Blackwood North Shore Project: Environmental Impact Statement

For

Flathead County Planning Board and County Commissioners

By

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Request: Major Variance per 5.1(A)(2a) of the Flathead County Lake and Lakeshore Protection Regulations

Environmental Impact Statement Review Elements as outlined in Review Procedure per 5.1(B)(2)

5.1 (B)(2)(b) 1): Description of the Proposed Project

Rick and Robin Blackwood own property on the North Shore of Flathead Lake near Bigfork (Fig. 1). This property has a severe erosion problem (Fig. 2) that they would like to stop by using a soft structure gravel beach approach that mimics shoreline restoration steps taken by the USFWS and MTFWP on those water fowl production (WPA) properties immediately to the west (Fig. 3). The Blackwood's approach is to utilize the concept of a recurved spit (Fig. 3 inset) to perform two functions; 1) stop the loss of land by stabilizing the shoreline and 2) provide protection from waves and the coupled battering action of logs for their existing dock. They also wish to contain the gravel that they place on their property. The restoration goal is to allow the waves and natural plant colonization do the work of shoreline restoration once the shoreline position has been stabilized with gravel and cobbles.

This shoreline restoration plan is intended to work with the existing processes of river currents and lake waves. These processes deliver new logs each year including the production and along shore drift of fine sediment and wood chips referred to as peat, and the deposition of wind-blown sand during lake drawdown. During lake draw-down, the lake bed is exposed and hence winds blowing over the exposed lake bed transport large volumes of sand. The wind-blown sand tends to deposit on the top backside of the gravel beaches bordering the wetland complex. This process of wind depositing sand and silt encourages colonization of riparian plants including rush, sedges, grasses, herbaceous plants and shrubs (see inset Photo B in Fig. 4 and Fig. 11). The peat is a dark fine-grained organic material that collects on shore and in the waters immediately lake-ward of the shoreline. It is formed as log rafts build along the shoreline and as logs abrade each other with each storm. It is anticipated that the peat like material and logs will over the years fill in the spit embayment (Fig. 4 yellow stippled areas) and naturally become colonized with riparian and wetland plants in the same manner that has occurred on the WPA to the west (Fig. 3 and inset Photo C Fig. 4).

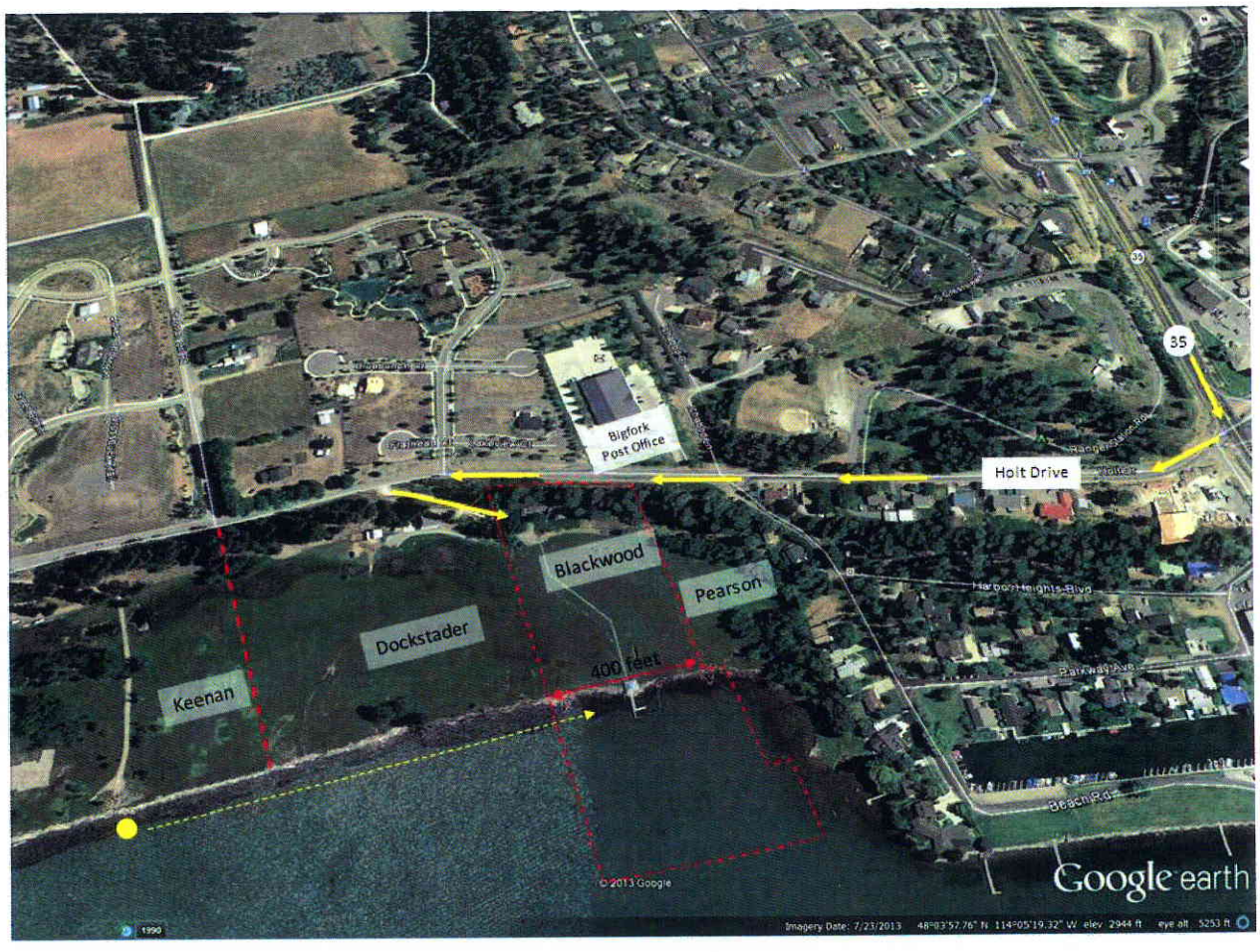

Figure 1. A location map showing the Blackwood property (red polygon) relative to neighboring properties along Holt Drive in Bigfork, MT. The existing haul road on the Keenan property will be used to bring material to the lake bed (yellow dot). Material will then be hauled across the lake bed (yellow dotted line) using a tracked haul-truck. Permission from the Dockstaders has been obtained.

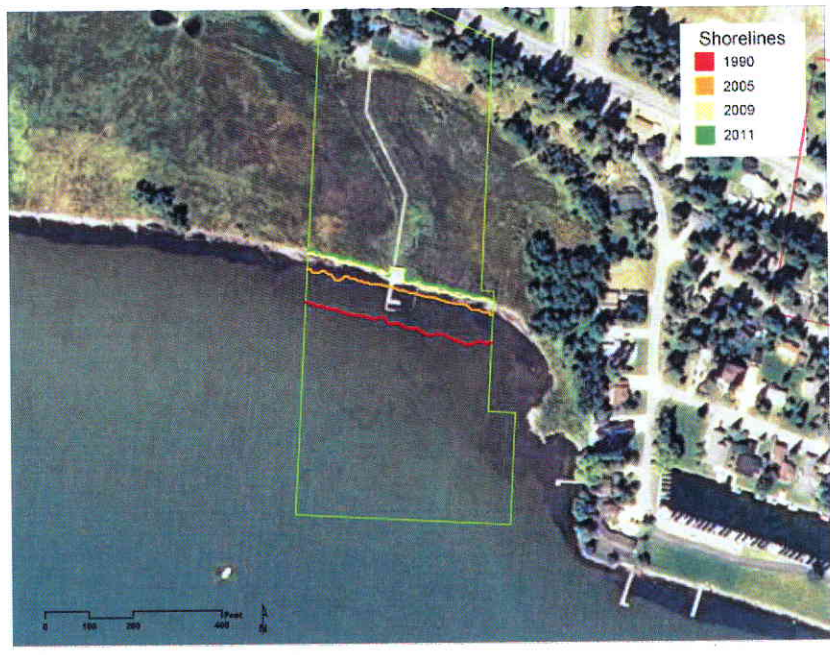

Figure 2. This graphic shows the Blackwood property (green polygon) and position of historical shoreline locations illustrating the extreme loss of land and associated wetland habitat (approximately 200 ft. since 1990).

Figure 3. This graphic is a July 23, 2013 aerial image of the North Shore. The insert shows a close-up of the spit constructed in 2009 on the USFWS (WPA) land. This structure is the design feature chosen for the Blackwood property. It will provide shoreline stability plus trap logs and peat material allowing natural shoreline restoration processes to develop additional wetland habitat while improving water clarity.

