immediately southwest of Buffalo Reef. The harbor also serves as a Harbor of Refuge for tribal fishing boats exercising treaty guaranteed fishing rights, resource agencies conducting fish assessments, and recreational boaters. The state began its Great Lakes Harbors Program in 1947 when the legislature created the Michigan State Waterways Commission. The Commission was granted authority and supporting funds to create a marine highway along 3,000 miles of Great Lakes shoreline. From 1947 to 1964, the Waterways Commission developed 83 Harbors of Refuge, enabling tens of thousands boaters to encircle Michigan using safe harbors and overnight hospitality. The program's goal is to locate Great Lakes harbors so no boater will ever be more than 15 shoreline miles from safety. Boaters have paid for much of this harbor network through taxes on marine fuel and boat registration fees. This harbor and several others also provide lake access for Native Americans to exercise their tribal fishing rights to meet treaty obligations.

At the Grand Traverse Harbor, the outer harbor breakwater is acting as a groin and preventing the southerly movement of the stamp sands (Figure 10). The USACE played an important role in the initial development and actual construction of the majority of Michigan's harbor network. The federal/state/local program of cooperation is aimed primarily at the development of the facilities. Responsibility for continued operation and maintenance lies with local communities and so reasonable fees are charged for upkeep and operation of the docks and other amenities located at the harbor.

Figure 10 Stamp sands erode from the enormous tailings pile at Gay (above), spreading along natural white-sand beaches (Jacobsville Sandstone) and across major rivers Traverse River, below.

2.2.3 Loss Whitefish Nursery Habitat

The stamp sands are washing over the Grand Traverse Harbor breakwater and in a few years, the stamp sands will migrate past the harbor structure and impact the white sands beach south of the Harbor that provide a nursery area for young of the year (YOY) whitefish. Traverse Point, Michigan is located approximately three miles south of Traverse Harbor.

By the year 2250 the migration of the sand will continue south of the harbor to Grand Traverse Point into the near shore areas about 36 feet in depth where energy is no longer sufficient enough to move coarse stamp sands (Figure 11). The fine-grained components of stamp sands will continue move across the lake. If the no action alternative is taken, the stamp sands are estimated to cover about 4800 acres (2000 acres of Buffalo Reef would be lost) as the material is moved by littoral drift and is uncontrolled.

Figure 11 Estimated disposition of the stamp sands circa 2250

Whitefish are taken by both tribal and state licensed commercial fishermen, but the recreational catch of whitefish is insignificant. Lake trout from Lake Superior are restricted to tribal catch and recreational catch. The tribal fishing data (mark and recapture) indicates that 80% of the lake trout remain within 50 miles of the location where spawned. Tribal catch data indicates 33% of the annual lake trout yield in Michigan waters of Lake Superior comes from within 50 miles of Buffalo Reef.

2.2.4 Meeting Treaty Obligations

Treaties with the Chippewa: According to the teachings of the Anishinaabe people, also known as the Chippewa or Ojibwe, it was the sacred Megis Shell that first guided the people to the rich regions of the Great Lakes. The Megis Shell was last seen near Madeline Island, which was one of the settling points for the tribal people migrating from the eastern shores of the continent. Lake Superior, or Gitchi (big) Gummi (water), provided bountiful sources of food including lake trout, whitefish and sturgeon

Tribal fishermen harvested fish using large birch bark canoes and gill nets constructed from twisted and knotted strands of willow bark. They also speared through the ice and fished with hand carved decoys. Several bands established villages on the shores of the lake in Michigan, Wisconsin, Minnesota, and Canada. As Europeans pushed into the Great Lakes region, the Anishinaabe people used fish to trade with French and English outposts. Fish soon became one of the mainstays in the diets of the early fur traders.

"*The eleven member tribes of the Great Lakes Indian Fish & Wildlife Commission (GLIFWC or Commission)*[3] *each entered into one or more treaties with the United States in the 1800s. In treaties signed in 1836*[4]*,1837*[5]*, 1842*[6]*, and 1854*[7]*, the tribes reserved hunting, fishing and gathering rights in the areas (land and water) ceded to the United States. It must be emphasized that these ceded territory rights were not given or granted by the United States, but were reserved by the tribes for themselves. The exercise of these rights was and continues to be fundamental to the tribes' culture and way of life, and explains their insistence on explicitly reserving them in the treaties.* ***The tribes share a traditional and continuing reliance upon fish, wildlife and plants to meet religious, ceremonial, medicinal, subsistence and economic needs****. Therefore, to maintain this lifeway and meet these needs, the tribes reserved the rights to hunt, fish and gather in the ceded territories*.[8] (*Fulfilling Ojibwe Treaty Promises – An Overview and Compendium of Relevant Cases, Statutes and Agreements*, Ann McCammon-Soltis and Kekek Jason Stark, Great Lakes Indian Fish & Wildlife Commission, 2009)(emphasis added). *The right to harvest fish in the Keweenaw*

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[3] GLIFWC member tribes are: in Wisconsin -- the Bad River Band of the Lake Superior Tribe of Chippewa Indians, Lac Courte Oreilles Band of Lake Superior Chippewa Indians, Lac du Flambeau Band of Lake Superior Chippewa Indians, Red Cliff Band of Lake Superior Chippewa Indians, St. Croix Chippewa Indians of Wisconsin, and Sokaogon Chippewa Community of the Mole Lake Band; in Minnesota -- Fond du Lac Band of Lake Superior Chippewa, and Mille Lacs Band of Ojibwe Indians; and in Michigan -- Bay Mills Indian Community, Keweenaw Bay Indian Community, and Lac Vieux Desert Band of Lake Superior Chippewa Indians.

[4]Treaty of 1836, 7 Stat. 491. —Article Thirteenth. The Indians stipulate for the right of hunting on the lands ceded, with the other usual privileges of occupancy, until the land is required for settlement.

[5]Treaty of 1837, 7 Stat. 536. —Article 5. The privilege of hunting, fishing, and gathering the wild rice, upon the lands, the rivers and the lakes included in the territory ceded, is guaranteed to the Indians, during the pleasure of the President of the United States.

[6]Treaty of 1842, 7 Stat. 591. —Article II. The Indians stipulate for the right of hunting on the ceded territory, with the other usual privileges of occupancy, until required to remove by the President of the United States.‖

[7]Treaty of 1854, 10 Stat. 1109. —Article 11. . .And such of them as reside in the territory hereby ceded, shall have the right to hunt and fish therein, until otherwise ordered by the President.

[8]In affirming the treaty rights of GLIFWC's member tribes, the courts took a —snapshot‖ of Ojibwe life at treaty times in order to determine the nature and extent of the rights that were reserved. In reaching their decisions, the courts made extensive findings on the Ojibwe's extensive knowledge and use of natural resources where each species played a role in supporting some part of the Ojibwe's lifeway and constituted the essence of Ojibwe culture. *See, e.g., Lac Courte Oreilles Band v. Wisconsin* (LCO III), 653 F. Supp. 1420, 1422-1429 (W.D. Wis. 1987); Mille *Lacs Band v. State of Minnesota*, 861 F. Supp. 784, 791-793 (D. Minn. 1994).

Bay waters of Lake Superior, without regard to Michigan fishing regulations, *was re-affirmed through the 1971 Jondreau decision.*[9]

Under the Constitution of the United States, these treaties are the supreme law of the land and the tribes maintain that each and every federal agency has a trust responsibility to these tribes and their treaty rights. Tribes hold the position that the USACE and other federal agencies' trust responsibility extends to the protection of the habitats that maintain the Lake Superior Treaty fishery.

- ***Religious and ceremonial needs:*** In proper perspective, the reservation of sovereign rights is part of the Anishinaabeg's on-going struggle to preserve a culture – a way of life and a set of deeply held values – that is best understood in terms of the tribes' relationship to *Aki* (earth) and the circle of the seasons. The Anishinaabeg are closely tied to the natural environment by a system of beliefs and practices that organize everyday life. This environmental human relationship involves a notion of geographic place that embodies the Anishinaabeg's human origin and historical identity, as well as the way the Anishinaabeg conceive their cultural reality in the modern world.[10]

  When hunting, fishing, or gathering, Anishinaabe see their role as part of both the natural and spiritual order. Anishinaabe spiritual beliefs mandate the use of certain plants, animals, and fish in ceremonies attendant to hunting, fishing, and gathering activities. These ceremonies ensure the perpetuation of the resources and the physical, mental, and spiritual well-being of the person.

  Three aspects of an Anishinaabe view of nature inextricably link the perpetuation of humans to the perpetuation of the natural world. This belief system holds that the line between human and non-human beings is ambiguous:

  • For the Anishinaabe, the difference between humans and non-humans, when determining who constitutes a spiritual being is less clearly defined. A spiritual being may manifest as a human, animal, plant, or rock but may also reside in or be associated with certain places, such as a mountain or body of water. As such, when an Anishinaabe is interacting with a part of their environment that may be deemed inanimate by some, there may still be spirits that need to be recognized and honored. All spiritual beings, whether human or non-human, have rights and warrant respect.

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[9] 1971 People of the State of Michigan v. William Jondreau (Jondreau decision), Reversed People v. Chosa (1930), 252 Michigan 154, 233 N.W. 205.

[10] In addition to the court decisions themselves, other sources documenting the essential role that natural resources play in Anishinaabeg culture include: Fish in The Lakes, Wild Rice, and Game in Abundance (James M. McClurken et al. eds., (2000); and, Wisconsin Academy of Sciences, Arts, and Letters, Chippewa Treaty Rights: The Reserved Rights of Wisconsin's Chippewa Indians in Historical Perspective (Ronald N. Satz 1991).

- Humans are not the masters of the world but rather weak and pitiable creatures, dependent upon all other non-human beings for survival. The proper attitude towards the natural world is one of caretaking, humility, and gratitude.

- The relationship of humans to the rest of nature is one of reciprocity. Animals, for example, will offer themselves to a hunter as an act of pity for his or her weakness. If the hunter does not accept this gift with feelings of respect and gratitude, the natural world will withdraw cooperation.

- Anishinaabe perpetuate this worldview and their attendant responsibilities to the natural world through stories, ceremonies, and language. These teachings instruct Anishinaabeg about how to care for, manage, and make decisions that affect the land and waters.

Given this worldview, the alteration or destruction of plant and animal communities without proper respect given to the non-human beings involved invites disaster, not only for the environments affected, but also for humans. Harm to the rights of non-human beings is equivalent to environmental harm. In a reciprocal world, such a violation is understood to have dire consequences for humans who disregard this relationship. In addition, human beings have a responsibility to be a voice for non-human beings who cannot speak for themselves.

Tribal members continue to harvest and rely on Lake Superior fish for religious purposes, including naming ceremonies, funerals, Midewiwin ceremonies and various seasonal feasts, as critical components in perpetuating Anishinaabe life ways.

