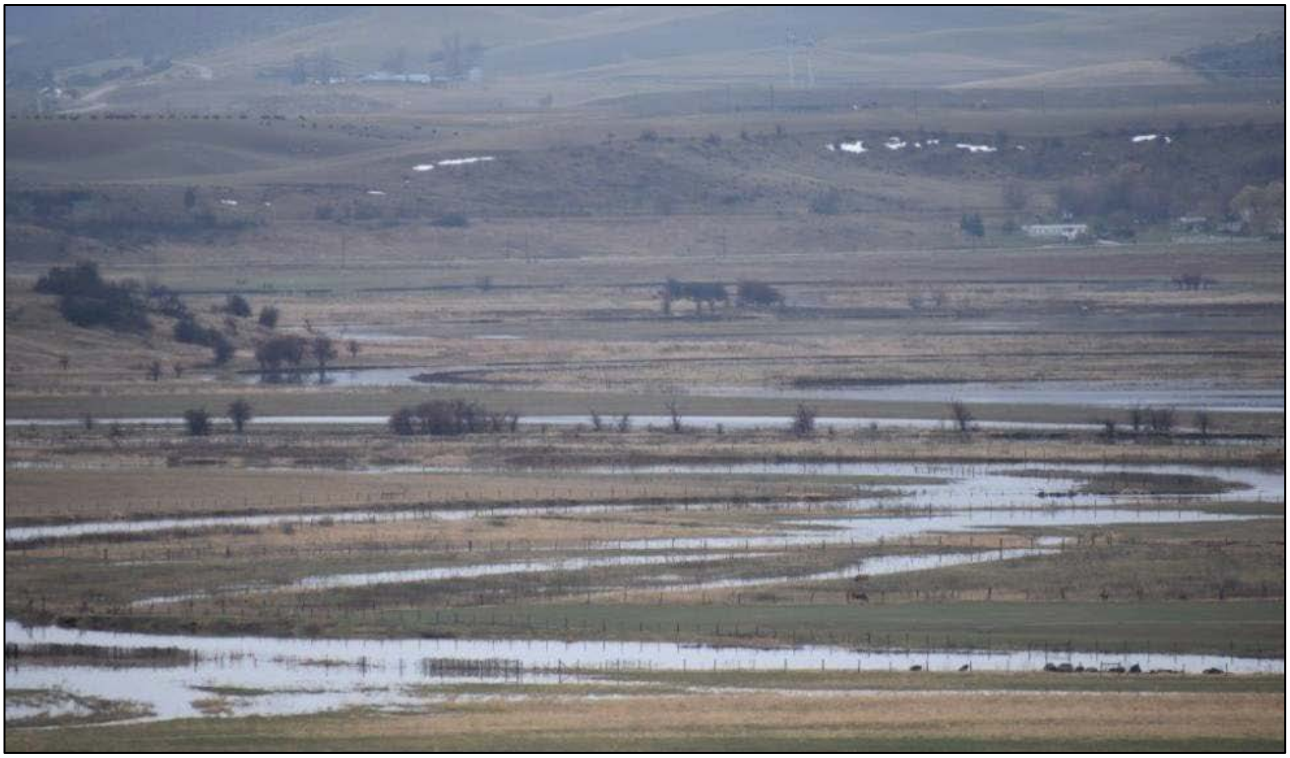
SODA HYDROELECTRIC PROJECT SPINNING RESERVE STUDY – INUNDATION LAND ASSESSMENT



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INTRODUCTION

PacifiCorp's Federal Energy Regulatory Commission (FERC) license for the Bear River Hydroelectric Project provides for the utilization of spinning reserve at the Soda Development. PacifiCorp has not declared spinning reserve at the Soda Development under the current license. Changing needs for reserve power created by the ever-increasing volume of variable renewable power (solar and wind) being integrated into the energy grid make it advantageous to implement spinning reserve operations at the Soda Development. In preparation for doing so, PacifiCorp and the Bear River Project Environmental Coordinating Committee (ECC) would like to understand and document the potential environmental effects of spinning reserve releases of up to 2,600 cfs from the Soda Development.

A release of up to 2,600 cfs would flood land areas outside of the existing river channel in some locations. To date, there has not been a consistent review of the area of inundation in regard to potential impacts on bank stability, land use/land cover, and water quality.

Based on field survey data and GIS mapping, this report identifies potential areas of bank erosion, and where impacts on agriculture, land use, and water quality could occur. Based on a potential future need to work with local landowners, these conditions are defined for each land parcel in the area of inundation associated with spinning reserve releases.