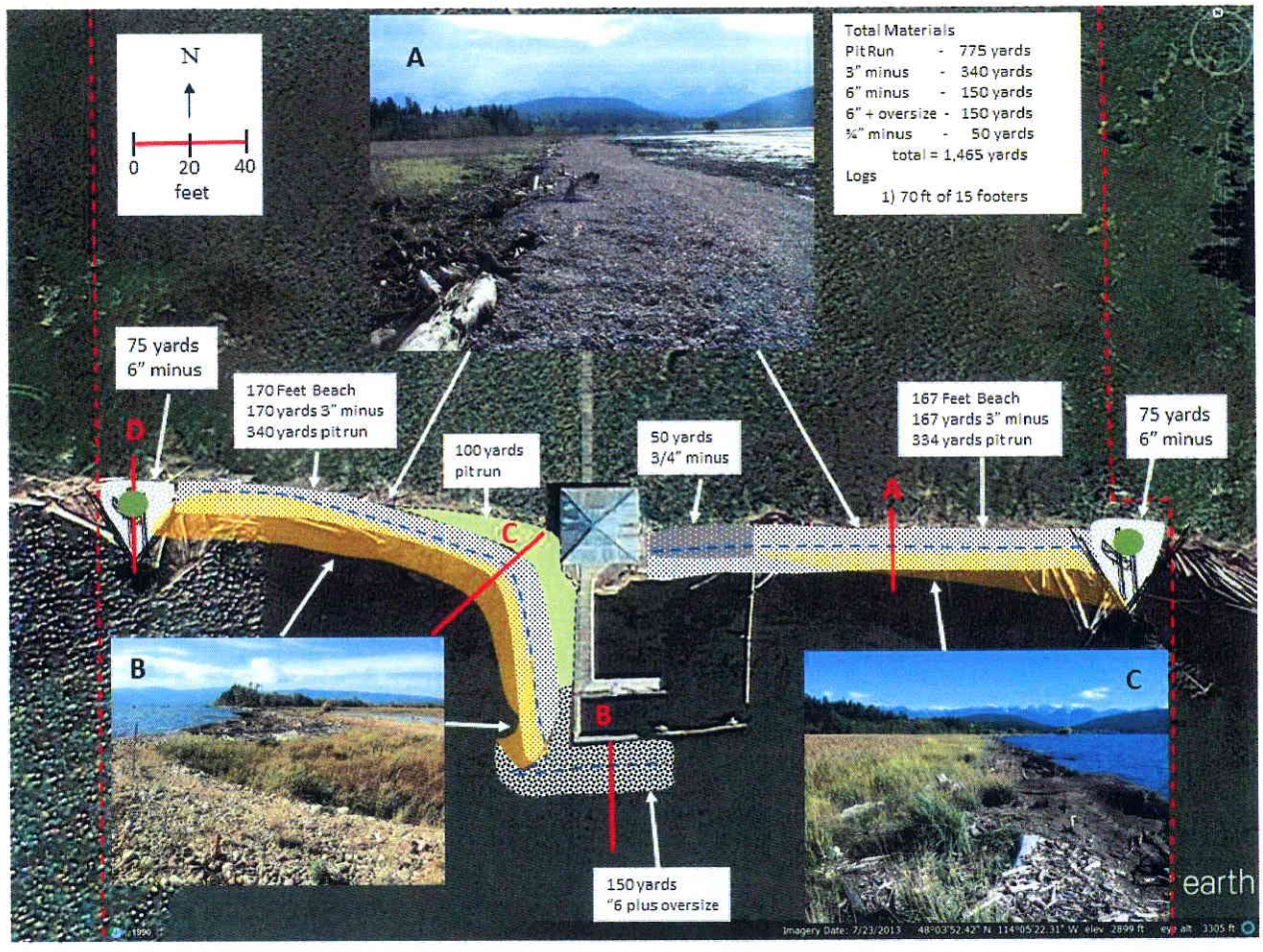

Figure 4. This plan view of the Blackwood shoreline restoration project shows location and spatial extent of all material, including size and volumes. Blue dotted line shows position of full-pool water line. The red lines with letters correspond to cross-sections shown in Figs. 6 and 7. Inset Photo A depicts what the shore attached gravel beach (diagrammed in Fig. 6A top cross-section) will look like following construction and before 2014 full pool season. Yellow stippled areas depict extent of expected future buildup of logs and peat material followed by natural recolonization of wetland plants similar to what has occurred on the WPA properties. Inset Photos B and C both taken October 4, 2013 show what the Blackwood beach and shoreline will look in 5 to 10 years. Photo A was taken in March 2007 and Photo C was in the same location 6 years later.

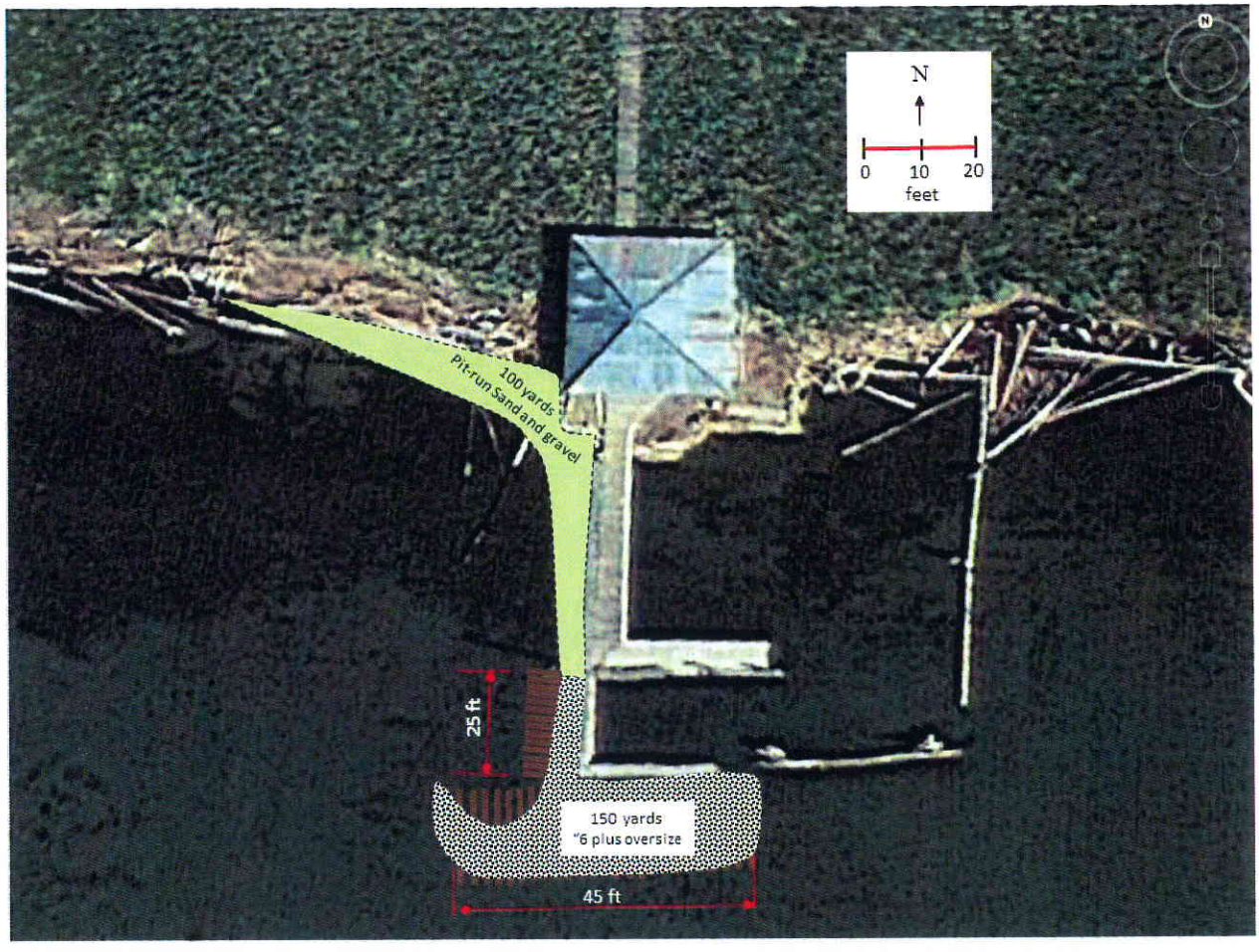

Figure 5. This July 23, 2013 photo shows phase 1 of construction, the placement of logs on the lake bed, plus location of cobble piled against the dock. These rocks will form the inner wall of the spit.