- ***Medicinal needs:*** GLIFWC's tribal leadership have noted that elders in their communities have reaffirmed the position that traditional foods, including fish, are medicine for Anishinaabe. Scientific studies have documented Lake Superior fish contain high levels of omega 3 oils.[11] Today, Ojibwe tribes experience high rates of diabetes and heart disease along with the high costs associated with medical treatment. The Centers for Disease Control and Prevention (CDC) report: 1) Native Americans are **twice** as likely as whites to have diabetes; 2) in about **2 out of 3** Native Americans with kidney failure, diabetes is the cause; and 3) medical costs for kidney failure from diabetes were about $82,000 per person in 2013.[12] On a positive note, the CDC reported, "Kidney failure from diabetes dropped by 54% in Native Americans between 1996 and 2013" and recommended the development of an integrated strategy using *"**population***

[11] "*The primary benefit of fish oil is the reduction of blood platelet activity, not blood cholesterol. Platelets are clot-forming cells which prevent excessive bleeding. Overly active Blood platelets, however, may help to accelerate the buildup of plaque, which is a deposit of fatty-fibrous material in a blood vessel wall. The blood clots formed by blood platelets may become stuck in a plaque-narrowed artery and trigger a heart attack. Thus, N-3 fish oils can prevent heart attacks by reducing both blood clotting activity of platelets and the formation of plaque. N-3 oils also have an effect on blood lipids...* Furthermore, the N-3 content of chub, herring, whitefish, lean lake trout or siscowet lake trout exceeds the N-3 content of chinook salmon, which is one of the best saltwater sources of N-3 fatty acids." ***Omega-3 Fatty Acid Content of Lake Superior Fish*** Paul B. Addis, Ph.D.

[12] https://www.cdc.gov/vitalsigns/aian-diabetes/index.html

health approaches to diabetes care which p*romote wellness of the entire community and connect people to local resources, including* ***healthy food****, transportation, housing, and mental health care."*[13]

- ***Subsistence***: The KBIC is dependent upon the Lake Superior fishery for subsistence*. "KBIC is known as a subsistence fishing Tribe (Gagnon 2011; GLIFWC 2013). Many respondents (59%) purchase fish from local Tribal fishermen and 52% agree that someone in their family benefits from commercial fishing. Many respondents report eating local fish at least once per month (66%), 31% report eating it once per week, and 18% report eating local fish three or more times per week."*[14]

- ***Commercial:*** In assessing the importance of natural resources to Reservation economies, it is important not to limit the benefit metrics to only full time jobs and income measures. In regard to tribal small boat commercial fisheries, sales of fish are often used to supplement subsistence harvests (i.e. selling a portion of the fish harvest to cover costs for gasoline and nets enable tribal members to participate in subsistence activities and provide food for their extended families). This is particularly important for tribal members working in lower paid jobs. The U.S. Census reported the KBIC had an 8.1% unemployment rate with 31.9% of the Households having income of $24,999 or less.[15]

Treaty with Canada*:* On October 11, 1955, the United States and Canada established a treaty to form the Great Lakes Fishery Commission with the purposes of: 1) developing coordinated programs of research in the Great Lakes, and, on the basis of the findings, recommend measures which will permit the maximum sustained productivity of stocks of fish of common concern; and 2) formulating and implementing a program to eradicate or minimize sea lamprey populations in the Great Lakes.[16]

This treaty resulted from the introduction of the parasitic sea lamprey in the early 1950s, which entered the lake via the Welland Canal, coupled with intensive commercial fishing

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[13] https://www.cdc.gov/vitalsigns/aian-diabetes/index.html

[14] Keweenaw Bay Indian Community Wildlife and Natural Resources' Survey Report 2013. Page21.

[15] L'Anse Reservation and Off-Reservation Trust Land, MI, 2012-2016 American Community Survey 5-Year Estimates.

Income and Benefits (In 2016 inflation-adjusted dollars)	Estimate	ACS Margin of Error
Total households	1,304	(+/-205)
Less than $10,000	136	(+/-58)
$10,000 to $14,999	84	(+/-32)
$15,000 to $24,999	196	(+/-54)

[16] The 1954 Convention on Great Lakes Fisheries—**a treaty between Canada and the United States**—created the Great Lakes Fishery Commission to control sea lampreys, advance science, and help agencies work together. http://www.glfc.org/history.php

resulting in a drastic reduction in fish stocks. Lake Superior's commercial lake trout harvest was reduced from 3.1 million pounds in 1951 to only 380,000 pounds in 1960. Whitefish harvest dropped 17 percent a year from 1955 to 1960.[17]

Tribes are active partners in the Great Lakes Fishery Commission and participate in the organization's structure through both the Council of Lake Committees (CLC) and Lake Superior Technical Committee.

The Council of Lakes Committees has formally gone on record supporting a solution to the mining stamp sand migration.

> *"The CLC applauds the commitment of the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers to develop and fund a short-term solution to the stamp sands migration issue and strongly encourages the EPA to advance funding to develop and implement a long-term solution. The loss of Buffalo Reef could undo more than 50 years of Lake Trout rehabilitation in this area and substantially reduce or eliminate reproduction of Lake Trout and Lake Whitefish in Keweenaw Bay. If the stamp sands continue to pollute Buffalo Reef and the surrounding area, the Lake Superior Committee's ability to achieve its Fish Community Objectives will be compromised, and tribal, commercial, and recreational fisheries in the region will be eliminated or reduced."*[18]

Great Lakes Water Quality Agreement (GLWQA): The U.S. and Canada first signed the Agreement in 1972. It was amended in 1983 and 1987. In 2012, it was updated to enhance water quality programs that ensure the "chemical, physical, and biological integrity" of the Great Lakes.[19]

Through the Habitat and Species Annex[20] of the 2012 Great Lakes Water Quality Agreement, Canada and the United States have committed to:

> *"… contribute to the achievement of the General and Specific Objectives of this Agreement by conserving, protecting, maintaining, restoring and enhancing the resilience of native species and their habitat, as well as by supporting essential ecosystem services."*

To accomplish goals established under the GLWQA, a binational action plan is developed for restoring and protecting the ecosystem of each respective lake. The Lake Superior Lakewide Action and Management Plan (LAMP) was developed by the Lake Superior Partnership. This partnership is led by the USEPA and Environment and Climate Change Canada, and is implemented binationally in cooperation with all Lake Superior stakeholders. The Lake Superior LAMP has established "Projects to Protect

[17] Lake Superior Indian Fishery, GLIFWC

[18] October 30, 2017 letter to Ms. Tinka Hyde, U.S. EPA- Great Lakes National Program Office from Brian Locke, Chair Council of Lake Committees of the Great Lakes Fishery Commission.

[19] https://www.epa.gov/glwqa/what-glwqa

[20] Annex 7- Habitat and Species

and Restore High-Quality Habitats" including to "investigate, evaluate, and if feasible, implement dredging solutions or other habitat restoration efforts at Buffalo Reef, Michigan."

In summary, the No Action Alternative results in the loss of the 2,200 acre Buffalo Reef, including a loss of benefits to the state and tribal commercial fishery, subsistence fishery and recreational fishery and the diminished use of Grand Traverse Harbor. "*The loss of Buffalo Reef could undo more than 50 years of Lake Trout rehabilitation in this area and substantially reduce or eliminate reproduction of Lake Trout and Lake Whitefish in Keweenaw Bay."*[21] Movement of the stamp sands south of Grand Traverse Harbor results in the loss of the white sands beach south of the harbor and the 117 acre larval whitefish rearing area adjacent to that beach. Additionally, the No Action Alternative will result in the loss of the 120 acre Grand Traverse Point Reef located south east of the juvenile recruitment area. The No Action Alternative allows the continuation of increased impacts to coastal wetlands in areas where stamp sands have changed the morphology of the nearshore. The No Action Alternative maintains the status quo and is not consistent with meeting the intent of the treaties signed with the various tribes in the region between 1836 and 1854. The tribes reserved hunting, fishing and gathering rights in the areas (land and water) ceded to the United States.

2.3 Action Alternatives

All the action alternatives involve the removal or storage of approximately 15M CY of stamps sands either by mechanical or hydraulic means. For most action alternatives, the mechanically or hydraulically dredged material will be placed on the uplands to dewater prior to being loaded into freighters or onto conveyor belts for movement to the placement site. The rate of movement of the dredged stamp sands will determine the size of the stockpiled material required for shipment or placement. The cost of dredging the required amount of stamp sands to meet project goals will be held constant throughout this report. The costs to transport the stamp sands to the final placement site varies with the type of transportation required and the amount of infrastructure improvement necessary to accommodate the different transportation methods, i.e. building a pier for loading a freighter or barge, real estate acquisitions/easements for conveyor systems, roads and other necessary infrastructure.

With removal of the stamp sands, some of the riparian waterfront home owners believe that the loss of the existing wide stamp sands beachfront would increase flooding and reduce ice shove protection that has existed for several decades. This issue will be further evaluated in the hydraulic model to determine the impact. If the original beach/off shore slope configuration can be restored, stamp sands removal would provide the same level of protection as that existed prior to inundation by stamp sands. This

[21] October 30, 2017 letter to Ms. Tinka Hyde, U.S. EPA- Great Lakes National Program Office from Brian Locke, Chair Council of Lake Committees of the Great Lakes Fishery Commission.

restoration may reduce impacts from storm surge that has become more pronounced in areas of stamp sand deposition. Better understanding of this issue is critical going forward. State and Federal permits are required for dredging and construction of any necessary infrastructure to implement any action alternative selected. At least some form of real estate easements or fee simple ownership of lands may be necessary. Depending on the date of project completion, the remaining un-impacted surface acreage of Buffalo Reef remains intact for fish spawning and at least some of the recreational and tribal spiritual, cultural, subsistence and commercial benefits remain.

2.3.1 Deep Water Disposal >30 meters deep or as far as can practically be pumped.

This alternative is being considered because the ultimate fate of this material if no action is taken is for this material to continue its migration down drift of the source pile and end up in deeper waters off the Grand Traverse Point. This alternative considers moving the material in a controlled manner to deep waters bypassing the high value reefs and avoiding impacts to the near shore juvenile recruitment areas.

This alternative consists of open water disposal of 15M CY of stamp sands into water greater than 30 meters in depth. At this depth, the environmental impact of placing this material is minimized. The stamp sands can be hydraulically moved and strategically placed in deep water where the overall footprint that is impacted by this material is reduced as opposed to the natural migration of the material, where the littoral drift would dictate the size and location of the impacted area.

An analysis of the topography in this area revealed that the closest deep water disposal sites are approximately three kilometers (1.8 miles) in a southeast direction as depicted in (Figure 12)

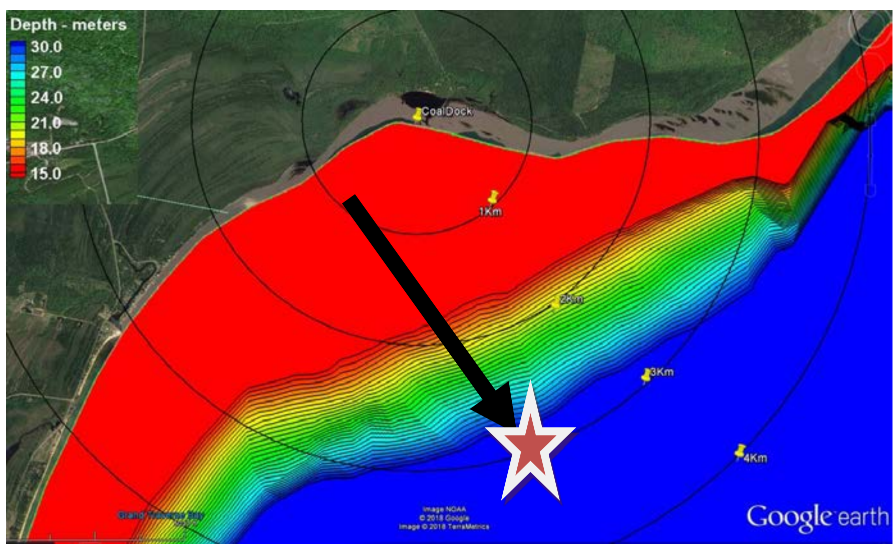

Figure 12 Proposed deep water disposal area.