OBJECTIVE AND ASSUMPTIONS

The objective of this study is to evaluate each land parcel in the area of inundation for potential impacts on bank stability, land cover/land use, and subsequent impacts on water quality following a spinning reserve release. Several clarifying assumptions and considerations should be noted here including:

1. Potential land resource impacts from a spinning reserve release are associated with the area of inundation only. This area is found between baseflow elevation and the elevation of maximum flow produced by a release from the Soda Development. This release would have a projected total flow of 2,600 cfs downstream of Soda Dam.
2. Base flow elevations are represented by the typical 1,000 – 1,200 cfs flows that occur in summer during the irrigation season.
3. The maximum extent of inundation is based on HEC-RAS modeling (BC&A 2017) and flooding that occurred in spring 2017 when Bear River flow in the Gentile Valley was estimated at approximately 3,000 cfs. This flow included approximately 2,500 cfs from Alexander Reservoir and ungaged tributary inflow between Alexander and Oneida reservoirs (BC&A 2017).
4. Land parcel boundaries represent the most recent data available from Franklin and Caribou counties. They are assumed to accurately represent the general location of each land parcel and the associated owner. Differences may exist between these boundaries and more recent field measurements completed by a licensed surveyor.
5. A spinning reserve release would not follow the "normative" hydrograph below Soda Dam and impacts on land resources would likely vary by season, magnitude, and duration of flow.
6. For the purposes of this study, the duration of a spinning release will be 2 hours, and one release per year is projected. This duration and frequency are based on the history of spinning reserve calls at PacifiCorp's Oneida Development. Once a spinning release call is made, the 2,600 cfs total flow will be achieved within 10 minutes. The release could happen at any time with the exception of periods when existing discharge from Soda Dam is 2,600 cfs (e.g., peak spring runoff) or when heavy ice is present on the reservoir or in the river that would create safety concerns.

METHODS

This section will describe each data set and the methods used to process data to identify potential impacts on bank stability, land use/land cover, and water quality, from a spinning reserve release. Data was obtained from several sources including: inundation area and aerial imagery data from PacifiCorp, Idaho Cropland Data Layer (CDL), bank stability survey data from Idaho Department of Environmental Quality (IDEQ), soil survey data from the Soil Survey Geographic Database (SSURGO) and U.S General Soil Map (STATSGO2), and surveyed parcel boundaries provided by PacifiCorp. Several other data sets were also produced from these original records to help define potential resource impacts following a spin release. All data was processed using ArcGIS, Google Earth Pro, and Microsoft Excel software.

Inundation area

The inundation area was defined by modeling completed by Bowen Collins & Associates at the request of PacifiCorp. The modeling used a digital elevation model, bathymetric survey data, and flow data from monitoring stations on the river. Photographs of the Gentile Valley floodplain in spring 2017 were used to validate the model results (BC&A 2017). The extent of inundation and the accompanying report were provided to Cirrus by PacifiCorp. The spatial extent of Bear River baseflow was mapped by PacifiCorp using a combination of NAIP and Bing imagery and represents a typical summer flow of 1,000-1,200 cfs (Zentner 2017).

Imagery Classification

During the summer of 2017, PacifiCorp contracted with GeoTerra to collect 6-inch resolution aerial imagery of the project area. A portion of this imagery within the PacifiCorp-provided inundation area was originally classified into five broad vegetation classes using supervised classification methods in the ENVI software package. Following additional image classification, these vegetation classes were later refined as herbaceous, woody, bare, water, and phragmites cover types.

The 2017 CDL was used by Cirrus to identify agricultural land use and crop type in the inundation area. This layer is a geo-referenced, crop-specific land cover data layer with a fairly coarse 30-meter ground resolution. PacifiCorp's 6-inch resolution aerial imagery and Google Earth were used as a high resolution base layer. The 2017 CDL layer was edited to match fence lines and other agriculture field boundaries appearing in the base layer. This process was completed for all land surfaces in the inundation area. While the high resolution imagery was reviewed, a search was completed for indications of land use (e.g., buildings, watering troughs, livestock trails, fences, etc.).

After the CDL was updated, any remaining gaps were filled using the five vegetation categories from the image classification. A total of twelve land cover categories were ultimately defined in the inundation area including alfalfa, bare soil, barley, corn, grass, oats, other hay/non-alfalfa, pasture, phragmites, spring wheat, water, and woody vegetation.

Bank Stability Survey

In summer 2015, the Pocatello Regional Office of the IDEQ surveyed 105 miles of the mainstem Bear River channel beginning approximately six miles above Bear Lake and ending about 30 miles below Oneida Reservoir. A total of 19.5 miles were surveyed in the Gentile Valley beginning at the River Road Bridge (Cheese Plant Bridge) and extending downstream to Highway 34 Bridge above Oneida Reservoir. All data records from this survey were provided by IDEQ.

During the survey, a GoPro camera was mounted on the bow of a canoe and programmed to take photos at 1-minute intervals. The location and time of each launch and take-out were recorded with GPS for all surveys. The location of each photo point was approximated with GIS measurements of river length, time of photo, and estimated travel time of the river.