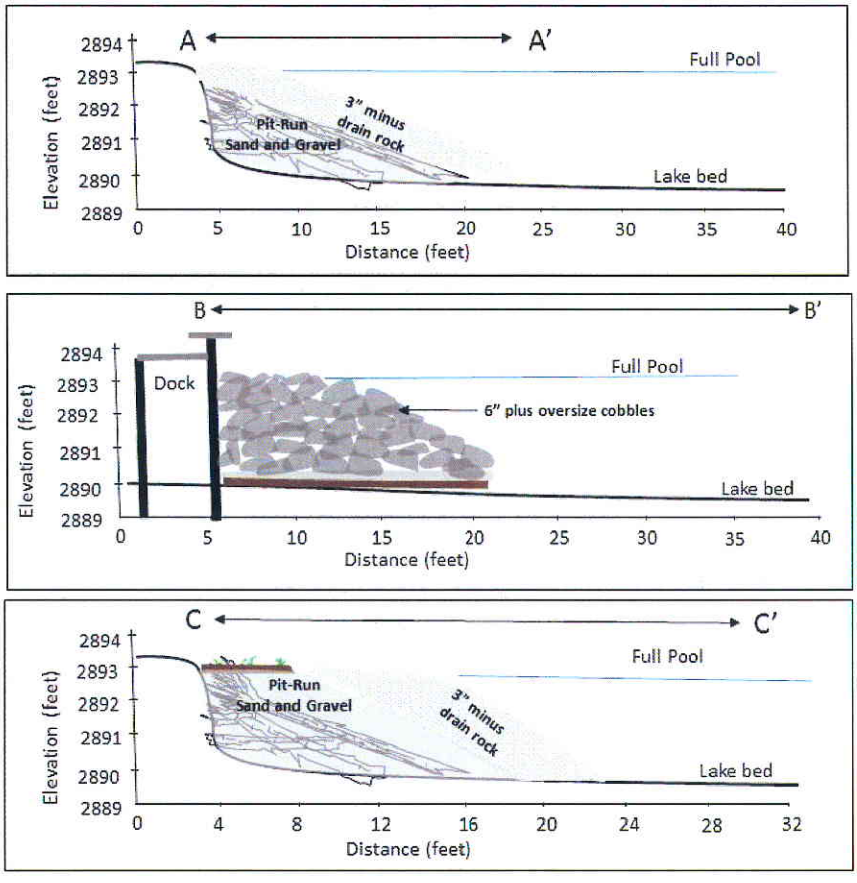

Figure 6. Cross-sections A, B and C of the proposed project corresponding to locations depicted with red lines in Fig. 4.

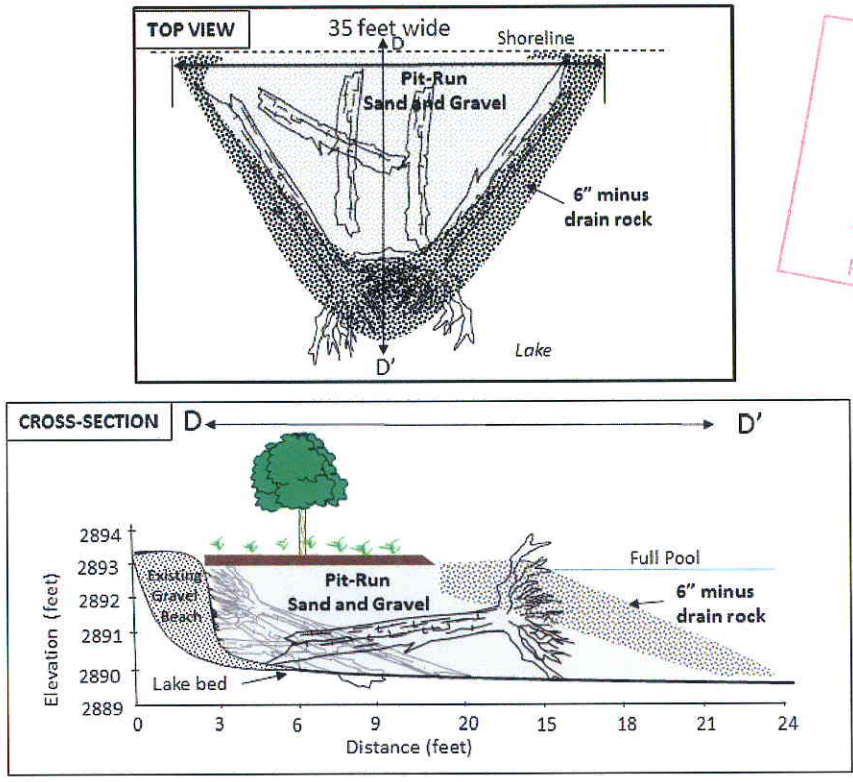

Figure 7. Plan view (top) and cross-section view of each V-end structure located near property boundaries as shown in Fig. 4. These structures will prevent loss of gravel to neighboring properties and protect property ends from shoreline erosion.

5.1 (B)(2)(b) 2): Description of and the reason for, the major variance being considered

THE DESCRIPTION OF THE MAJOR VARIANCE: We are requesting to place 3.6 cubic yards per foot of shoreline for a total of 1,465 cubic yards of gravel and cobble material on the lake bed. This amount exceeds the minor variance threshold.

This variance request is in response to the Flathead County Board of Commissioners decision to deny the request for a minor variance as described in Lakeshore Variance Permit # FLV-13-12. Hence, we are addressing the concerns of the Commissioners as outlined in the Board of Commissioners Letter dated 1-22-2014 and preparing this Environmental Impact Statement.

We are requesting to be allowed to use the same volume of gravel material per linear foot as used to stop erosion on neighboring private land and neighboring State and Federal land. Nearly 2 miles of the North Shore of Flathead Lake have been protected using these volumes of gravel/cobble material per foot. Indeed, the Army Corps of Engineers has already granted the Blackwood's a 2014 permit (see attached). Moreover, this request for variance is in keeping with the Kerr Project Partners decision (see attached FERC Approval of North Flathead Completion Report 021114) as it directly

underscores the in depth review and oversight the gravel beach / cobble spit approach has had over the years beginning in 1985. Moreover, the Kerr partners stand in agreement that rip-rap and seawalls are not viable alternatives to stop erosion on the North Shore. That is precisely why these gravel/cobble alternatives were chosen and given variance to the Flathead County Lake and Lakeshore Protection Regulations 4 F(2) h 1-10. The first variance to these regulations (4 F(2) h 1-10) were granted by the Flathead County Commission in 2005 and the latest in 2013. The only conclusion that can be made here is that Flathead County Lake and Lakeshore Protection Regulations 4.3(F)(2)(h) (1-10) are not adequate and or applicable to the North Shore. That is precisely the conclusion of this Kerr Partner group including the past and recent Flathead County Commissioners (see article 75 in attached FERC Approval of North Flathead Completion Report 021114) all backed by over 3 decades of research on the North Shore by the University of Montana, Flathead Lake Biological Station.

The reason we are requesting a major variance from Flathead County Lake and Lakeshore Protection Regulations 4 F(2) h 1-6, is straight forward and extends much beyond past decisions. These regulations do not serve the needs of land owners that have lake shorelines or reservoir shorelines where water level is controlled by a dam and the shorelines are eroding, especially eroding wetland shorelines. They simply do not allow for property owners to both protect their property and the eroding shoreline that fish and wildlife habitat depend upon. Moreover, these regulations drive owners toward hard structures like rip-rap and seawalls that cause damage to neighboring properties and ecological harm to the lake. Hence, the Blackwoods only recourse is to ask for a major variance.

Fundamentally, one of two actions needs to be taken by Flathead County in order for homeowners to protect their property and that is

1) Change the Flathead County Lake and Lakeshore Protection Regulations 4 F(2) h 1-6.
Or
2) Allow a major variance to these regulations on a case by case basis as requested.

The Blackwoods are asking for a major variance to the Flathead County Lake and Lakeshore Protection Regulations 4 F(2) h 1-6, because they want to follow the most ecologically sound approach possible to stop the loss of property and restore as much of this critical land as possible. Hence, they have contracted with the University of Montana, Flathead Lake Biological Station to provide the best plan possible to achieve both of these goals 1) protect their property and 2) restore as much critical wetland habitat as possible. And they want to be able to be treated in same manner as other private citizens that have used the gravel beach approach and the Federal and State land owners that have also used these techniques. Indeed these gravel beach and cobble spit techniques have been proven to work and proven to have clear ecological and water quality benefits to the lake. That is fundamentally why the variance requested to Flathead County Lake and Lakeshore Protection Regulations 4 F(2) h 1-6, should be granted as an appropriate, fair and consistent ruling by the commissioners.