Stamp sands would be hydraulically pumped as far as practical, with the discharge directly on the bottom of the lake. For planning purposes, the underwater pile would average 50 feet thick, the bottom area of the lake covered would be approximately 150 – 200 acres. Some drift of materials and incomplete consolidation of placed materials would be expected, so the area impacted might be two to three times this estimate.

2.3.2 Alternative Risk Assessment.

The placement of 15M CY of stamp sand into waters approximately 30 m in depth in Lake Superior has the potential to directly and indirectly reduce biological productivity and the occurrence of plants, invertebrates, and fish in disposal areas and adjacent habitats. This depth range provides habitat for most species of Lake Superior fish throughout all or part of their life. Fish use these depths for general occupation, transitional habitats, feeding, and spawning. The non-winter use of these habitats, based on sampling in other areas with similar water depths, slope, and substrate, can be estimated based on long-term surveys of the U.S. Geological Survey and the Michigan Department of Natural Resources (MDNR).

The U.S. Geological Survey has conducted population surveys of fish in Lake Superior since 1957. These surveys show that near-shore habitats around 30 meters deep contain the highest number of fish species (Figure 1). Work by Nancy Auer at Michigan Technological University has shown the highest abundances of common benthic invertebrate species, such as *Diporeia*, occur at 30-75 m depths. Common fish species in this depth zone include both prey fish, such as rainbow smelt, trout-perch, ninespine stickleback, and sculpins, and piscivores, including lean lake trout, Pacific salmon, and burbot. *Diporeia* is a common prey item of fish living in this depth zone. A quantitative estimate of the amount of species-specific invertebrate and fish biomass that would be lost from the proposed action could be made with additional sampling in the affected area.

<u>Deeper water disposal</u>

Tribal agencies are also concerned that areas of deep water habitat, defined as 30 meters or deeper, are more biologically important than is generally known. Since 1996, GLIFWC has conducted deep water fish community surveys documenting the use of these areas by siscowet lake trout, deep water ciscoes, and sculpin (Table 1). If this alternative is to be considered, a full assessment of impacts to deep water habitats is required.

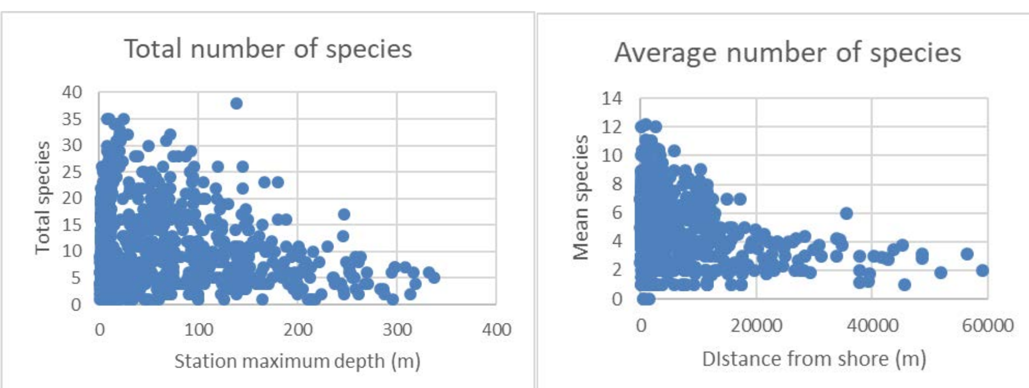

Table 1 Total number of unique species collected at stations with differing depths and the average number of species collected in relation to the distance from shore

The placement of 15M CY of stamp sand into waters >30 meters in Lake Superior has the potential to directly and indirectly reduce biological productivity and the occurrence of invertebrates, and fish in disposal areas. Deeper waters of Lake Superior support large populations of fish that use these habits for general occupation, transient habitat, feeding, and spawning. The summer use of these habitats, based on water depth, can be estimated based on annual surveys of the U.S. Geological Survey. The use of the proposed area for fish spawning is less known for lake trout, but the proposed area is likely used for spawning by deep water sculpin and potentially kiyi. A quantitative estimate of the amount of fish-specific biomass that would be lost can be estimated from the lake wide average values presented above. Better estimates of invertebrate and fish biomass loss could be made with additional sampling in the affected area.

The U.S. Geological Survey conducts annual population surveys of the offshore demersal fish of Lake Superior in waters >90 meters deep. Over the past six years (2011-2017) the average and median observed number of fish species at these sampling stations was four species and ranged from one to eight species. Deepwater sculpin, kiyi, and siscowet Lake Trout made up >90 of the total biomass collected at these sites. Bloater and pygmy whitefish were the most common other species collected, but both species were generally limited to depths <110 m. Mean and median lakewide biomass from 2011-2017 was 6.9 kilograms per hectare (kg/ha) and 5.9 kg/ha, respectively (Table 2). These biomass levels are similar to that observed in shallower near-shore waters. These samples were collected in Lake Superior by the U.S. Geological Survey from 1957-2017. Samples were collected in spring, summer, and fall using bottom trawls and gill nets.

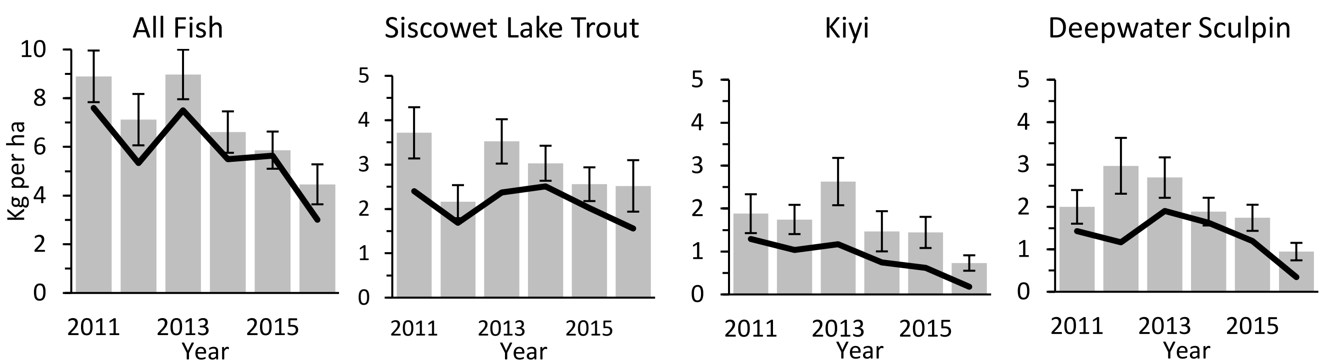

Table 2 Lake Superior annual offshore fish biomass (Kg/ha) estimates based on summer bottom trawling of waters >90 m deep by the U.S. Geological Survey.

Deepwater sculpin and kiyi feed primarily on *Diporeia* and *Mysis*, the two most abundant invertebrates in offshore waters. In 2016, the U.S. Geological Survey found that on average deep water sculpin diets consisted of 36% *Diporeia*, 32% Mysis, 22% fish eggs, and 10% other benthic invertebrates based on prey biomass. Kiyi diets consisted of 97% *Mysis*. *Diporeia* and other deeper water benthic invertebrates such as small clams, live on the bottom of the lake throughout their life. *Mysis* occupy bottom habitats during the day and migrate up into the water column at night. In longer term studies of siscowet lake trout diets, the U.S. Geological Survey and other previously published studies have found that siscowet lake trout feed principally on *Mysis* when small (<250 mm) before switching to consuming more fish, principally deep water sculpin and kiyi, as well as pelagic cisco, as they grow larger. The placement of stamp sands would eliminate benthic associated invertebrate prey in the disposal area and likely reduce it in adjacent areas. The lack of invertebrate prey would most likely eliminate the use of this area for deep water sculpin and kiyi and thus impact feeding in waters of siscowet lake trout.

In addition, this alternative would likely require an Environmental Impact Statement and an associated Record of Decision. This requirement would add several years to the implementation process and would likely still have some residual risk associated to litigation. There are substantial regulatory hurdles to overcome with the open lake placement of stamp sands. Under State Regulation 324.32515a reads in part “the permit shall allow, at the discretion of the applicant, open lake disposal of dredge material that is not contaminated with toxic substances as defined in State Regulation 323.1205 of the Michigan administrative code in waters at the 30-meter depth contour or deeper”. Any materials must comply with state water quality standards. The stamp sands are toxic to aquatic life and makes this option unlikely to be permit-able. To implement this option would require changes to the current regulations from regulating agencies such as the MDEQ and the USACE. These policy changes would also add several years to the implementation phase.

Tribal agencies do not believe the deep-water alternative is viable. While there is reduced sediment transport at depths greater than 30 meters, sediment transports are not eliminated at this depth. Sediment movement caused by surface turbulence (wave action) is possible at depths of over 40 meters[22]. There is a risk of fine stamp sand materials moving south along natural lakebed channels into Keweenaw Bay, and into the KBIC (Figure 13). This would cause irreparable harm to trust lands in an area that is already impacted by stamp sands. At this time there is little or no data to support the notion that stamp sands, once deposited in a “deep water” location, would not move to other areas and create new

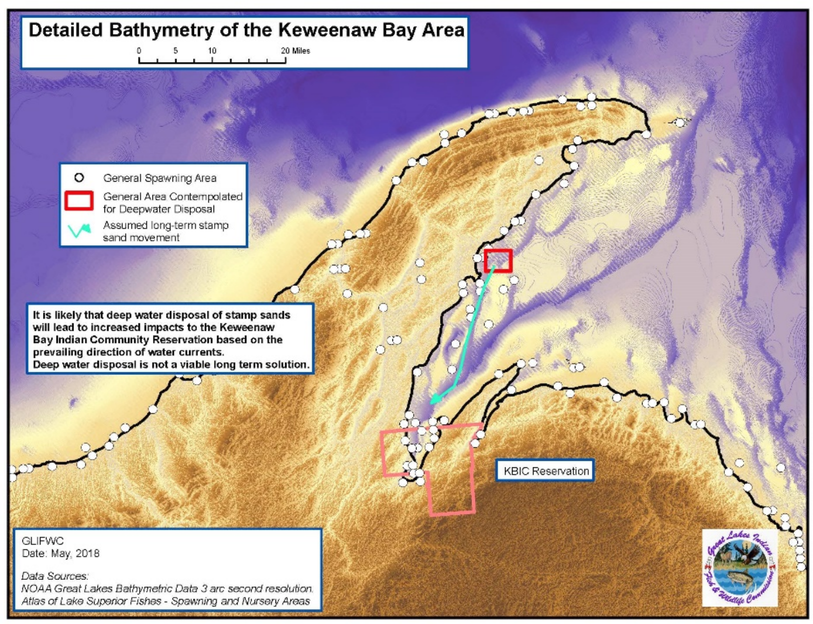

Figure 13 Bathymetry of Keweenaw Bay Area

[22] Devidson-Arnott and Greenwood, 2002

environmental problems**.** The assumption that placing the material in deep water would reduce the footprint of contaminated area is not a certainty.