The photo at each survey point was reviewed by IDEQ to identify the presence/absence of woody riparian vegetation, unstable banks, uncovered banks, and any efforts to stabilize channel banks such as rip-rap, stream barbs, cars, bricks, etc. Invasive species (i.e. Russian olive trees) were identified as they appeared in each photo. In-channel wood was also recorded because of the positive influence on bank stability and fish habitat (IDEQ 2017a). Survey data included left and right bank measurements. Definitions for survey categories include:

Riparian Woody Vegetation – presence of any perennial trees or shrubs close enough to the bank that roots may be protecting the bank from erosion (e.g., cottonwood, willow, hawthorn, juniper, maple, spruce, pine, russian olive, salt cedar, etc.).

Unstable Bank – bank stability was evaluated using the Beneficial Use Reconnaissance Program (BURP) survey protocol. Banks are considered **stable** if 1) no obvious blocks of bank are broken away and lying adjacent to bank, 2) the bank has not obviously slipped and no slumps are present, 3) no cracks or fractures are present indicating the bank is about to move, and 4) bank is mostly covered (i.e. >50 percent) and bank angle is <80 degrees from horizontal (IDEQ 2017b). The channel bank is considered **unstable** if **any** of these features are present, or if bank cover is <50 percent and bank angle is >80 degrees from horizontal.

Uncovered Bank – based on BURP protocol (IDEQ 2017b), banks are considered **covered** if > 50 percent of banks are protected by perennial vegetation, plant roots, logs with 4-inch diameter, cobbles, or some combination of these. If cover from these categories is **< 50 percent**, the bank is considered **uncovered**.

Note that all survey categories were measured independently at each photo point. Some overlap occurs between measurement categories, but the relationships are not always obvious. For instance, it is likely that survey points with riparian vegetation would have equivalent amounts of bank cover. However, if riparian vegetation was not present, bank cover could still be high and consist of cobbles or logs. Banks with riparian woody vegetation could also be unstable due to vertical cracks and undercuts that occur despite the bank stabilizing force provided by deep plant roots.

This land use assessment edited the location of survey points where possible, by geo-referencing to obvious land features captured in photos such as trees, telephone poles, bank meanders, eroding banks, etc. For photos that could not be geo-referenced, survey point locations were adjusted by equally spacing them between points with known locations. Each survey point was identified with an adjacent tax parcel using GIS. The percent of survey points identified in each category (i.e. woody riparian vegetation, unstable banks, etc.) were calculated for each tax parcel in a spreadsheet. An additional metric was added in this land use assessment by counting survey points that identified both unstable and uncovered banks. This metric provides a means to identify areas with the greatest potential for impacts on instability and bank erosion from a spinning reserve release.

The bank length for each parcel was measured by tracing the river right and river left edge of the polygon that represented Bear River baseflow (Zentner 2017) with the ArcGIS trace tool. These lines were used to measure the individual bank length of each tax parcel.

Soil Survey

Soil survey information was used to determine erosion hazard ratings and runoff potential for the area of inundation in each tax parcel. Soil data were used from the STATSGO2 and SSURGO soil databases. The STATSGO2 database combines high-resolution surveys (e.g., SSURGO) with other geographic data to create a comprehensive soil map for the entire United States (NRCS 2018). Both surveys are a recognized source of information for determining erodible areas and developing erosion control plans (NRCS 1995).

The STATSGO2 database provides the only available soils data in Caribou County while both SSURGO and STATSGO2 data are available for Franklin County. Soil erosion hazard and runoff potential estimates are only found in the SSURGO database. This land use assessment estimated these parameters for parcels in Caribou County with STATSGO2 data including soil texture (i.e. percent clay) and saturated hydraulic conductivity (NRCS 1997).

Tax Parcel Boundaries

Land Parcel boundaries for areas in Caribou and Franklin counties were prepared by professional surveyors licensed in Idaho. This process included reviewing parcel deeds, title reports, locating survey monuments, and plotting legal descriptions for each parcel. These parcels were selected for further analysis of bank stability, land cover/land use, erosion hazard, and runoff potential. Figure 1 Appendix A shows all parcels with inundation in each county.

RESULTS

This section describes the results of the GIS assessment of each land parcel in the area of inundation. Potential impacts are identified in regard to bank stability, land cover/land use, and water quality degradation produced by a spinning reserve release. Results will be reviewed for each of the three categories followed by a discussion of the concerns highlighted by these results.

A general summary of results for each county is shown in Table 1. The land parcel boundaries that intersect with inundation areas are shown in Figure 1 (Appendix A). Note that not all parcels are located adjacent to the Bear River channel. Some areas of inundation are located on old channel features or drainage swales away from the main Bear River channel that were not included in the bank stability survey. As a result, some land parcels do not have corresponding results for bank stability.

Table 1. Summary results of land assessment for inundation areas in Franklin and Caribou counties.