This EIS addresses each section of Flathead County Lake and Lakeshore Protection Regulations 4 F(2) h 1-6 as they specifically pertain to the need to exceed volume and depth standards, and add rock where current regulations do not allow and as specifically requested by the planning board.

4F(2)h (1). *Application of rock is allowed where the predominate existing surface is gravel.*

- The site is a sand lake bed produced by a river delta over the last 10,000 years, hence we cannot change the geologic setting.

4F(2)h (2). *Application of rock is not permitted in the following areas: wetlands and sites subject to strong wave action or currents; sites covered predominately by vegetation; or below average low water.*

- The site is approximately 7 feet above average low water and is lakebed is completely absent of vegetation. It is a barren sand bed due to the extreme level of wave erosion that is removing the existing wetland.
- The wetland is exposed to strong wave action that is precisely why it needs the volume of gravel and cobbles requested to combat that wave action through forcing of wave breaking and swash action offshore and away from the shoreline. Details of this are explained further below in this EIS. Strong currents competent to transport gravel (e.g., as defined in Lorang and Hauer 2003 and 2006) and measured with an Accoustic Doppler current Profiler (results reported in Lorang 2007) do not exist at this site.

4F(2)h (3). *Placement of fill directly into the waters of any lake is prohibited.*

- No material will be placed directly into the waters of the lake.

4F(2)h (4). *All fill shall be clean, washed rock with a minimum diameter of ¾ inch and a maximum diameter to be determined at the time of on site inspection free of silts, sands and fines. Rock type, size and color shall approximate that existing on the adjacent lakeshore.*

- Two goals exist for this project beyond the protection of property loss; 1) improve the water quality over current conditions and into the future 2) encourage natural colonization of wetland plants to restore the loss of important wildlife habitat. In order to achieve goal 1, erosion of the wetland and subsequent introduction of those nutrient rich sediments must stop. Hence, we are proposing to build a beach in front of the eroding wetland shoreline that will stop both the resuspension of sediments and the reintroduction of new nutrient rich sediments in accordance with the research findings of FLBS (Hauer et al. 1988, Lorang and Stanford 1988), and thereby improve water quality now and into the future. The core of the beach needs to be pit run material containing sands and silts because wetland plants cannot colonize and grow in washed gravel. These plants need sands and silts in the interstices of the gravel from which their roots can establish, grow and allow the plants to thrive as demonstrated on the State and Federal lands (see Figs. 4, 10, 11 and 13). The cover layer will be clean gravel screened of sands, silts and fines. This layering mimics gravel beaches found around Flathead Lake as well as those throughout Flathead County including Glacier Park.
- Rock type, size and color will exactly represent gravel beaches found throughout Flathead Lake. Rock size, volume and location has been specifically designed (Figs. 4 and 6) based on wave energy, water depth and degree of dynamic response as outlined in research papers on this topic (Lorang 1991, 2000 and 2002).

4F(2)h (5). *Maximum fill depth is four to six inches.*

- This regulation is arbitrary and fundamentally flawed. If the maximum depth at the shoreline was four to six inches, the maximum physically possible wave height would be 70% of those depth limits or up to 4 inches. Hence, maximum wave heights could only reach 4 inches, and under those conditions, there would not be an erosion problem in the first place.
- Survey transect data from the site show in Fig. 6 that the elevation of the lake bed at the inflection between the lake bed and the marsh bank is approximately 2890, which makes summer-time water depth during full pool regulated lake level to be approximately 3 feet deep. Clearly a variance is required in order to make a beach that causes waves to break offshore dissipating the wave energy away from this bank. This is an example of a regulation being out of touch with the reality of the volume of fill required for a gravel beach or rip-rap and seawall alternatives for that matter. Ironically, both rip-rap and seawalls are shore protection alternatives that the Flathead County Lake and Lakeshore Protection Regulations allow.

4F(2)h (6) *The volume of fill shall not exceed one cubic yard per sixteen lineal feet of lake frontage.*

- It is impossible to adhere to this regulation even if rip-rap or seawalls were the chosen option. Again, this is a case where the Flathead County Lake and Lakeshore Protection Regulations are in direct contradiction and consequently drive shore protection design towards rip-rap and seawalls as the only permitted solutions for stopping or preventing shoreline erosion.
- We will need a variance to this specific regulation in order to build a beach that through its dynamic behavior of adjusting to wave action from storm to storm will naturally dissipate wave energy and hence stop erosion..

THE REASON FOR A MAJOR VARIANCE is that the proposed project is the only viable solution available to the Blackwoods **TO PREVENT CONTINUED MAJOR LOSS OF LAND AND PROPERTY** due to shoreline erosion. The North Shore has suffered the highest level of shoreline erosion and loss of land compared to any parcel of land in Flathead County (Fig. 8). And the Blackwood property is a small piece (~400 ft) of the 2 ½ miles of North Shore that have used gravel beach approaches at the volumes being requested in this variance. Indeed while the Blackwoods are being denied a permit, nearly 3 times the volume of material per foot has been used on the USFW service and MTFWP property.

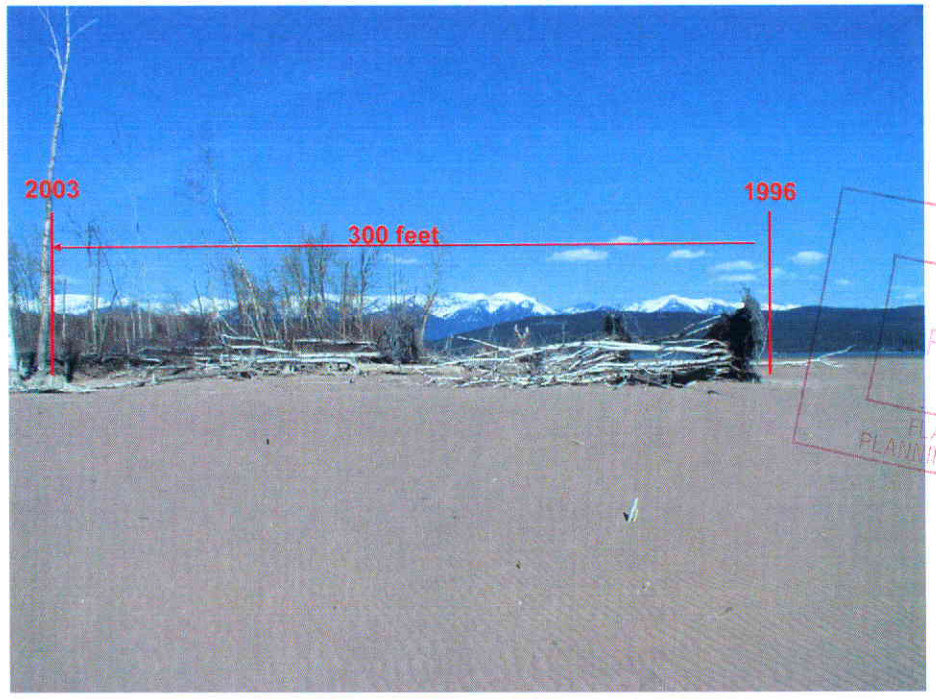

Figure 8. This photograph of the North Shore taken in May 2003 clearly shows the severity of erosion. Every tree and patch of riparian vegetation in this photograph is now gone and what is left is flat sandy lake bed that is essentially an ecological desert. The exact same situation exists on the Blackwood property.

The reason why the neighboring North Shore properties have received permits from all local, State and Federal agencies to build gravel beaches and cobble spits is because it is the best solution and one that has been vetted over the past decade by all agencies. These North Shore erosion control and shoreline restoration projects, and the proposed Blackwood project, follow results and findings from over 3 decades of scientific research conducted by the University of Montana, Flathead Lake Biological Station (Lorang 1984, Lorang and Stanford 1988, Lorang 1991, Lorang et al. 1993a&b, Lorang and Stanford 1993, Lorang 2000, Lorang 2002, Collins 2005, McPhillips 2006, Shultz 2006, Dupuis 2007, Silverstein 2007, Lorang 2007, Lorang 2013). The completed projects have clearly demonstrated the benefits of using gravel and cobbles as proposed for this project for stopping erosion, improving water quality, and enhancing nearshore aquatic, riparian and wetland habitat.