Furthermore, Kerfoot et al. have documented a copper water sediment halo extending from the Keweenaw Peninsula throughout a large portion of Lake Superior (Figure 14). This halo is the result of stamp sand materials and dissolved copper from mining operations transported great distances. It is reasonable to say that some percentage of this material was deposited in areas close to shore and then became re-suspended in the water column. There has definitely been an increased load of copper to many spawning areas in the lake (halo and spawning site map). A more robust characterization of sediment transport in Lake Superior is needed before this alternative is seriously considered.

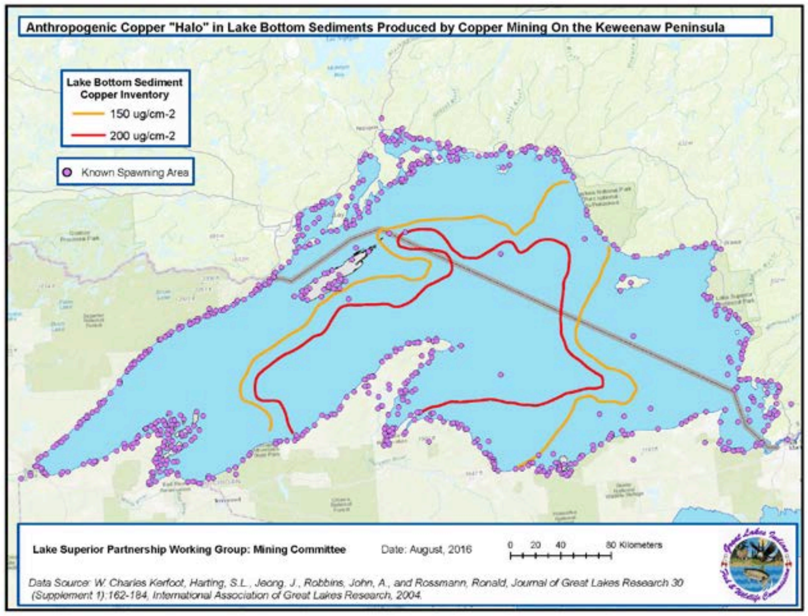

Figure 14 Anthropogenic Copper "Halo" Around the Keweenaw Peninsula

2.4 Disposal Near the Source Pile.

The following alternatives evaluate cost effective options that keep the material closer to the source pile. These options include hydraulic and mechanical placement options including the use of hydraulic pumps and conveyors that can cost effectively move the material shorter distances inland. Each evaluation will consist of a high level description with a map or drawing that contains enough detail to inform the reader of the initial intent of the alternative. In addition, each alternative will have a high level risk assessment that will be used to identify potential risks that could impact the cost and schedule and the likelihood of the alternative being implementable. In some instances the risk assessment may identify issues that are so significant that the cost or the political implications would be so great as to eliminate the alternative from further consideration.

2.4.1 Maintenance Dredging at Grand Traverse Harbor and in the Trough WITH a Stone Revetment in Place.

This alternative consist of building a 9900 foot. stone revetment along the shoreline around the eastern and southern edge of the existing source pile and extending the revetment westward along the shoreline (Figure 15) with enough capacity to contain approximately 11.4M CY of dredged stamp sands that will be placed behind the revetment at regularly required intervals. The area required is approximately 200 acres with an approximate height of 60 feet above the ordinary high watermark. By leveraging the sand already in place at these locations there is an opportunity to avoid the additional cost and time needed to dredge approximately 3.6M CY of stamp sands. It is estimated that approximately 3.1M CY still exists in the original source pile and approximately another 500,000 CY is down drift of the source pile along the shore in the area where the revetment would be constructed. Construction of the rock revetment will also require the construction of a shipping pier somewhere near the south east edge of the revetment to facilitate the delivery of the quarry stone via barge and act as a groin to capture the stamp sands that are moving towards Buffalo Reef and Grand Traverse Harbor. The revetment would be constructed to extend from bedrock to approximately +10 feet. above the ordinary high water mark (Figure 16). The stamp sand material above the revetment will be capped to prevent erosion due to wind and runoff.

Figure 15 Stone Revetment Alternative

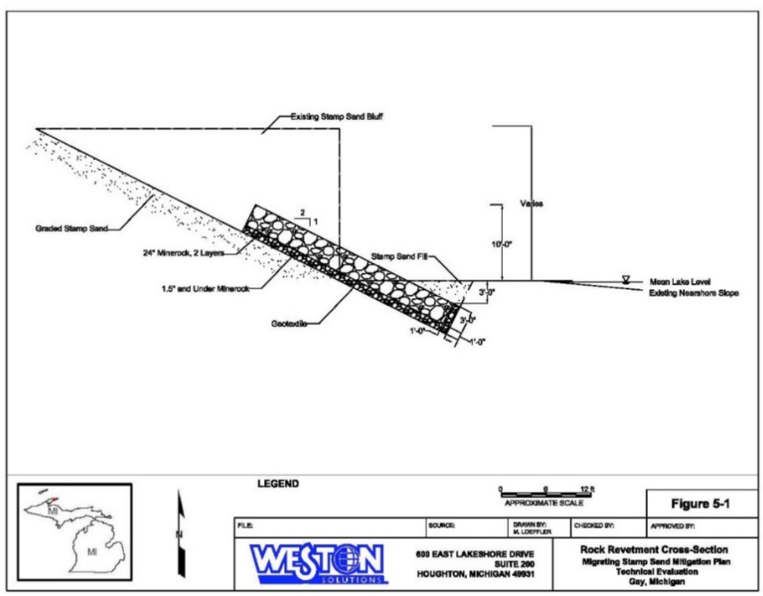

Figure 16 Stone Revetment Cross Section

If the stamp sands ultimately have a beneficial use and are removed from behind the revetment, the revetment will fail as the proposed design is armor protection using the stamp sands as bulk backing material.

2.4.1.1 Alternative Risk Assessment.

The existing stamp sands pile is a placement location that has lower ecological impacts because similar material would be placed on like material and the reduced environmental impact may be the easiest course of action given the potential for environmental objections. Nonetheless this alternative may require the preparation of an Environmental Impact Statement (EIS) to study what the effects placement of over 10 M tons of stamp sands on Lake Superior bottom lands would have to the surrounding area. Preparation of an EIS and can add up to 2.5 years to the implementation schedule. In addition, any placement on top of the original source pile will require coordination with the State Historic Preservation Office. Long term maintenance of the revetment and the cap will need to be considered in any cost estimate. In addition, copper leachate from stamp sands in near shore areas will continue as this option does not include building a liner under the pile to capture or contain this material. The real estate requirements for this alternative will include the use of state owned bottomlands for the construction of the pier and the revetment. In addition, an assessment of the adjacent riparian property owner's rights will need to be accounted for in any real estate plan.

2.4.2 Maintenance Dredging at Grand Traverse Harbor and Trough WITHOUT Revetment

Kerfoot (2017) indicates that approximately 70,000 CY are deposited on the beach annually and 15,000 CY are deposited into the trough. In order to keep the trough clear and keep stamp sands from moving along the beach and engulfing the harbor, at a minimum, these amounts must be accounted for. This alternative only accounts for the dredging activities and assumes that the placement would be directly on the beach for dewatering in preparation for beneficial use by others. This alternative assumes that any of the transportation costs for the material to other sites for processing/reuse are the responsibility of other interested parties. For the purpose of this alternative analysis, the dredge would occur as follows:

Beach: 70,000 CY per year until the approximately 11 MMT of stamp sands that will move along the beach [3.1 (original pile) + 8 (on the beach) MMT are exhausted (values from Kerfoot, 2017, page 4)]. At 1.6 MT per CY of stamp, this is 11.1 MMT/1.6 = 8 M CY. If the beach dredging is done at three year, 200,000 CY intervals, dredging will occur for 40 years.

Trough: By difference, we expect to remove approximately 4M CYDS of stamp sands from the Bay (15M CYDS total, 8M CYDS from the beach, 3M CYDS from the original deposit. If the trough is dredged on 9 year intervals, each interval will require 15,000 CY annual accumulation x nine years = 140,000 CYDS. This dredging would be expected to occur for 5M CYDS/15,000 CY accumulation in the trough/yr = 330 years.

Given that some native sands will inevitably be captured along with the stamp sands during dredging, the actual amount that has to be dredged will be larger than stated above.

2.4.2.1 Alternative Risk Assessment.

Dependency on a third party to continuously demand this product over an estimated 330 year lifespan has inherent risks associated with it including the possibility of the beneficial user going bankrupt. Additionally, regulatory requirements can change over time exposing this product to potential handling and use changes in the future that may impact the beneficial user or how and where this material can be stored or mined from the lakebed. Any long term management plan that depends on a third party to continuously demand this product would need an alternative plan that can be implemented to account for the inherent risks associated with this alternative.

2.4.3 Dredge Everything with On Land Disposal in Nearby Wetlands.

This alternative involves the placement of stamp sands immediately adjacent to the existing shoreline (Figure 17). Conveyors would be used to move the material a mile or less to nearby wetlands. The sands could be capped to eliminate infiltration driven leachate generation. Stamp sands at this site could be segregated by differing grain size characteristics to facilitate future beneficial use. The map identifies wetland areas that could be used for long term storage of stamp sands. Because these areas are so close to the shoreline no more than 3000 feet. of conveyors would be required, reducing the transportation costs for this option. The real estate required for 15 Million CY of stamp sand is equivalent to 100 feet high over 100 acres. Side slopes are required so an area of about 150-200 acres would allow for a 100 foot tall pile.

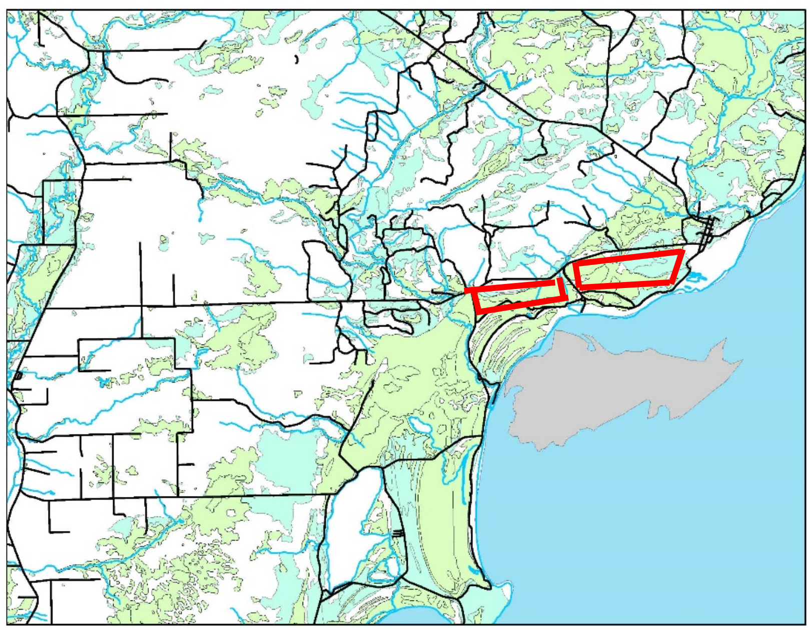

Figure 17 Wetland Disposal Alternative

2.4.3.1 Alternative Risk Assessment.

In order to obtain a permit to fill wetlands, it must be demonstrated that this is the feasible and prudent alternative with the least impact to regulated resources. Mitigation, would be required for all filled wetlands, and could drastically change the cost to implement this alternative.