Category	Franklin County	Caribou County	Total
Land parcels with inundation	54	11	65
Land parcel owners	22	9	31
Area of inundation in land parcels (ac)*	337	117	454
Bank length (ft)	98,298	29,832	128,130

***These are the actual acres of land inundation. The inundation areas on most parcels occur in a matrix of inundated and non-inundated lands. When these areas are "squared" up to produce potential easement boundaries that encompass the inundation areas, the total potential easement area is 762 acres.**

Bank Stability

The results of the 2017 IDEQ bank stability survey (IDEQ 2017a) are presented in Tables 2 and 3 (Appendix B) for land parcels in Caribou and Franklin County adjacent to the Bear River, respectively. The length of Bear River channel bank is also provided for each land parcel. As described in the methods section, the percent of data points that identify surveyed features were made for the river left and river right banks and averaged together. Note that some parcels do not have survey data due to the extent of where the survey began and ended for the day. Figures 2 and 3 (Appendix A) show parcels in the inundation area symbolized by percent of stable banks and percent riparian woody vegetation, respectively.

A summary of key results in regard to bank stability of land parcels with inundation area includes the following:

- A total of 128,130 feet (24.3 miles) of Bear River channel banks (i.e. both right and left banks) occur in land parcels that would be subject to inundation from a spinning reserve release.
- A total of 15 parcels and approximately 19,222 feet of bank length had more than 50 percent unstable/uncovered banks (i.e., both unstable and uncovered banks were identified at the same survey point). However, several of these same parcels also had banks with substantial riparian woody vegetation, including six parcels where banks had 50 percent or more cover. Banks with unstable features that also include riparian vegetation cover have potential for re-stabilization through continued vegetation growth, if further erosion can be prevented.
- A total of 55 parcels containing approximately 114,469 feet of Bear Riverbanks had 50 percent or less unstable/uncovered banks. This group of parcels included 35 parcels with 25 percent or less unstable/uncovered banks.
- A total of 22 parcels and 42,833 feet of bank length had more than 50 percent riparian woody vegetation.
- Channel stabilization efforts were observed on 16 parcels. The percent of bank length covered by these practices in most parcels was less than 50 percent. One parcel had 100 percent bank stabilization in place.
- Caribou County had more than twice as many parcels associated with channel stabilization compared to Franklin County.

<u>Land Cover/Land Use</u>

The results of the land cover/land use assessment are shown in Tables 4 and 5 (Appendix B) for Caribou and Franklin counties, respectively, for areas that would be inundated during a spinning reserve release. A total of 11 different land cover types were identified in the inundation areas found in land parcels.

Figures 4 and 5 (Appendix A) show land cover/land use for areas of inundation in Caribou and Franklin counties, respectively. A summary of key results in regard to land cover/land use in areas of inundation located in each land parcel includes the following:

- The total area of inundation in land parcels is approximately 454 acres.
- The area of inundation for any land parcel ranges <0.05–45.3 acres. Approximately one-fourth of land parcels (14 of 65) would have inundation of 0.5 acres or less including 5 parcels with < 0.05 acres of inundation. Ten land parcels include 275.2 acres of inundation which is more than half of the 454 acres of inundation located in the 65 land parcels in the project area.
- The largest land cover type that would experience inundation is pasture (229.7 acres), followed by grass (70.7 acres) and alfalfa (57.1 acres) which total 357.6 acres. Land cover types with the lowest area of inundation include spring wheat (0.4 acres), barley (1.3 acres), and bare ground (6.2 acres). In addition to alfalfa, spring wheat, and barley, other crop types in the area of inundation include corn (17.5 acres) and oats (7.7 acres).
- No built structures including corrals, storage sheds, barns, etc. or areas of intensive use such as feeding, watering, hay storage, etc. were identified in areas of inundation during a review of the project area using high resolution photography and Google Earth coverage.
- Irrigation equipment (e.g., center pivots and wheel lines) were identified in inundation areas on six parcels including four parcels in Franklin County and two parcels in Caribou County.

Water Quality

The water quality assessment used bank stability survey data and land cover data to identify areas with potential to degrade water quality during a spinning reserve release. These results are shown in Tables 6 and 7 (Appendix B) for Caribou and Franklin counties, respectively. Potential bank erosion and Bear River sedimentation was estimated using bank stability survey data (percent unstable/uncovered banks and percent riparian wood vegetation) and erosion hazard ratings. Potential nutrient loading from areas grazed by livestock was based on land cover types in the area of inundation (pasture, grass, and other hay/non-alfalfa) and runoff potential. Figure 6 (Appendix A) shows parcels with inundation that include bare ground greater than or equal to 0.1 acres and parcels containing 1 acre or more of potential grazed land with Moderate or High runoff potential.