Hence, the shore protection design presented as a solution to the Blackwood property utilizes a well demonstrated alternative approach for stopping erosion, improving water quality and restoring important wetland habitat on the North Shore of Flathead Lake. At the same time the design provides protection for existing structures that were previously approved by Flathead County Board of Commissioners and constructed on the property. This approach was been well vetted by the Army Corps of Engineers (ACOE), the Montana Department of Environmental Quality, Flathead County Conservation Corps and past Flathead County Planning Board and Board of Commissioners. Indeed, initial conceptual design ideas were first developed by the University of Montana in the fall of 2006 in consultation with PPLM, CSKT, USFWS and MFWP referred to as the North Shore Working Group (NSWG). These design ideas were then fully developed into a final design plan of action (Lorang 2007. *Conceptual Soft Structure Plan or the North Shore of Flathead Lake: Erosion Control and Nearshore Aquatic/Wetland Habitat Restoration* U of M Final Design Report). The plan agreed

upon by the NSWG was to build the shore protection structures in a series of phases from 2007 to 2013 and then monitor thru 2014.

The ACOE issued a section 404 permit (ACOE No. NOW-2007-00744-MTM) for the entire North Shore WPA project in January 2008 and an additional permit to place fill on February 7, 2013. Flathead County issued a separate lakeshore permit for the restoration work in January 2012 and an additional lakeshore permit (#flv-13-01) on February 19, 2013. Flathead County officials conducted an inspection of the completed project on March 1, 2013. The FCCD, MFWP and MTEPA were consulted throughout the permitting process. MFWP, USFWS and CSKT were also involved in all design planning and permit support. The USFWS issued special use permits each year for all WPA erosion beach and backshore habitat construction work. Lastly, the Army Corps of Engineers on 2-11-14 issued a permit (Corps No.NWO-2103-02499-MTM, signed copy attached) authorizing the Blackwoods to "construct a dynamic equilibrium beach and cobble spit around the existing dock".

In conclusion, **THE REASON FOR A MAJOR VARIANCE** is to allow Rick and Robin Blackwood to protect their land and property plus enhance the shoreline habitat in the same manner as the other neighboring private, State and Federal landowners. It is a fair request and consistent with nearly a decade of permits issued for the North Shore. The Blackwood project is the first one that has ever been denied; hence we hope that the 2014 Flathead County Board of Commissioners find sufficient information to approve this major variance request.

5.1 (B)(2)(b) 3): Description of the existing conditions

Specific conditions at the Blackwood property are that water depth against the marsh bank as shown in survey transect data (Fig. 6) is approximately 3 feet deep during maximum full pool conditions. Water depth is the ultimate control on wave height. Offshore deep water waves can vary as a function of wind speed, direction and duration; however, the wave power available at the shoreline is limited by water depth. Waves can get bigger offshore, but that means they will simply break further offshore. Lake seiches can elevate the water depth by up to a foot at the specific Blackwood location (Morrison et al. 2005). Hence maximum wave height impacting the shoreline would be approximately 70% of the full pool water depth (3 ft) plus the seiche elevation (1 ft). Therefore maximum significant wave height (mean of the highest 1/3 a design wave ht criterion) would be approximately 3 ft. In addition, these specific sites are exposed to the maximum fetch of the lake and dominant wind directions from both the south and west. Hence the long-term cumulative wave energy is the greatest at the Blackwood location, and it is why the shoreline erosion and loss of land is so severe at this specific site. Boat wakes also contribute to the wave climate at the Blackwood property because the property is located near Bigfork Harbor and increased boat traffic. Research has shown that boat wakes can cause up to 0.01to 0.22 mm of erosion along these types of unconsolidated banks (Bauer et al. 2002). While this might not seem like an erosion problem, hundreds and perhaps 1000s of boat passages over the course of the full pool summer season do can add up to a significant portion of the total land loss.

In addition, the water depths and hence wave conditions at the Blackwood's match very closely with the location of the cobble spit bordering the USFWS and MTFWS (Figs. 3 and 10). That is why the spit proposed for the Blackwood's is designed specifically after the WPA spit with design adjustments that take into consideration the dock on the Blackwood property and wave power. of gravel and cobble is required for the Blackwood spit as compared to the WPA spit.

The far western spit on the WPA near the river mouth (Fig. 3) required over 8 cubic yards per foot to build even though the cumulative deep-water wave energy is less than the Blackwood property (see Figure 7 in Lorang 2007). More material was required for the WPA spit than is requested for the Blackwood property because the WPA spit lies in much deeper water where the wave power is much greater.

In addition to the wave power being high, the existing conditions are one where numerous logs and wood debris line the marsh shoreline (Fig. 9). In the last 14 years since 1990, this shoreline has eroded back over 200 feet due to wave erosion (Fig. 2), and if left unprotected, it will move back another 10 to 15 feet this coming 2014 full pool season. This mass of floating logs becomes a battering ram, even under small wave conditions that occur daily due to thermally driven winds, and are rapidly destroying the dock and damaging the beach house as well as eroding the marsh shoreline. Details of these shoreline erosion processes can be found in past research on the topic (Lorang et al. 1993a & b). The only solution to stop erosion and protect the existing structures is to build the proposed gravel beach and cobble spit. Piling docks and walk ways cannot survive the battering without the added protection afforded by a gravel beach or cobble spit. The gravel beach and cobble spit proposed for the Blackwoods not only stops erosion and protects the structures, but also allows the logs and debris to anchor on a solid base that in turn allows natural shoreline restoration process to take hold and create new and valuable wetland habitat (Figs. 4, 10 & 11) (Lorang 1991, Lorang et al. 1993a&b, Lorang 2007).

Figure 9. A high resolution, July 13, 2013, Google Earth image of the Blackwood property showing the extensive mass of logs and wood debris plus. Note the eroding shoreline has nearly moved past the beach house. This shoreline was in front of the beach house when originally constructed.

Figure 10. A high resolution July 23, 2013 Google Earth image of the cobble spit built on the neighboring North Shore property. This spit is larger and contains nearly 3 times the volume of gravel material than the one requested in the Blackwood project. Note the natural development of riparian/wetland vegetation in the spit embayment. This is precisely what will happen on the Blackwood property.

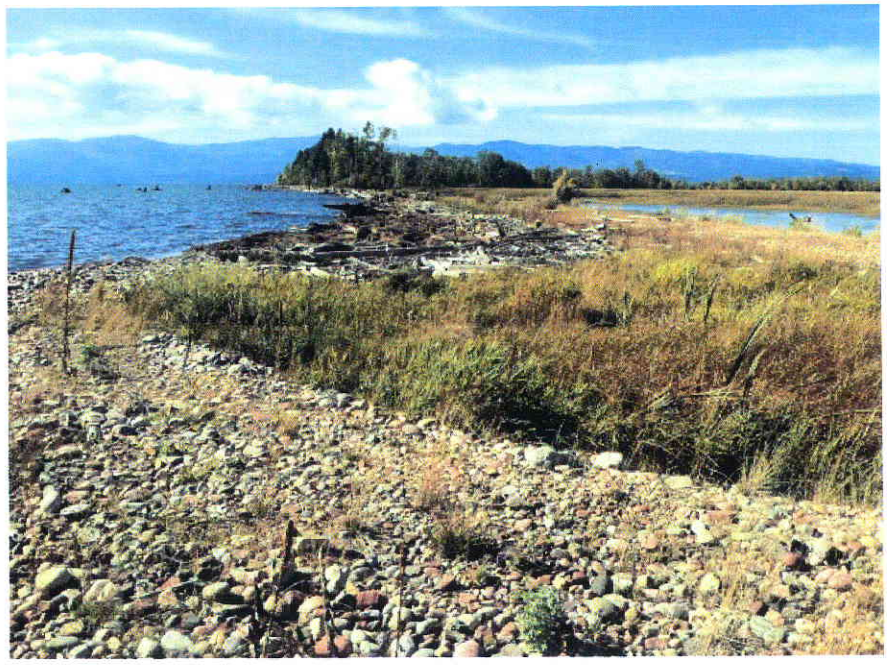

Figure 11. A ground photo of the spit shown in Fig. 10 taken on October 4, 2013 that shows the result of the natural recolonization of wetland and riparian vegetation that has occurred since the spit was constructed in 2008. This process will continue into the future naturally reclaiming lost wetland habitat and it will do so without human intervention and at no additional cost to anyone.

5. 1 (B)(2)(b) 4): Description of anticipated impacts as they relate to each of the Policy Criteria in Section 4.1

Section 4.1 (A) Materially diminish water quality

The Blackwood project, if completed will greatly enhance and improve the water quality by reducing nutrient loading into Flathead Lake caused by the resuspension of fine sediments and introduction of fine sediment from the eroding marsh as documented by the research conducted at the Flathead Lake Biological Station (Lorang and Stanford 1988). Moreover, the State of Montana has thoroughly reviewed the past projects and this particular project as part of the ACOE permit and issued state water quality approval for the project, thereby allowing ACOE to issue a permit.