Placement on a nearby large land area (150 acres or more) with single or multiple ownerships involves real estate issues, possibly involving condemnation or outright purchase at a cost higher than prevailing land prices. Construction may require a berm to contain material or additional lands for stacking the stamp sands material at a less than natural angle of repose. Loss of existing habitat will occur at the placement site. In addition, the pile's dimensions could also impact the surrounding community's view shed, drawing potential comments and concerns about the change in landscape. Leachate will continue to enter the lake, albeit at a greatly reduced rate if the storage pile is capped. If uncapped, wind and water erosion would have to be controlled.

The value of wetlands to the Anishinaabeg (the first people) lies in their cultural significance. From the wetlands are gathered innumerable plant species that fill the medicine cabinets of the traditional healers. These medicines are effective and vital to the well-being of the people and play an important role in their ability to practice food sovereignty. Today, as was true in the past and will be into the future, the Anishinaabeg take on the responsibility to fulfill their First Treaty with the Creator to protect, defend, and wisely use the resources of their natural environment. The Anishinaabeg seek a pro-active approach to wetlands throughout their ceded territory using the guiding principles of stewardship for Seven Generations. Through this approach, the Anishinaabe acknowledge their role as caretakers and nurturers of the mutually beneficial relationships that exist between the land and people. This pathway incorporates Traditional Ecological Knowledge, beliefs, and values. From the Creation Story, stewardship recognizes the interconnections and obligations of the Anishinaabeg to all wildlife and their habitats. In the creation story of the Anishinabe people, out of nothing, rock, water, fire, and wind came to be -- notably, nibi (water) is a primary element (KBIC-Wildlife Stewardship Plan). Traditionally, tribal members of the KBIC still live an active ceremonial life and undertake hunting and gathering in the wetlands of the Keweenaw Peninsula and throughout Michigan's Upper Peninsula.

In Anishinaabemowin, the language of the Ojibwe, the words for bog (mashkiig), swamp (waabashkiki) and medicine (mashkiki) are similar in origin, suggesting a connection between these types of wetland ecosystems and the location where many medicinal plants are found. Medicines gathered from wetlands may contain cures for humanity we may not yet know of. These lands and plants must be afforded every protection possible. Because plants gathered from the wetlands are used medicinally, it is of utmost importance that the environment in which the plants grow is free of contamination. The effectiveness of the medicines would be all together compromised if the toxin-laden stamp sands were to be dredged onto adjacent wetland sites. The Anishinaabeg are dedicated to proposition that the expanses of wetlands, like those in the Keweenaw, are sacred ground, places of rejuvenation, places of heritage and the place where our medicine cabinets reside. These natural medicines are a gift from Gichi Manidoo (Great Spirit). Traditional teachings provide the means by which the Anishinaabeg procure mashkiki (medicine) from the Gichi manidoo gitigan (Creator's garden). Water loving plants such as manoomin (wild rice), apakweshkway (cat-tail), magkii midaasan (pitcher plant), mashkiigimin (cranberry), and mashkii anibish (Labrador tea) are some examples of plants gathered for traditional food or drink. Baapaagimaak (black ash), mashkiiwaatig (tamarack) and giishik (cedar), are trees used medicinally, ceremonially and creatively for the weaving of baskets and other traditional items. The teachings are handed down from generation to generation for religious purposes that include naming ceremonies, funerals, and Midewiwin ceremonies and feasts that are critical to the Anishinaabe way of life. For generations, the Indigenous people of the Great Lakes region have gathered from the wetlands and these areas have played an important role in human development. Within the wetlands are significant religious, historical and archaeological gems of value to many cultures.

All of the numerous plants within our wetlands have value. These plants do not thrive if in isolation from one another. This following list of over 60 wetland plants that comprise the wetland species in the Keweenaw;

Speckled Alder		Bog Goldenrods		Rushes
Broad-leaved arrowhead		Hollies		Sedges
Black Ash		Horsetails		Skunk cabbages
Bladderwort		Wild Iris		Smartweeds
Blueberries		Jack-in-the-pulpit		Black spruce
Bog Rosemary		Jewelweed		Stonewort
Boneset		Joe-pye-weed		Sumacs
Bulrushes		Labrador tea		Sundews
Bur-reeds		Lady slippers		Sweet gale
Buttonbush		Laurels		Tamarack
Wild Calla		Leatherleaf		Swamp thistle
Northern White Cedar		Lobelia		Turtleheads
Cattails		Loosestrife		Blue vervain
Chokeberries		Marsh marigold		Watercress
Cinquefoils		Meadowsweet		Water hemlock
Cotton grasses		Swamp milkweed		Water lilies
Cranberries		Sphagnum mosses		Milfoils
Red Osier Dogwood		Nut-grasses		Plantain
Duckweeds		Orchids		Wild rice
Elderberries		Pitcher plants		Black willow
Ferns		Pondweeds		
Gentians		Swamp rose		

In addition, Littorella uniflkora, Callitriche hermaphroditica, Caltha natans and Gentiana linearis are Michigan species of special concern or designated threatened. The relationships that exist uniquely between these species nourishes and strengthens them; in turn, they offer to people, within the reaches of their remarkable array of phytochemicals, food and medicines that heal the wounds of spirit and body.

Wetlands also serve important ecological functions, as abating the extremes of fluctuating water levels, filtering sediments, providing habitat in which fish, birds and other wildlife can thrive. These high quality ecosystems function fully only when water and air quality are pure, the obligation exists to protect the wider ecosystem and all life that depends on it --human, fish, wildlife, plants and trees.

2.4.4 Dredge Everything with Disposal in a Newly Constructed Landfill Nearby.

This option requires moving the material further inland than the last alternative. The storage location would be in the nearest uplands, about a mile from Lake Superior (Figure 18). As stated above, land acquisition will be required. Moving the material landward would require the construction of a landfill type containment system at the placement site(s) possibly consisting of a clay or synthetic liner for long term closure. Long term maintenance after closure will be required. The movement of the stamp sands to these locations requires a transport system to move the sand from the lakefront inland to the placement area(s). The most cost effective modes of transportation is either by hydraulic pipeline or conveyor belt. Placement via hydraulic pipeline would require recycle or disposal of decant waters authorized by a National Pollutant Discharge Elimination System permit. For the purpose of this evaluation, it is assumed that all materials would be dewatered at the beach area and then transported via conveyor belt to the placement site to avert the need to dispose/recycle or treat decant waters generated by the hydraulic movement of the material.

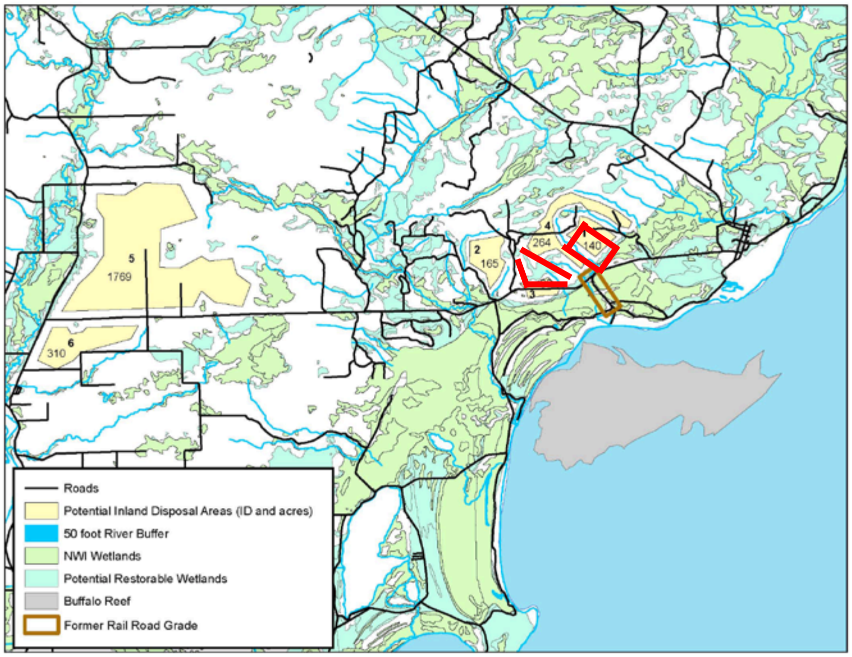

Figure 18 Proposed Nearby Landfills

2.4.4.1 Alternative Risk Assessment.

This alternative may require the preparation of an Environmental Impact Statement (EIS) to study what the effects of a landfill type facility would have to the surrounding area. Preparation of an EIS can add up to 2.5 years to the implementation schedule. The use of conveyors would require construction easements or permanent access agreements through multiple property owners. This project will likely result in the loss of existing habitat including wetlands.

2.5 Disposal Offsite.

These disposal options were developed to evaluate offsite disposal options that do not include the use of traditional overland transportation methods such as hauling in trucks or movement by trains. The initial evaluation precluded these transportation options because the cost of transportation proved to be the most prohibitive cost for disposal. Only transportation by ship or barge proved to be an economical transportation option for longer distances.

All of the following options assume that a temporary loading facility would be constructed to support at least a Class 8 sized self-unloading Laker vessel (730-849 feet). The proposed facility would be capable of protecting the vessel from Lake Superior wave action during the loading process. In addition, the loading facility would act as a groin to capture migrating stamp sands along the shore. The offload of the material would likely be directed onto conveyors or near-shore areas that are constructed to support this material for beneficial use or disposal inland by other interested parties. Both loading and unloading areas would also be dredged to a depth that allows for the entrance and exit of a fully loaded ship. For estimating purposes a similar facility to protect the vessel from wave action during the offloading process will be assumed to either be in place or constructed at the designated offloading site(s). For this estimate, it is assumed that a Class 8 self-unloading Laker vessel would transport 35,000 tons during a 127 hour roundtrip voyage. This alternative would also have a maintenance cost associated with the access channel. Failure to maintain the access channel(s) would result in lite loading ships or barges to prevent the loaded vessel from running aground on a shoal in the access channel.