A summary of key results in regard to potential water quality degradation associated with each land parcel includes the following:

- As stated previously, 15 parcels had 50 percent or more unstable/uncovered banks. Although these parcels included survey points where banks were classified as unstable (IDEQ 2017b), six of the parcels also had banks with50 percent or more riparian vegetation cover. Erosion features on parcels with riparian vegetation could be due to bank undercuts or other erosion that happened despite the presence of riparian vegetation. If further erosion can be prevented, unstable bank features with riparian vegetation have potential for re-stabilization through continued vegetation growth.
- A total of 6.2 acres of bare ground would be inundated during a spinning reserve release. Of the 65 land parcels receiving inundation, 16 had no bare ground and 36 had areas of bare ground <0.05 acres.
- The majority of bare ground in the inundation areas was limited to five parcels with bare ground greater than or equal to 0.5 acres. The largest areas of bare ground were found in two parcels with bare area of 1.5 acres and 1.4 acres. Erosion hazard for these parcels was moderate and slight, respectively.
- The area of inundation in one land parcel had a severe hazard rating. However, the parcel is <0.05 acres. A total of 44 of 90 parcels have inundation areas with a slight erosion hazard.
- Inundated areas that had potential for livestock grazing totaled approximately 339 acres of the 454 total acres of inundation. Most land parcels (39 of 65) had areas of potential grazing of 1 acre or more. No information is currently available on grazing use (e.g., grazed vs. ungrazed or properly grazed vs. poorly grazed) in these areas. Some of these areas may be ungrazed or properly grazed with little or no impacts on water quality.
- Most parcels (34 of 65) had inundation areas with a moderate or high runoff potential. This is a conservative estimate due to the limited soil data for parcels in Caribou County; soil in some of these parcels likely has fair or low runoff potential.

DISCUSSION

This section discusses the land assessment results in regard to impacts that could occur under a worst-case scenario for bank stability, flood damage to existing agricultural or other land uses, and water quality. This discussion assumes the release could happen randomly one time per year with the exception of periods when existing discharge from Soda Dam is 2,600 cfs (e.g., peak spring runoff) or when heavy ice is present on the reservoir or in the river that would create safety concerns.

Bank Stability

Loss of bank stability is a concern for property owners in regard to maintaining soil resources and property value as river channel banks erode and migrate. This process occurs naturally to some extent in all rivers and is influenced by bank conditions and soil properties. Three factors should be considered when identifying the potential impacts of a spinning reserve release on bank stability including water elevation, bank stability/cover, and seasonal soil conditions.

The potential for bank erosion and instability to occur during a spinning reserve release is influenced by soil exposure to moving water. As water elevations rise with increased flow, moving water erodes the bank face and saturates the soil profile. The extent of bank erosion and saturation is also influenced by surface cover and soil texture (i.e., clay, silt, or sand). Increased water elevation provides some outward pressure and support to saturated channel banks. This support is lost when flows decrease, water elevation drops, and water drains from saturated soil into the river. Channel banks are especially susceptible to sloughing during this time, due to increased pore pressure in saturated soil. Steep channel banks without riparian vegetation and root structure are susceptible to erosion particularly if the soil has limited cohesion (e.g., silt or sand). Channel banks with high moisture content that experience disruption from freeze-thaw cycles are also more prone to erosion.

In regard to change in water surface elevation, the difference between base flow and 2,600 cfs can be used to define the magnitude of change by season. Bear River hydrology below Soda Dam is generally defined by three periods with corresponding baseflows: Fall/Winter, 181 cfs; Spring Runoff, 475 cfs; and Summer Irrigation, 781 cfs (Baldwin 2017). There are additional hydrologic periods defined by flood control releases or extremely high runoff. Flood control releases are captured in the Fall/Winter period, and a spinning reserve release would not occur during extremely high runoff. Based on these baseflow numbers, the Fall/Winter hydrologic period has the greatest potential for a change in water elevation and potential impacts on bank stability, followed by the Spring Runoff period.

In regard to bank stability and bank cover, IDEQ has described the Bear River in Gentile Valley as follows (IDEQ 2017a):

> "The Gentile Valley contained the most degraded river habitat of the Bear River in Idaho. The section of river was characterized by high levels of unstable and uncovered banks, the lowest percentage of images with woody riparian vegetation, and little in-channel wood, despite the highest percentage of images where channel stabilization efforts were visible… Channel stabilization efforts in this section of river tend to armor banks with rip rap without addressing the underlying problem of lack of riparian buffer between crops and pasture and the river corridor."

The IDEQ weighted mean for uncovered and unstable banks in Gentile Valley measured 35.3 percent and 41 percent, respectively (IDEQ 2017a). These values indicate a reach-wide condition for riverbanks in the area of inundation. Bank stability values reported in this land use assessment for each land parcel can be used by PacifiCorp to identify localized areas of concern that may be influenced by a spinning reserve release.

The unstable/uncovered value in Table 2 (Appendix B) indicates the percent of survey points where both unstable and uncovered banks were observed. Based on results of the survey and characteristics of a spinning reserve release, 50 percent unstable/uncovered bank is a reasonable threshold to identify areas of highest potential impact. Most land parcels (70 total) were rated at less than 50 percent unstable/uncovered, and 41 parcels had 25 percent or less unstable/uncovered banks. Any riparian vegetation and/or channel stabilization efforts in these same areas will benefit streambank integrity. In general, these parcels have a relatively low potential for sloughing during and immediately following a spinning reserve release. Furthermore, any lasting impacts on bank stability in these parcels following a release would likely be undetectable from impacts generated by flows in the normative hydrograph.