Section 4.1 (B) Materially diminish habitat for fish and wildlife

The Blackwood project, if completed will greatly enhance and improve habitat in this area of Flathead Lake as demonstrated by National Science Foundation research conducted by the University of Montana's Flathead Lake Biological Station (Collins 2005, McPhillips 2006, Shultz 2006, Dupuis 2007, Silverstein 2007).

Section 4.1 (C) Interfere with Navigation or other lawful recreation

The Blackwood project as proposed will greatly improve safe navigation and recreation in this area of the north shore. Under current conditions the vast mass of floating logs (Fig. 9) proves to be a very real threat to boating in this area. This issue will be solved once the gravel beach and cobble spit are in place allowing the waves to push these floating hazards on to stable ground.

Section 4.1 (D) Create a Public Nuisance

The current conditions of the shoreline as shown in the photograph below (Fig. 12) are a public nuisance. The public is allowed to walk on the exposed lakebed and are attracted the mass of logs against the marsh shorelines. Walking across these logs is very hazardous. If the proposed project is allowed to be constructed this public nuisance will go away.

Figure 12. This is a photograph taken in January 2014 of the logs fronting the Blackwood property.

Section 4.1 (E) Create a visual impact discordant with the natural scenic values, as determined by the governing body, where such values form the predominant landscape elements; and

The project as proposed will not create a visual impact discordant with the natural scenic values as depicted in Fig. 12. The Blackwood shoreline will look like the other North Shore shorelines that have used gravel beach and cobble spit treatments to stop the erosion (Figs. 13, 12, 11, 10 and 11).

Figure 13. The photograph on the left taken in March 2007 shows what 3.6 cubic yards per foot looks like immediately after placement of the gravel. The photograph taken at the same location but on October 4, 2013 shows what the Blackwood shoreline will look like in the future after waves have piled logs, wood debris and peat on to the beach, which has completely buried the gravel. Note the clear water in the photograph on the right. This photograph provides a visual demonstration of how this proposed treatment will improve water quality over current conditions while also maintaining visual continuity with the current landscape setting.

Section 4.1 (F) Alter the characteristics of the shoreline.

The only characteristic of the current shoreline that will be altered is that erosion will stop. Hydrologic structure, function and connection to the wetlands and the lake will remain.

5.1 (B)(2)(b) 5) Alternatives to the proposed project, which would not require a major variance:

Here are the alternatives:

1) No action
    a. This would result in continued major loss of land and associated wetland habitat and loss of private property consisting of the existing dock and gazebo.
    b. In addition it would result in continued input of nutrients from the resuspension of sediments during every wave event and the continual input of new nutrient rich sediments from the eroding wetlands.
2) Seawall and or rip-rap
    a. These hard alternatives have severe negative impacts to lake ecology and accelerate the erosion and loss of land to neighboring properties.

3) The amount and depth allowed
    a. The allowable amount and depth of rock fill allowed is insufficient to stop the erosion.

There are no other alternatives that would not require a major variance. Rip-rap and sea walls (Fig. 14) are both hard structure alternatives that are traditionally used in shoreline erosion situations. However, in the case of these proposals, sea walls and rip-rap (Fig. 14) have been deemed inappropriate for erosion control along the marsh wetland shoreline composing the North Shore as outlined in sections above and additional reports (Lorang 2007 and 2013).

All of the issues listed in section 4.3 (F)(2)(h) (1-10) have been addressed in over a decade of scrutiny through Federal, State and Flathead County permitting processes. Moreover the 2005 Flathead County Board of Commissioners were pioneers in allowing variances to these regulations so that gravel beaches could be built and their utility demonstrated.

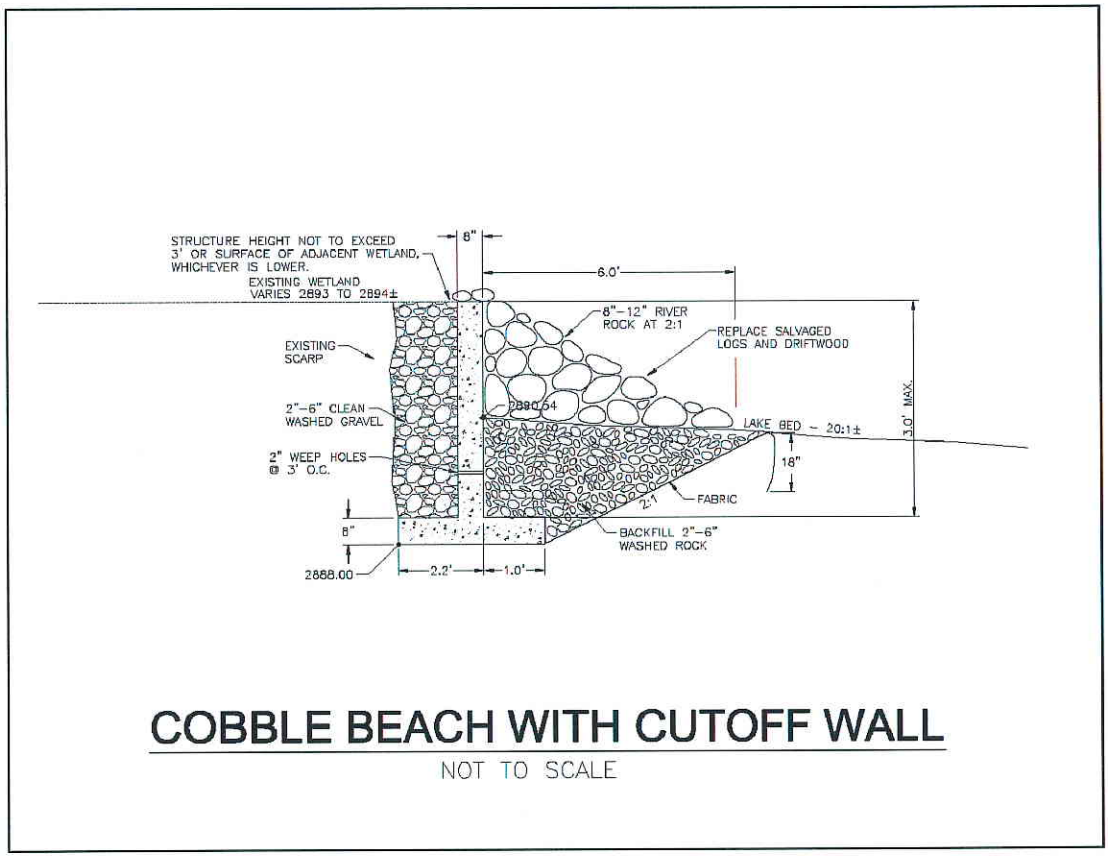

Figure 14. A cross-section of a traditional shore protection approach deemed inappropriate for the North Shore by the Army Corps of Engineers, USFWS, MTFWS, State lands and water quality agencies, FCCD, CSKT, and the University of MT FLBS.

There are many reasons that rip-rap and sea walls have been deemed inappropriate. In the case of concrete sea walls as depicted in Fig. 14, these structures completely cutoff the direct hydrological connection with the lake, thereby fundamentally destroying the structure and function of interconnected lake-wetland ecosystem. This is in part why the North Shore combined sea wall and

rip-rap (Fig. 14) was denied. In addition an equally important reason for not allowing sea walls and rip-rap along the North Shore is the harm that they create by accelerating the rate of erosion to neighboring properties due to the reflection of wave energy from these hard structures (Fig. 15). Mathematically wave energy (E) is expressed in the following manner:

$$E = \frac{1}{8}\rho g H^2$$

where ρ is the density of water, g acceleration due to gravity and H is wave height. How this equation is linked to lake level regulation and applied to the North Shore in regards to erosion can be found in Lorang et al. 1993b. When waves strike a sea-wall or rip-rap, the reflected wave travels offshore and meets the next set of incoming waves. This increases wave heights in front of the structure and exponentially increases the energy as shown by the energy equation above. The result is scour to the lake bed in front of the sea wall and accelerated erosion to: either side of the structure, up to 70% of the structure length along shore and 10% of the structure length inland (Fig. 15, Lorang 2000, 2002 and references therein). In the case of the North Shore, this would accelerate the loss of valuable wetland and wildlife habitat. However, the ultimate impact is the domino effect that seawalls cause because once a section of sea wall or rip-rap is built, the neighboring properties are forced to also build such hard structures to combat the accelerated erosion problem, thereby transferring the problem along the shore. Scour in front of the hard structures is also a problem in that the benthic community (aquatic plants and insects) can no longer survive on the lake bed. This then transfers to negative impacts for juvenile fish that rear and feed in the shallow shoreline environments of the lake. Research by the University of Montana on this very topic has shown that gravel beaches and cobble spits greatly improve both aquatic and wetland habitat thereby increasing benthic diversity, (Collins 2005, Shultz 2006) juvenile fish (Collins 2005, Dupuis 2007) and eventually song bird populations (Silverstein 2007).