2.5.1 Dredge 15M CY with disposal into the White Pine Mine Tailings Basins

This alternative assumes all of the criteria outlined in Section 2.4 apply to this alternative and that the required disposal area would be 300 acres, 30 feet high. The capped pile would be sloped to exclude infiltration into the stamp sands. Both a loading facility and an offload facility would be required to be constructed. Approximately 17,000 feet of conveyors would be required to move the material from an offload facility near Silver City inland to the western edge of the northern most tailings basin (Figure 19). The owner of the facility would either charge a fee for the use of the tailings basin or wish to transfer ownership/responsibility for the basin to the government. Because this facility is already utilized as a mining tailings basin, a permit modification may suffice to utilize the facility for this purpose. This alternative would require a closure

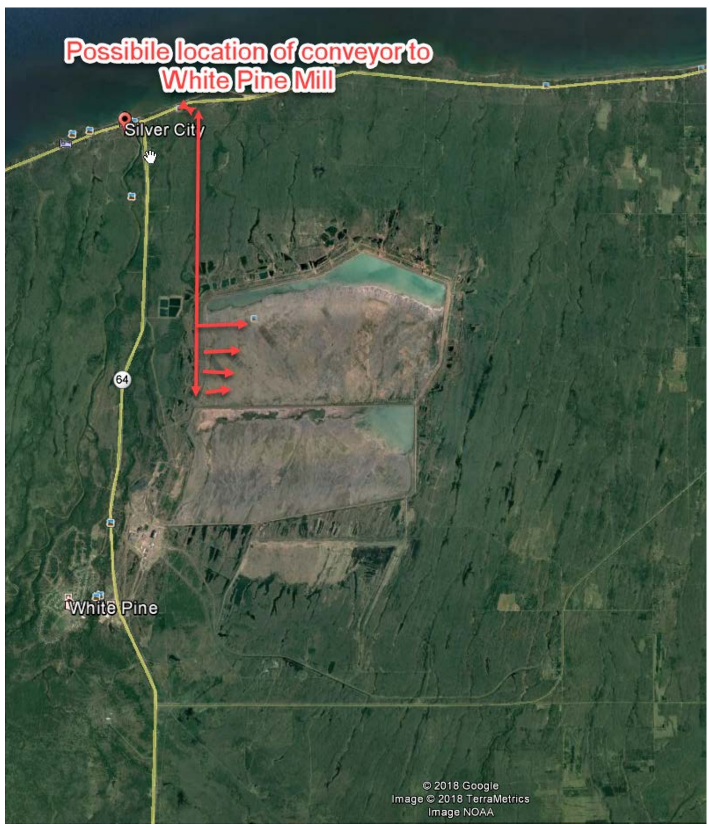

Figure 19 Proposed placement at White Pine Mill

plan that may include a cap to exclude precipitation. For the purpose of evaluating this alternative, we will assume that some Operations and Maintenance would be required to maintain the cap at this location. Finally, transportation costs from this remote location makes offsite beneficial use unlikely in the future.

2.5.1.1 Alternative Risk Assessment.

This facility is located in a sparsely populated area where mining has gone on for over 100 years. The stamp sands from Gay are similar to the 150M CY of tailings already in place at this facility. This option would likely receive less public concern than other potential sites. Real estate acquisitions and easements would also be simplified in this area, as there are fewer landowners with which to negotiate. There would still be some maintenance cost associated with the cap. There is risk that the MDEQ would not allow placement of stamp sands here without constructing a lined facility, which would drastically change the associated cost for implementation at this site. it is likely that an EIS will be needed if a permit modification is not an option. An EIS would drastically change the availability of this facility for implementation, as an EIS could take an additional 2.5 years for approval. There is also risk that the owners of the facility would require that the tailings basins be purchased along with responsibility for existing environmental liabilities.

2.5.2 Dredge Everything with Disposal in a Quarry Close to the Great Lakes.

This option is identical to alternative 2.4.1 in that the 15M CY will be loaded onto a ship and transported to a quarry that is close to the Great Lakes for storage for future beneficial use. The main difference here is that the offload area is in an existing harbor that has been designed and permitted to accommodate self-unloading ships. In addition, this option assumes that the disposal site is close to the harbor. For the purpose of this assessment, it was assumed that the quarry is within one mile of the offload point and that 200 acres is readily available for the disposal site. It was also assumed that the maximum distance to the quarry from Gay, Michigan is 300 nautical miles.

2.5.2.1 Alternative Risk Assessment.

A disposal permit would need to be granted or, if the quarry already has a permit, modified before the site could be utilized. The facility would have to be selected/improved to protect local ground and surface waters. Since the local population would be unfamiliar with copper mine tailings, their opposition to placement of stamp sands is likely. Using an existing harbor may require additional permits or infrastructure to accommodate this new type of material.

2.5.3 Dredge with Disposal in an Existing Landfill(s)

This alternative considers loading the stamp sands onto a ship and disposing of them in a licensed landfill in close proximity to navigable waters of the Great Lakes. Further investigation determined that it was highly unlikely that a single facility was capable of accommodating the disposal of the entire 15M CY. In addition, interviews with facility owners revealed their interest in using the material as daily cover but most would likely only consume a few hundred thousand cubic yards of material in the life span of their facilities. This alternative would require using multiple disposal sites, each with site specific logistical implications needed to transport the sand to its final location. A preliminary search revealed that there are very few facilities located within 300 nautical miles of Gay that fit these specifications. This would drive the price of transportation higher, especially if multiple stops are required during any given movement.

2.5.3.1 Alternative Risk Assessment.

Because a single commercial disposal facility is not likely able to accommodate the entire 15M CY of material and each site owner would likely have different logistical needs to get the material to their stockpile location(s). This option would be extremely expensive to implement, as each facility owner would need to able to accommodate a defined amount of material in a single location in a very short timeframe. Otherwise the cost for shipping will increase dramatically if the ship is delayed for any reason. There would also be an associated tipping fee. Many owner/operators would give a discount for any material that they would be using as daily cover. However, any tonnage above and beyond the daily cover requirement will be assed at the market rate for disposal. Combining this with the real estate issues associated with negotiating with multiple land owners in multiple locations and the varying modes of transportation required to move the sand from the offload point to the stockpile locations would categorize this option a very high risk alternative.

2.5.4 Dredge Everything with Disposal in the Keweenaw Mine Shafts.

Disposal into mine shafts results in minimal surface disturbance. However, there are extreme difficulties associated with accessing the volume of mine openings required to place stamp sands into the abandoned mines. Placement into the old mine shafts would require the mine to be dewatered. The water removed from the mine would need to be treated and disposed of properly. Once dewatered, an extensive engineering analysis would need to be conducted to assess the internal infrastructure improvements that would be required prior to reopening the shafts safely. Since ore was extracted from the mines along underground veins located in horizontal drifts, stamp sand placement could not be done solely from the ground surface. After 100+ years, the timbers supporting the mine workings are unsafe and unfit for human access without considerable improvements.

Once the mine is operational, the bulk of the filling would need to be along the horizontal drifts as the vertical shafts have insufficient dimensions to handle the required capacity. Filling along the horizontal drifts would be accomplished by conveyor. The volume of crushed rock creating the stamp sands is greater than the in-place rock that was removed by at least one third volume. This constraint could require the reopening of several mines in the area to accommodate the estimated 15M cubic yards.

The average distance to the mine shafts is about 12 miles from Gay, Michigan. (Figure 20) Movement of the stamp sands from the beach by truck is cost prohibitive. Transport can be done by conveyor utilizing many of the decommissioned railroad tracks in the area but this option is also costly as the distance is substantial.

Figure 20 Historic Mining Sites

Once the mine is filled, there will be a process to reclose the mine shafts. Mine shafts would have to be purchased from mineral rights owners. Filling a mine with stamp sands would render remaining copper and other minerals inaccessible, so the purchase of mineral rights should not be taken for granted.

2.5.4.1 Alternative Risk Assessment.

There is the potential to impact the drinking water aquifer even though the disposal of stamp sands into the mines results in the placement of like material on like material. This risk could drive a continued need for monitoring after the mines are filled and could require periodic removal and treatment of the water in the mine driving up operation and maintenance costs in perpetuity.

MDEQ disposal permits will also be required, which could have different conditions at each site, complicating the design and implementation of this alternative. Because there is potential to impact the drinking water, it is likely that an EIS would be required prior to any implementation. Geologically, it is possible that none of the mines being considered may be appropriate for filling for hydrological reasons, this may not be known until a mine is dewatered and an engineering assessment is completed.

This alternative involves long overland transportation distances over the entire Keweenaw Peninsula. Easements or Rights of Entry would be required for mine use from multiple mine property owners and likely many public and private entities.

Because this option requires the use of decommissioned mines to be reconditioned and made safe for filling, and because of the fact that each mine would have site specific logistical needs to get the sand to its final location it is recommended that this alternative no longer be considered as the risks to implementation are cost and time prohibitive.

2.5.5 Beneficial Use – In or Out of State

There are many proposals from the private sector under consideration. These proposals range from on-site processing to the movement of the sand to another location for processing and/or use. Some of the proposals still have a hazardous byproduct after processing and some of the proposals may have special disposal requirements at the end of the product life cycle that need to be considered.

To date, most of the proposals being contemplated have not made it past the conceptual phase. Developing an end use for this product has proven to be challenging.

Loading system requirements for removing stamp sands from Gay are dependent upon the beneficial use contemplated. For efficient transport, a loading pier is required for vessel movement. Transportation movement methods at the offloading location are the responsibility of the end user. Permits may be required from the state at the location of the end user for use of the stamp sands as a marketable product. If processing occurs on-site, then the byproduct of that process will may still need to be placed in an approved facility. If the byproduct proves to be benign then that material will still need to be contained onsite. If a beneficial use can be realized in a timely manner, then the requirements for additional lands and easements are minimized along with the time delays for the required construction permits. The BRTF, in partnership with private and public organizations are aggressively pursuing beneficial use as a complete or partial solution to this problem.

For the purpose of this evaluation, beneficial use will only be considered as a complement to any selected alternative(s) in this plan. Care will be taken to design the selected alternative(s) with future beneficial use in mind so that like materials can be easily cataloged and accessible to interested entrepreneurs.

2.5.5.1 Alternative Risk Assessment.

Beneficial use of stamp sands, either in Michigan or out of state, will require approval for the proposed product that incorporates the stamp sands at the destination state. Movement of stamp sands to another state may present public relations hurdles and will require close coordination with the affected state(s). The state regulatory evaluation of the end product will need to cover future recycling use, ensuring that the final product at the end of its life cycle will not cause another site of environmental contamination, i.e. use of stamp sands for aggregate in asphalt or concrete. Will the discharged product create a leachate problem when they are broken or ground up for reuse at a later date?

Reliance on beneficial use is inherently risky because the proposed demand for the material can drastically change over time as other more cost effective materials are developed or discovered. In addition, regulatory requirements can change over time, requiring manufactures to change the way the material is transported, stored, processed or recycled. These requirements would force manufactures to invest in unplanned capital improvements that could negatively impact any profitable business plan that was reliant on this material. These external pressures could force the company to abandon this product or close down any further operations that are contingent on the use of stamp sands in a products life cycle.

2.5.6 Stocking the Fishery

This alternative evaluates the feasibility of stocking fish to replenish the fish population due to the loss of Buffalo Reef. For the purpose of this evaluation only Lake Trout and Whitefish will be assessed for restocking. This option will assume that hatcheries will be built or that existing hatcheries will be expanded that are capable of producing at least 1.5 times the current annual harvest measured in round pounds and is sufficient to meet the demand of the commercial fishing industry and protect against mortality rates due to predation and conveyance out of the system due to migration.