A total of 15 parcels were identified that had 50 percent or more unstable/uncovered banks that comprise a total length of 22,528 feet. These parcels would be most susceptible to impacts on bank stability during a spinning reserve release. Riparian vegetation was noted at levels of 50 percent or more on six of these parcels, which would help reduce potential impacts. All parcels with this level of unstable/uncovered banks would likely be susceptible to impacts from peak flows that occur during other times of the year.

In regard to seasonal influences on soil condition, saturated soil is less cohesive which provides a greater opportunity for runoff or stream flow to erode channel banks. Soil surfaces are disrupted when soil moisture freezes and expands. Soil moisture can freeze at greater depths when exposed in channel banks and create outward expansion. If this movement is considerable, vertical banks can slough.

Based on these results, impacts on bank stability from a spinning reserve release would be greatest on the 15 parcels with 50 percent or more uncovered-unstable banks during the spring season when soil is saturated and recently disturbed by freeze-thaw cycles. Potential impacts would also be high during the fall/winter due to changes in water surface elevation although banks could be frozen and less susceptible to erosion. Potential impacts on bank stability from a release during the summer irrigation season would be relatively less compared to other seasons due to higher baseflows (i.e. less potential change in water elevation) and low soil moisture in channel banks.

Land Cover/Land Use

Water from a spinning reserve release would temporarily cover land in the Bear River floodplain. Some of these land areas are covered by floods that occur during spring runoff. Other land areas in the floodplain are used more consistently because they are not flooded by peak flows that occur in the normative hydrograph. Impacts on land cover/land use from a spinning reserve release should consider the sensitivity of land cover types to flooding, physical structures used for farming or other land use activities, and sediment deposited in areas of inundation by the Bear River.

A total of 11 cover types were identified in the area of inundation. However, over half of the 454 acres of inundation are covered by pasture (229.7 acres) and grass (70.7 acres). The land cover types used for agricultural harvest include alfalfa, corn, oats, barley, and spring wheat. Flooding impacts on agricultural crops occur differently based on the crop type and length of inundation, growth stage, and temperature during flooding (DuPont Pioneer 2018).

Small grain crop types (i.e. wheat, oats, barley) can withstand 1-2 days of flooding and saturated soils (Peel 2000). Larger grain crops, such as corn can endure 2-4 days of flooding. Alfalfa can usually survive several days of flooding during the dormant season and less so when it is growing actively (Putnam et al. 2017). Pastures and grass cover types are more tolerant of flooding compared to legumes (e.g., alfalfa) and can generally tolerate flowing water for a few days to a week (Barnhart 2008). In terms of plant growth stage, smaller crops in the earliest growth stages are most easily damaged by flooding. High temperatures can decrease the survival of inundated crops by 50 percent or more compared to survival in cold temperatures, due to the change in plant metabolism (Dupont Pioneer 2018). The greatest potential impacts could occur in fields where seedlings have recently emerged.

Based on this information and the limited duration of a spinning reserve release, impacts on land cover are dependent on how quickly flood water returns to the Bear River. The spinning reserve release will typically last 2 hours, which is much less than the critical duration for cover types in the area of inundation. Some areas will drain quickly via surface runoff. However, some water could be trapped in low-lying areas and dissipate slowly over time through infiltration. In general, moving water contains more oxygen than stagnant water, so impacts would be minimal in areas where water moves quickly back to the Bear River. Areas with ponded water will create low oxygen conditions over time that impact plant roots. Mature plants with established root systems (e.g., pasture, grass, and woody vegetation) are less susceptible to oxygen depletion than newly planted crops (e.g., wheat, oats, and corn). If ponding occurs in land areas where new and immature plants exist, some damage could potentially occur from a spinning reserve release due to oxygen deprivation or if seedlings are covered by sediment.

This assessment completed a detailed review of aerial imagery in the inundation area. No structures such as buildings, watering troughs, fences, roads, etc. were identified. However, irrigation equipment (e.g., center pivots and wheel lines) was identified on six land parcels (Table 3, Appendix B). This type of equipment would likely not experience direct damage from a spinning reserve release during the growing season, based on the depth and duration of inundation. After flood waters have receded however, the soil will be saturated for several days or longer. Although center pivot irrigation systems are designed to operate in wet conditions, saturated soils following inundation may not immediately support movement by heavy center pivot equipment. In these conditions, wheels on each tower could create deep ruts or become stuck if soils were not allowed to drain. Extended waiting for the soil to dry could create problems in meeting irrigation needs in other areas of the field.

In regard to sediment deposition, a spinning reserve release could resuspend sediment deposits in the Bear River channel, depending on the location and time of year. This process was studied as part of addressing impacts from boater flow releases in Black Canyon. Turbidity and sediment loading have been monitored at the boater take out downstream of the mouth of Black Canyon during each boater flow release since 2008 (ERI 2010, IDEQ 2015b). Monitoring data indicate that peak turbidity and suspended sediment have steadily decreased each year, likely in response to the flushing effect of peak flows (IDEQ 2015b). No monitoring has tracked the fate of Bear River suspended sediment through the Gentile Valley and downstream to Oneida Reservoir. One recent study has identified a fluvial deposit near the confluence of Cottonwood Creek (BC&A 2017). However, this deposit is primarily a cobble delta produced by spring discharge from Cottonwood Creek and is not a deposition of fines from upstream Bear River flow.