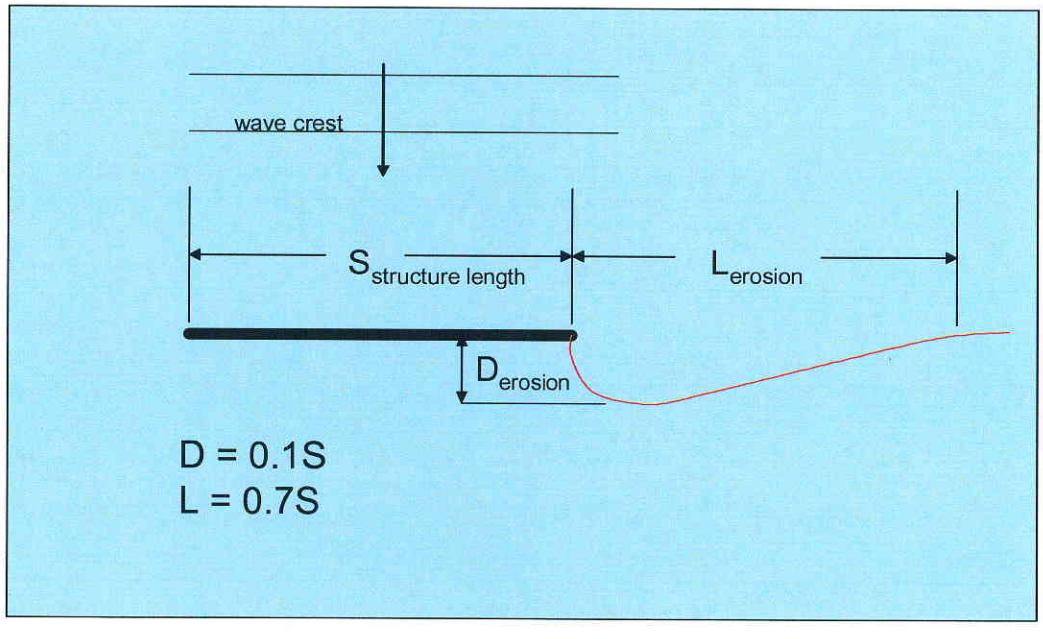

Figure 15. A schematic drawing depicting the "end-scour" (red line) that occurs to neighboring properties (the impact occurs to both sides of the structure) as a function of the structure length.

The reason that gravel beaches do not cause these types of scour and erosion issues is because beaches react in a dynamic nature to wave action (Fig. 16). Waves break offshore away from the shoreline dissipating energy through the wave breaking, the friction associated with swash run-up and energy extracted during the transport of gravels forming a beach crest and a step (Figs. 16 & 17). The step forms at the point where backwash meets the next breaking wave resulting in the increased build-up of gravel forming the step that in turn forces more wave breaking and energy dissipation. This feedback mechanism of the a gravel beach protects the backshore from erosion while not scouring the lake bed offshore or accelerating erosion to neighboring properties. Hence, it is the preferred alternative shore protection measure and the reason why it has been used on the North Shore for nearly a decade and throughout Flathead Lake (Figs. 19, 20 & 21). Indeed, the City of Polson working in collaboration with the Confederated Salish and Kootenai Tribes (CSKT) and Lake County Board of Commissioners and the University of Montana, Flathead Lake Biological Station removed a sea wall at Salish Point and built a gravel beach built in its place that now serves as a popular public swim beach and City Park (Fig. 20).

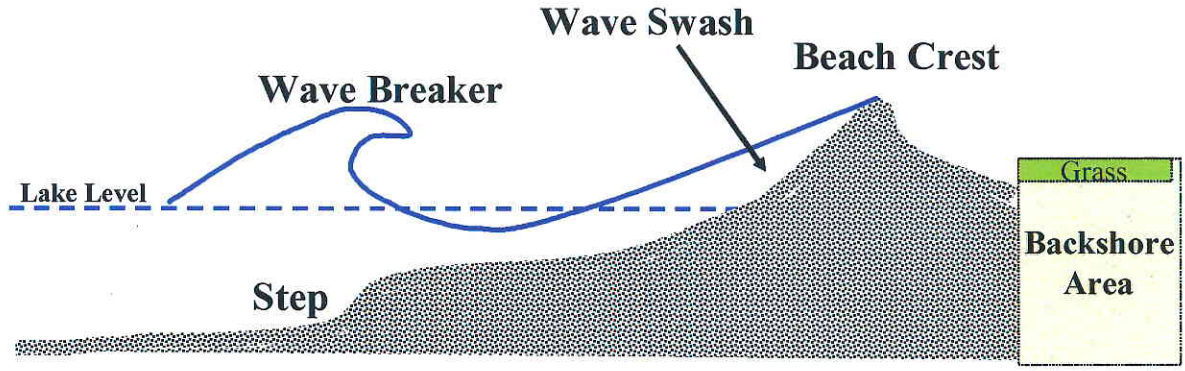

Figure 16. A schematic that depicts gravel beach morphology and related wave dynamics. This coupled feedback process results in the dissipation of erosive wave energy away from the backshore area a process that prevents the loss of land and private property.

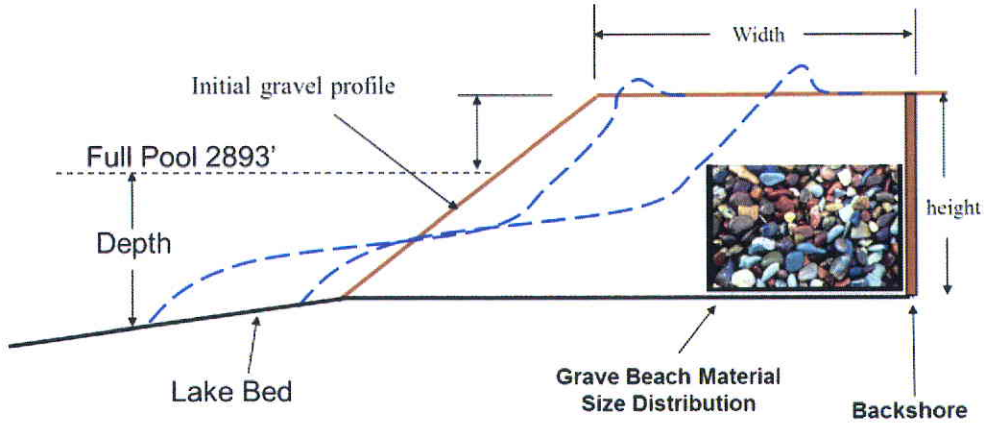

Figure 17. This schematic depicts the width, height and hence volume of gravel needed to make a beach. The blue lines depict how the waves will rework the gravel material into a step and beach crest adjusting in form to storm wave events. For the North Shore, 3.6 cubic yards of material are required to allow a beach to develop. Figures 18 and 19 show measured results from the first gravel beach built on the North Shore and permitted by the Flathead County Board of Commissioners in 2005. Note that waves build a crest to an elevation of 2894', approximately 1 foot above the regulated full pool elevation (Fig.19).

Figure 18. Top photograph shows North Shore property in 2005 after a single major storm event eroded the shoreline back approximately 6 feet. The shoreline prior to the storm was at the edge of the tree that is now in the lake. Note in the top photograph, the floating logs on the bank that gouge the soils of the bank cause further erosion. The bottom photograph was taken a few weeks later after construction of the gravel beach. Note logs and wood debris being pushed up on to the beach stranding them there and hence eliminating the ramming affect that causes erosion and damages docks.