The average annual harvest is 375,020 round pounds for both whitefish and lake trout. The projected requirement will be 562,530 round pounds

Fish	Annual Round Pounds Harvested	Hatchery Projection Requirements
Whitefish - Tribal and Non-Tribal Fishers	237,439	356,158
Lake trout - Tribal Fishers	137,581	206,372
Total Pounds	**375,020**	**562,530**

Table 3 Average Annual Harvest

2.5.6.1 Lake Trout Production

Federal, Tribal, and State investment in lake trout rehabilitation has been ongoing since the mid 1960's as evidenced through fish stocking records (Table 4). *As noted earlier, the Council of Lakes Committee (CLC) has gone on record stating, "As a part of a lakewide plan to restore Lake Trout in Lake Superior, more than 1.6 million Lake Trout were stocked on Buffalo Reef to re-establish this population."*

Table 4 1966 – 1995 Lake Superior Lake Trout Stocking – Big Traverse Bay – Grid 1125

YEAR	NO_STOCKED	STAGE	AGENCY
1966	151,820	y	USFWS
1967	151,802	y	USFWS
1968	152,215	y	USFWS
1969	99,840	y	USFWS
1969	101,300	y	USFWS
1974	98,800	y	USFWS
1975	50,000	y	USFWS
1975	75,000	y	USFWS
1975	25,000	y	USFWS
1977	28,000	y	USFWS
1985	50,445	y	USFWS
1985	*38,146*	*ff*	USFWS
1986	52,000	y	USFWS
1989	54,500	y	USFWS
1991	47,390	y	USFWS
1991	47,400	y	USFWS
1992	64,000	y	USFWS
1992	23,552	y	USFWS
1992	8,448	y	USFWS
1993	61,300	y	USFWS
1994	56,800	y	USFWS
1994	16,200	y	USFWS
1994	38,300	y	USFWS
1995	62,184	y	MIDNR
1995	12,816	y	MIDNR
Subtotal Lake Trout Stocked	**1,567,258**		
Less fingerlings	38,146		
Subtotal Lake Trout Yearlings Stocked	**1,529,112**		

U.S. Fish and Wildlife Service (USFWS) lake trout rehabilitation efforts, which were started in the 1960's, were supported with high quality spawning habitat on Buffalo Reef. This would not be the case if mining stamp sands continue to degrade the spawning reef. Degradation of spawning habitat would not only jeopardize the subsistence, commercial and sport fisheries at Big Traverse Bay, but also put added stress upon Keweenaw Bay fisheries.

Since 1995, USFWS and the KBIC have continued to invest in Lake Trout rehabilitation efforts. The USFWS stocked 742,489 lake trout of various sizes from 1996-2012 in Keweenaw Bay (Table 5). The number of lake trout stocked at specific size categories is contained in the MDNR Fish Stocking Database[23].

Table 5 Size and number stocked by federal hatchery to restore Lake Trout populations in Keweenaw Bay 1996-2012

6-7 inch yearling Lake Trout	
Number Stocked from 1996-2005	698,098
7-8 inch yearling Lake Trout	
Number Stocked from 1996-2001	43,700
31-34 inch Extended Growth Lake Trout	
Subtotal Extended Lake Trout Stocked in 2012	691

[23] https://www.michigandnr.com/fishstock/

The KBIC stocked 751,284 lake trout of various sizes from 1996-2012 in Keweenaw Bay (Table 6). The number of lake trout stocked at specific size categories is contained in the MDNR Fish Stocking Database[24].

Table 6 Size and number stocked by KBIC to restore Lake Trout populations in Keweenaw Bay 1994-2012

1-2 inch fingerling Lake Trout	
Number Stocked in 2012	36,135
2-3 inch fingerling Lake Trout	
Number Stocked in 2011	58,415
4-5 inch yearling Lake Trout	
Number Stocked from 1995-2006	52,450
5-6 inch yearling Lake Trout	
Number Stocked from 1994-2011	76,681
6-7 inch yearling Lake Trout	
Number Stocked from 1995-2012	420,702
7-8 inch yearling Lake Trout	
Number Stocked from 1994-2009	92,093
8-9 inch yearling Lake Trout	
Number Stocked from 1995	7,650
9-10 inch Extended Growth Lake Trout	
Subtotal Extended Lake Trout Stocked 2003-2005	6,899
20-21 inch Extended Growth Lake Trout	
Subtotal Extended Lake Trout Stocked 2006	259

Benefit Transfer calculation of Buffalo Reef spawning production: Natural capital is produced by ecosystems, or biological communities interacting with their physical

24 https://www.michigandnr.com/fishstock/

environment. Just as healthy wetlands have the ability to clean water similar to urban waste water treatment plants, Buffalo Reef and its nearby shoreline nursery areas produce fish and function similar to a fish hatchery.

2.5.6.2 Whitefish Production

Currently there are no federal, tribal or state production facilities for Lake Whitefish (*Coregonus clupeaformis*) on the Great Lakes. Stocking occurred in the Great Lakes in the 1960s after populations declined due to sea lamprey predation. However, "propagation efforts were unsuccessful in arresting the decline of these fishes, perhaps because the stocking densities were too low. It appears that stocking densities must exceed 41% of the natural hatch to produce measurable success in a planting program that augments natural reproduction. Stocking of any of the Great Lakes with lake whitefish at these levels would require several billion fry per lake annually. Such a program is too large to be practical and intensified protection of the remaining stocks would be more cost effective." (Todd, T. 1986)[25].

2.5.6.3 Alternative Risk Assessment

This alternative assumes that replacement of the fishery is possible. Given that there is no suitable site for such a facility with requisite size, location, fresh water supply, etc. Even if such a site did exist, the costs of obtaining the land, building and maintaining the facility, hiring staff, supplying fish food through the different rearing cycles, etc., would be significant on an annual basis, let alone into the future for all the years to come. Furthermore, fish raised in such a facility would be subject to considerable mortality when stocked. Those that survived could compromise the genetic integrity of the native fish populations that have adapted naturally to local conditions. Also, stocked fish would likely translocate to other areas of the lake due to the lack of food and habitat; therefore they would contribute little to the local fishery.

2.5.7 Building a New Reef

This option considers building a new reef in whole or in part near or adjacent to Buffalo Reef. This option would consider leveraging the estimated 600,000 cubic yards of stone that is projected to be excavated as part of the proposed new lock in Sault Saint Marie, Michigan. This option could be considered in part or in whole to either do nothing to stop the inundation of the stamp sands onto Buffalo Reef and the juvenile recruitment areas or be used in conjunction with one or several of the other alternatives as a mitigation step to recover or maintain the reef over time.

Recent evidence suggests that the littoral drift and the annual outflow from the Tobacco River and other tributaries into Lake Superior are charging the system up drift of the main pile with native sands that are moving southwest over areas that have been previously covered with stamp sands that have already moved out towards Buffalo

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[25] Todd, Thomas N. Artificial propagation of coregonines in the management of the Laurentian Great Lakes. 1986. USGS Publications Warehouse. http://pubs.er.usgs.gov/publication/70006508.

Reef. This movement of native sands is contributing to the restoration of areas that have been previously inundated with stamp sands.

This option would consider the placement of stone in these areas (Figure 21) to promote the establishment of spawning areas that are northeast of Buffalo Reef but in close proximity to areas of the reef that are still viable for spawning. This close proximity will increase the chances that the new reef will be utilized by the target species for spawning. In addition, the area towards the shoreline adjacent to the new reef would be ideal to establish additional juvenile recruitment areas for the whitefish.

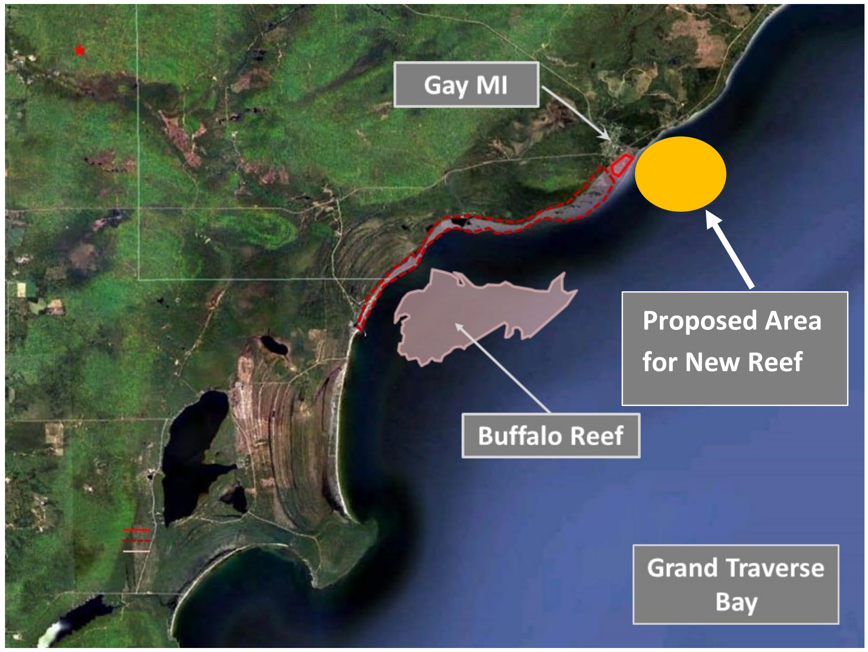

Figure 21 Build New Reef Proposal.

As stone is made available at the Soo, or other stone would either be directly loaded onto barges or placed on barges after the stone has been excavated from the channel. These barges would then be strategically unloaded in areas designated by fishery experts. This process could be repeated as more areas become free of the stamp sands. Essentially, the process could keep pace with the natural littoral drift of the sand or could be accelerated in areas that removal of the sand has already occurred.

2.5.7.1 Alternative Risk Assessment

Building a new reef could potentially replace the production on Buffalo Reef. There is extensive literature about aspects and qualities of the reef that would need to be adhered to for construction of the reef. For example, the following text is excerpted from the abstract of Marsden et al. 1995[26]:

> "Lake trout spawning habitat quality is defined by the presence or absence of olfactory cues for homing, reef location with respect to the shoreline, water depth, proximity to nursery areas, reef size, contour, substrate size and shape, depth of interstitial spaces, water temperature at spawning time, water quality in interstitial spaces, and the presence of egg and fry predators. …. No direct evidence of egg

[26] J. Ellen Marsden, J.E., J. M. Casselman, T.A. Edsall, R. F. Elliott, J. D. Fitzsimons, W.H. Horns, B.A. Manny, S.C. McAughey, P.G. Sly, and B.L. Swanson. 1995. Lake Trout Spawning Habitat in the Great Lakes — a Review of Current Knowledge. Journal of Great Lakes Research, 21(S1): 487-497

> deposition has been collected from sites deeper than 18 m. interstitial space and, therefore, substrate size and shape, appear to be critical for both site selection by adults and protection of eggs and fry. Water quality is clearly important for egg incubation, but the critical parameters which define water quality have not yet been well determined in the field. Exposure to wave energy, dictated in part by reef location, may maintain high water quality but may also damage or dislodge eggs. The importance of olfactory cues, water temperature, and proximity to nursery habitat to spawning trout is unclear. Limited data suggest that egg and fry predators, particularly exotic species, may critically affect fry production and survival. …… changes in water quality and species composition may negatively affect early life stages."

However, even if built in accordance with characteristics such as those mentioned above, it is not guaranteed a replacement reef would serve the intention of providing spawning habitat for lake trout and lake whitefish. Fitzsimons[27] (1996) reviewed evidence of lake trout egg deposition on several man-made reefs in the Great Lakes but he could not clearly determine why some reefs were used by lake trout and others were not. This illustrates the difficulty of reliably duplicating something in nature with complexities beyond our understanding. Therefore, there is considerable risk in expending the costs and effort to build a replacement reef which may or may not serve its intended purpose.