Initial spinning reserve release flows may resuspend sediment deposits in the Bear River channel. Similar to the boater flow releases, the initial release would likely mobilize more material than successive releases. Some of the suspended sediment transported by the spinning reserve release would be deposited on land cover types in the inundation area but this impact would decrease over time. The magnitude and extent of initial impacts would likely be similar to or less than what occurred during the 2017 spring flooding event. Perennial land cover types such as pasture, grass, and alfalfa (which comprise the majority of the inundation area) would be more tolerant of sediment deposition than small grain cover types.

Water Quality

Water quality is a concern in the Bear River between Alexander and Oneida Reservoirs. This segment is currently impaired for temperature and has an approved TMDL for total suspended solids (TSS) and total phosphorus (Total P; IDEQ 2017c). As a result, any activities leading to water quality degradation for these parameters are addressed in this land assessment report.

Water temperature impacts have been addressed in a separate report (Cirrus 2019). In regard to potential water quality impacts on TSS and Total P resulting from a spinning reserve release, this report identifies inundated areas that could contribute to both parameters. Table 4 (Appendix B) define the percent of unstable banks and areas of bare ground in Caribou County and Franklin County respectively, with potential to contribute suspended sediment during a spin release. A potential source of Total P can be defined by areas of livestock grazing in the area of inundation for each land parcel. These areas are also defined for each land parcel.

A total of 15 parcels were identified that had 50 percent or more unstable/uncovered banks comprising a total length of 22,528 feet. The channel banks in these parcels would be susceptible to bank erosion and have a potential impact on sediment loading during a spinning reserve release. Based on their existing condition, channel banks in these parcels would likely be more susceptible to additional erosion as a result of the release. Total bare ground in the area of inundation (i.e. away from channel banks) is 6.2 acres and represents the greatest potential source of surface erosion. The majority of this area is included in five parcels with areas of bare ground greater than or equal to 0.5 acres. The largest areas of bare ground are found in two parcels with bare areas of 1.5 acres and 1.4 acres. Erosion hazard for these parcels is moderate and slight, respectively. The potential for delivering sediment to the Bear River would depend in part on the velocity of return flow draining from flooded areas back to the Bear River channel. The distance between bare areas and the presence of vegetation that could filter runoff would also influence sediment transport to the Bear River.

Other sources of bare ground would include areas where rotational crops are planted such as barley, oats, wheat, and corn. If these areas are inundated when fields are tilled or before crop covers can establish, erosion could occur in a similar way to perennially bare areas. During a spinning reserve release, soil surfaces would become saturated. Soil without surface vegetation could be particularly susceptible to erosion. The rate of erosion from bare areas would be a function of the rate and duration of flowing water across the soil surface. If surface runoff back to the river is slow, much of this suspended load could be deposited before it reaches the river channel. Any bare areas that are ponded following a release would not contribute erosion.

Total phosphorous in return flow from inundated areas to the Bear River would contribute to water quality degradation. Based on land cover data, the potential for nutrient loading is greatest from areas where livestock grazing could occur. More than half of the inundation area is comprised of these land cover types (e.g., pasture, grass, and other/non-alfalfa). Areas for individual parcels are included in Table 4 (Appendix B). A spinning reserve release would cover these areas and Total P contained in livestock manure could be transported in return flows to the Bear River as flood waters recede. Some phosphorus loads could be removed by vegetation or other obstacles that slow runoff and filter suspended material. Similar to sediment loads, some of the flood water would be trapped in ponds or low areas and not contribute to nutrient loading and water quality degradation.

Flooding and return flows from a spinning reserve release would contribute some sediment and nutrient loading from the area of inundation. A portion of this area is flooded by existing peak flows with some potential to transport sediment and nutrients to the Bear River when flood waters recede. A spinning reserve release would create one additional flood event per year that would extend beyond existing flood plains and capture additional sediment and phosphorus from source areas. The magnitude of any increase in loading by return flow to the Bear River is uncertain but would likely be limited. Floodplains typically act as a sink of sediment and nutrients and not a source. However, the rate of declining flows following a spinning reserve release is much quicker than would occur under natural peak flows. As a result, receding flood waters may have increased potential to transport sediment and nutrients back to the Bear River, in comparison to a natural flood event.

CONCLUSION

This land use assessment has identified potential impacts from a spinning reserve assessment on bank stability, land cover/land use, and water quality. The area of greatest impact on each of these resources has been discussed and impacts for each parcel are identified in Figures 2–6 and Tables 2–7 (Appendix B). Although smaller areas of impact shouldn’t be ignored, priority areas and landowners can be identified from these results and used as needed to address potential impacts.