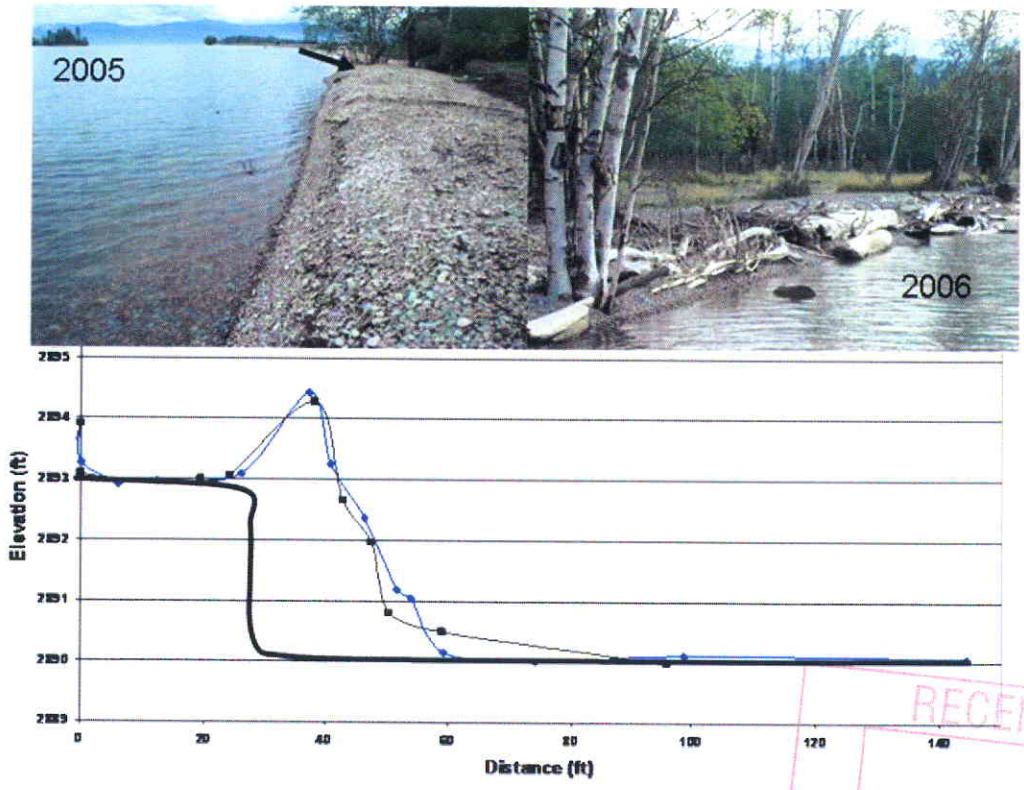

Figure 19. Photographs of the same North Shore property shown in Fig. 18, but comparing 2005 and 2006 and plots of survey transect data of these beaches after waves have had a chance to build a beach crest. This project was permitted by the 2005 Flathead County Board of Commissioners (FCBC). The foresights of that board actually lead the way for the adoption of gravel beaches as a shore protection alternative. That coupled with the willingness of the private landowner to try and do what was best for Flathead Lake. Note the logs incorporated into the beach by wave action in the 2006 photograph (upper right). Now instead of causing erosion they are helping strengthen the beach. This science-based solution derived from observing natural gravel beaches around the lake, and then applying these lessons is depicted in Figs. 18, 19, 20 & 21.

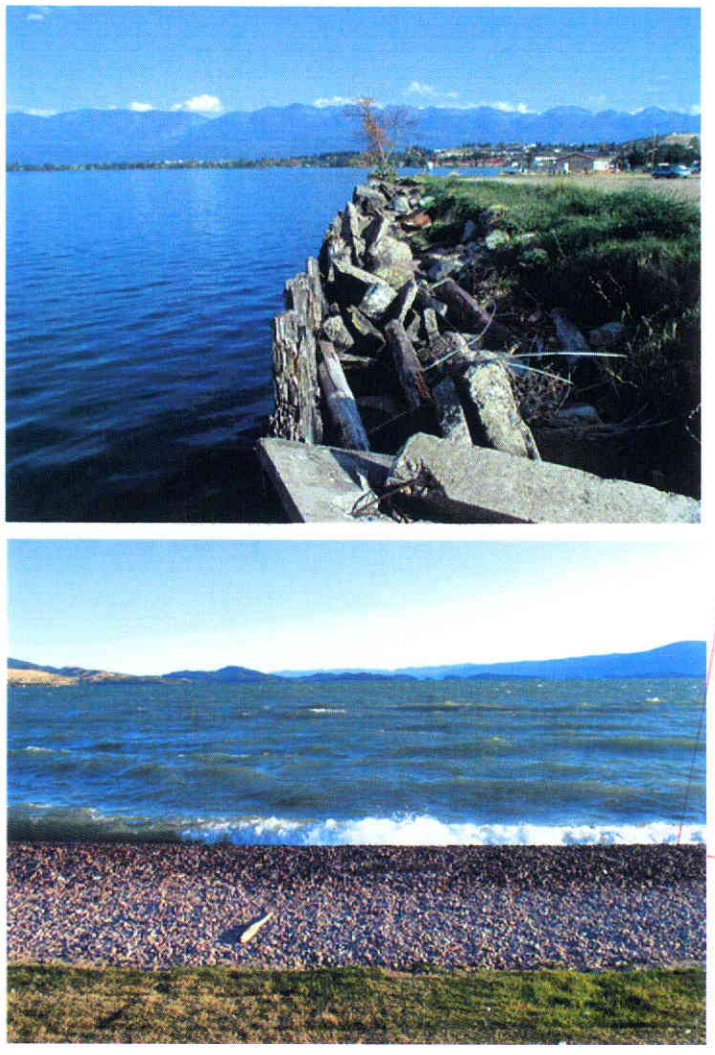

Figure 20. The top photograph shows the sea wall at Salish point in the City of Polson that was removed by CSKT. The lower photograph shows waves breaking on the gravel beach at the same location. Salish Point is now a park operated by CSKT and a popular swimming beach in walking distance from downtown Polson.

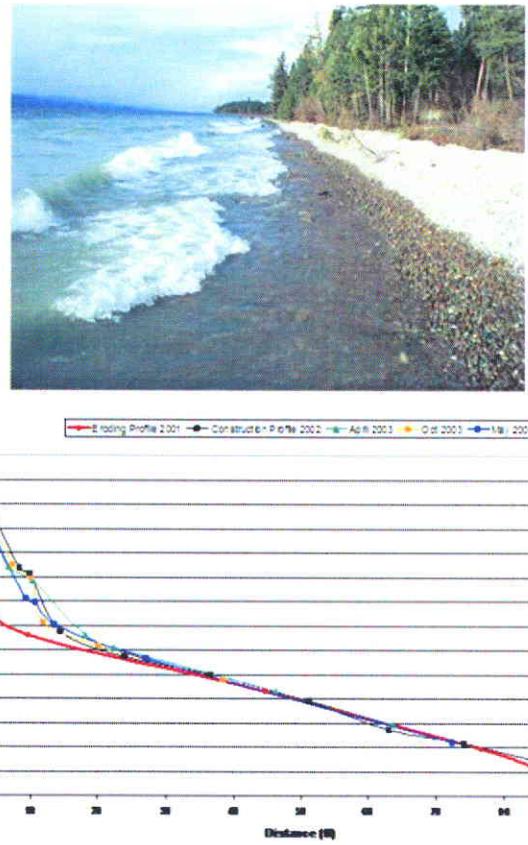

Figure 21. The top photograph shows waves breaking on the gravel beach constructed at the CSKT campground. Note waves breaking offshore followed by swash moving shoreward up the beach face. The graphs on the bottom are plots of survey transect data showing the eroding profile prior to beach construction (red line) and the remaining plots show beach changes over four consecutive years following beach construction. CSKT has been at the forefront for over a decade promoting this natural soft structure alternative to sea walls and rip rap.

5.1 (B)(2)(b) 6). Any other information that may be required

The Army Corps of Engineers after receiving approval from CSKT, and appropriate State Agencies has issued a permit to the Blackwoods to complete the project as proposed.

The Blackwoods have the right to protect their land and property. And they have the right to use the best possible options as demonstrated and permitted on neighboring private, State and Federal property and backed by decades of research conducted by the University of Montana, FLBS. The Flathead County Board of Commissioners has the right to request as much information as possible to make a decision on this major variance request. In this particular instance there is a wealth of information by University researchers, CSKT, local, State and Federal agencies from which the current FCBC can make a decision.

In addition the Blackwoods have the right to pursue their happiness, which includes the ability to engage in boating recreation on the lake. The only solution to protect their dock is the cobble spit

plan put forward (Fig. 4). We are hoping that all private landowners would be allowed to do the same because the outcome from that would benefit Flathead Lake, through improved water quality, fish and wildlife habitat and shoreline restoration. The construction of cobble spits on private lands, as permitted and completed on the neighboring State and Federal lands (Fig. 1) would allow waves to use the natural supply of sand and wood and passively restore the North Shore of Flathead Lake as depicted in Fig. 11.

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