In addition to these general concerns, there are specific issues with constructing a spawning reef as a replacement for Buffalo Reef.

1. The artificial reef must be constructed updrift of the stamp sands so as to avoid the problems faced by Buffalo Reef itself. Downdrift from the reef, nursery habitat is severely impacted by stamp sands. No juvenile whitefish were found on stamp sand beaches during GLIFWC seining. Juvenile fish would have to swim updrift in order to find unimpacted habitat from a constructed reef. This normally unnecessary expenditure of energy by juvenile fish is not likely to occur. Similarly, juvenile Lake Trout would have to swim updrift in order to find habitat/food resources not impacted by stamp sands.

2. The unimpacted "beach" habitat near the proposed artificial reef is different than the beach habitat downdrift of Buffalo Reef. The habitat near the proposed artificial reef is rocky, indicating a higher energy environment that may not be as suitable as nursery habitat for juvenile whitefish.

Dr. Charles Kerfoot of Michigan Technological University has done considerable research on Buffalo Reef. He provided the following comments to Evelyn Ravindran of KBIC:

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[27] Fitzsimons, J.D. 1996. The significance of man-made structures for lake trout spawning in the Great Lakes: are they a viable alternative to natural reefs? Canadian Journal of Fisheries and Aquatic Sciences, 53(S1): 142-151

“*I did some reading on recent studies, and looked over some of our LiDAR and ROV scenes, just to get a bit of information about what is unique about Buffalo Reef relative to fish spawning. Building a "new" reef seems a bit risky, aiding coastal recovery seems less risky. Something could be done to enhance recovering coastal shelf sites along the northern stretch. You might be able to re-boulder some of the area being lost along the northern cobble fields of Buffalo Reef (i.e. placement of cobbles/boulders in a clump on the newly cleared regions). You would have to check that fish are using the site. The effort might enhance chances that lineages of fish would return to Buffalo Reef once it is cleaned up. Here are some observations and concerns.*

1) *Buffalo Reef has some unusual features, notably the combination of a bedrock (Jacobsville Sandstone) promontory surrounded by boulder fields filled with glacial erratics (nicely rounded cobbles and boulders of heterogeneous nature). The reef's horizontal spread is unusual. It is also a “living” reef, as the boulders and cobbles are covered by an actively photosynthesizing layer of diatoms (algae) and bacteria, producing food for invertebrates. Fish eggs are dropped into the crevices between the boulders and cobbles, a boundary layer protected from waves (Figure 22). Some of this structure would be difficult to duplicate.*

Figure 22 Photo of Buffalo Reef

2) *The coastal zone off of Gay is reverting to its prior natural conditions, as wave action has washed the surface clean of stamp sands. I initially thought that rounded cobbles might be dropped over that surface to form mounds. However, the surface is flatter than Buffalo Reef and the coastal zone narrower, wave action would likely be more intense and lessen the chance of successful egg hatching. Besides you would have to duplicate the spacing of boulders (fine interstitial distances) on Buffalo Reef. The effort is not out of the question. Invertebrates are returning to the cleared region of the shelf off the former northern end of the Gay pile, so there would be food. The region does not have the topographic highs and lows of Buffalo Reef-places where fish can hide, turn around without being noticed.*

3) *There are relatively few places (natural reefs) that have been studied, to give us an idea where exactly fish (Lake Trout, Whitefish) drop their eggs and what kinds of microenvironments they favor. The exception is Binder et al's 2018*[28] *long-term acoustic telemetry study of lake trout habit in the 19-27 km2*

[28] *Binder, T.R., Farha, S., Thompson, H.T....Krueger, CC. 2018. Fine-scale acoustic telemetry reveals unexpected lake trout, Salvelinus namaycush, spawning habitats in northern Lake Huron, Nart America. Ecol. Freshw. Fish. 27:594-605.*

region of Drummond Island Refuge, Lake Huron. The argument against stocking fish is the demonstrated impaired spawning behavior and spawning site selection by hatchery-reared fish (Bronte et al. 2003)[29]. Natural lake trout spawning has been observed on rocky substrates at depths ranging from about 0.3 to 20m (Fitzsimons 1994)[30]. Suitable Buffalo Reef habitat is similar, extending down to around 22m (Fig. 2).

4) *Binder et al (2018) found that fish could be capricious (fickle) as out of 5 potential spawning reefs, fish tended to dominate one location (Horseshoe Reef). However, they did use 4 other reefs, but totally avoided another that seemed suitable from substrate conditions. Tight proximity of cobbles and boulders and little interstitial space (<10 cm) were key features where eggs were dropped (Binder et al. 2018). I suppose you could consider constructing a "suitable" spawning area on the re-cleared regions, hoping to get resident fish to do some spawning, so they would switch back to Buffalo Reef once it was cleared up.*

My feelings are to put effort into removing the migrating stamp sand bars, aiding cleaning up the coastal zone, and trying to remove the amount that has moved onto the reef. A removal demonstration project would be good to try."

Finally, it should be noted that the 600,000 CY of stone from construction of the Soo Locks will construct a 120 acre reef that averages three feet deep. Buffalo Reef is 2200 acres. KBIC is also concerned about the introduction of invasive species if rock from this source is utilized.

2.6 Ecological investments and economic benefits:

Commercial and recreational fisheries: The Bad River, Red Cliff and Keweenaw Bay tribes retain rights to harvest fish from the Michigan waters of Lake Superior under the 1842 and 1854 treaties. Mark and recapture data indicate that 80% of lake trout and whitefish remain within 50 miles of the location where they were spawned (Table 7). Within 50 miles of Buffalo Reef, tribes commercially harvested 8,080,261 pounds of whitefish and 2,800,088 pounds of lake trout from 1986 to 2015 yielding a long-term average annual harvest of 269,342 pounds of whitefish and 93,336 pounds of lake trout.

[29] *Bronte, C.R., Jonas, J., Holey, M.E., Eshenroder, R.L., Toneys, M.L., McKee, P...Hess, R. 2003. Possible impediments to lake trout restoration in Lake Michigan. Lake Trout Task Group report to the Lake Michigan Committee, Great Lakes Fish. Comm.*

[30] *Fitzsimons, J.D. 1994. An evaluation of lake trout spawning habitat characteristics and methods for their detection (No. 1962). Burlington, ON: Fisheries and Oceans Canada.*

In the past fifteen years (i.e. 2001-2016), tribal catch data indicates that 37% of the lake trout and whitefish harvest in the 1842 treaty ceded area within Michigan waters of Lake

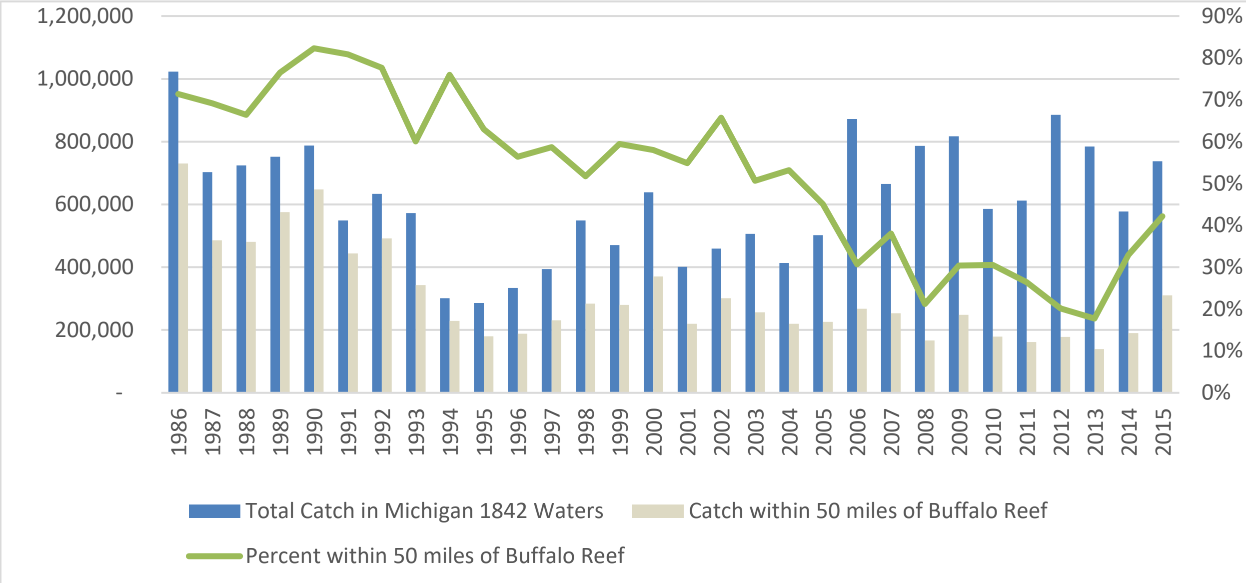

Table 7 Tribal harvests within 50 miles of Buffalo Reef.

Superior comes from within 50 miles of Buffalo Reef (i.e. 136,375 pounds of whitefish and 61,830 pounds of lake trout average annual yield 2001-2016).

Economic benefits: An economic benefit analysis has been conducted by Jeff Ratcliffe, Executive Director of the Keweenaw Economic Development Alliance (Table 8). The analysis collected tribal fish harvest data from the GLIFWC along with conversion factors for round pounds, dressed pounds and filet pounds. Surveys were conducted to ascertain price per pound prices and production costs including labor and operating costs. Recreational and Charter costs were obtained from MDNR creel data and Charter Fishing Reports.

Table 8 Estimated Economic Loss from Stamp Sands Migration at Gay

Fish	Round Pounds	Dressed Pounds	Filet Pounds
Whitefish - Tribal Fishers	173,524	148,311	74,156
Lake trout - Tribal Fishers	137,581	110,065	55,033
Whitefish - Non-tribal Fishers	63,915	54,628	27,314
Total Pounds	**375,020**	**313,004**	**156,502**
Fish	**Price Per Pound**	**Total Pounds**	**Total Costs**
Dockside WF Price Round	$1.81	237,439	$429,764
Dockside LT Price Round	$0.69	137,581	$94,931

Wholesale Price Dressed	$4.00	313,004	$1,252,016
Retail Price Filets	$12.95	156,502	$2,026,701
		Total Value of Fish	**$3,803,412**
Value of the Local Fishery			
	Rate		
Labor Value of Fishers	56% of Dockside Sales	$524,695	$293,829
Operating Cost of Fishers	40% of Dockside Sales	$524,965	$209,878
Total Value			$503,708
Industry Multiplier	1.5% of Total Value		$7,600
Total Value of Fishers			**$511,308**
Recreational Fishing			$165,543
Charter Fishing			$210,000
Total Estimated Annual Value of the Fishery			**$4,690,263**

3.0 Ranking of the Long Term Adaptive Management Plan Alternatives.

This chapter will be completed after the BRTF has evaluated comments from the public on the alternatives selected for preliminary review in the February, 2019 draft report. The BRTF will release a proposed ranking criteria and add high level cost estimates for each alternative in early summer, 2019. A public meeting will be held to take comments on the ranking criteria and cost estimates during the summer. The BRTF will release proposed alternative rankings for comment in the fall of 2019. When the field of alternatives has been narrowed down to the top few implementable alternatives, the BRTF will develop a detailed feasibility study that will include implementation cost estimates and the ecological benefits associated with the top alternatives.