Bank stabilization efforts involving riparian vegetation could have the greatest potential to stabilize streambanks and filter water that enters floodplains as well as return flows. These types of efforts could benefit landowners, IDEQ, and PacifiCorp by maintaining channel banks during the normative hydrograph as well as during peak flows created by a spinning reserve release.

No buildings or other structures are located in the inundation area. Some impacts could occur on agricultural fields with center pivots if inundation creates soil conditions that prevent irrigation from continuing on schedule. Sediment deposits on land used for agriculture could occur following a spinning reserve release.

The majority of land cover in the inundation area is pasture or grass which tolerates inundation and deposition. Based on monitoring data, the magnitude and extent of deposition would decrease over time.

Water quality degradation created by return flows following a spinning reserve release would depend on the rate of decreased flow and the subsequent rate of return flows to the Bear River. Areas without surface vegetation, including barren and tilled areas, could be especially susceptible to erosion and contribute to sedimentation and nutrient loading.

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APPENDIX A: FIGURES

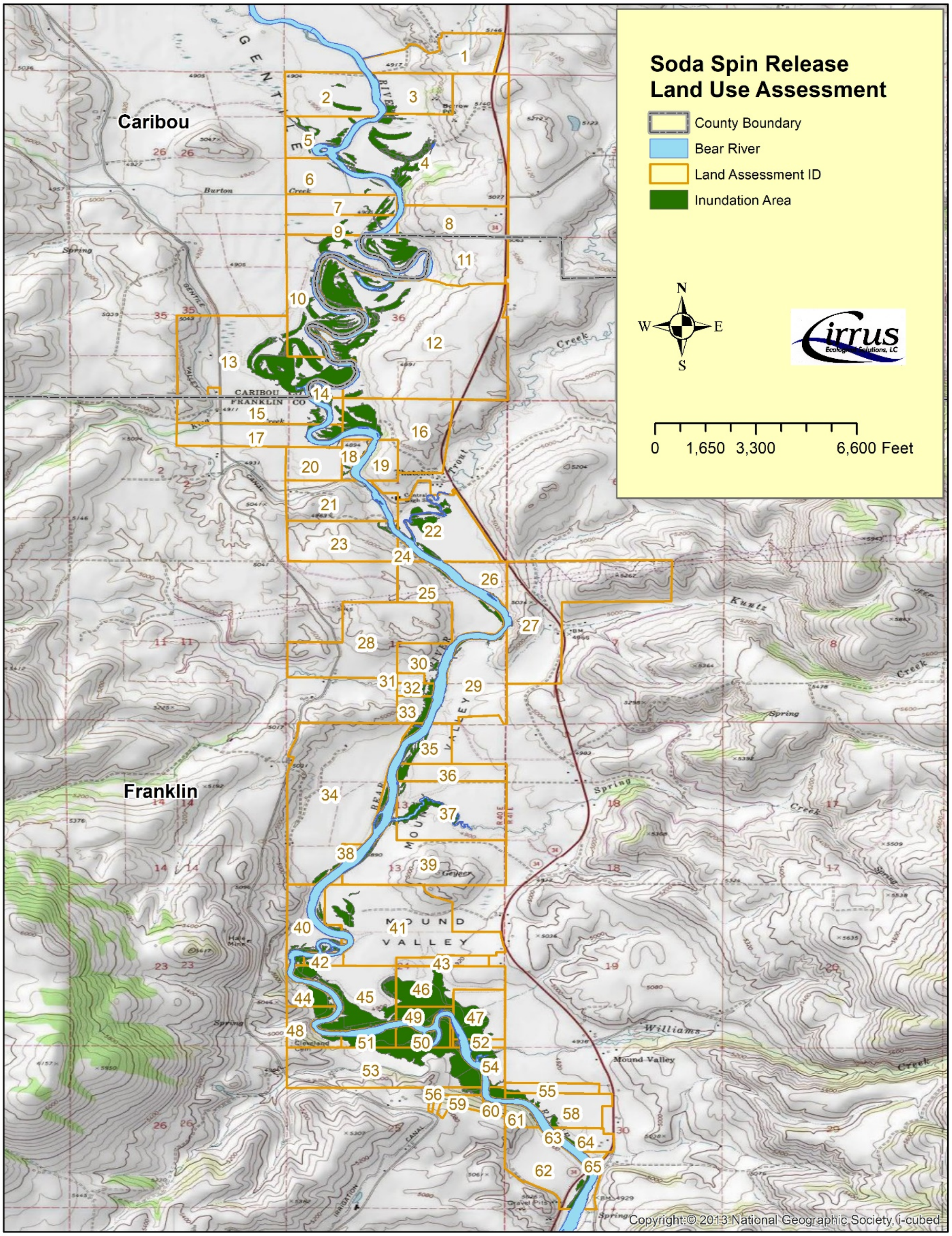

Figure 1. Land parcels in Caribou and Franklin counties that would include areas of inundation from a spinning reserve release of up to 2,600 cfs from Soda Dam.

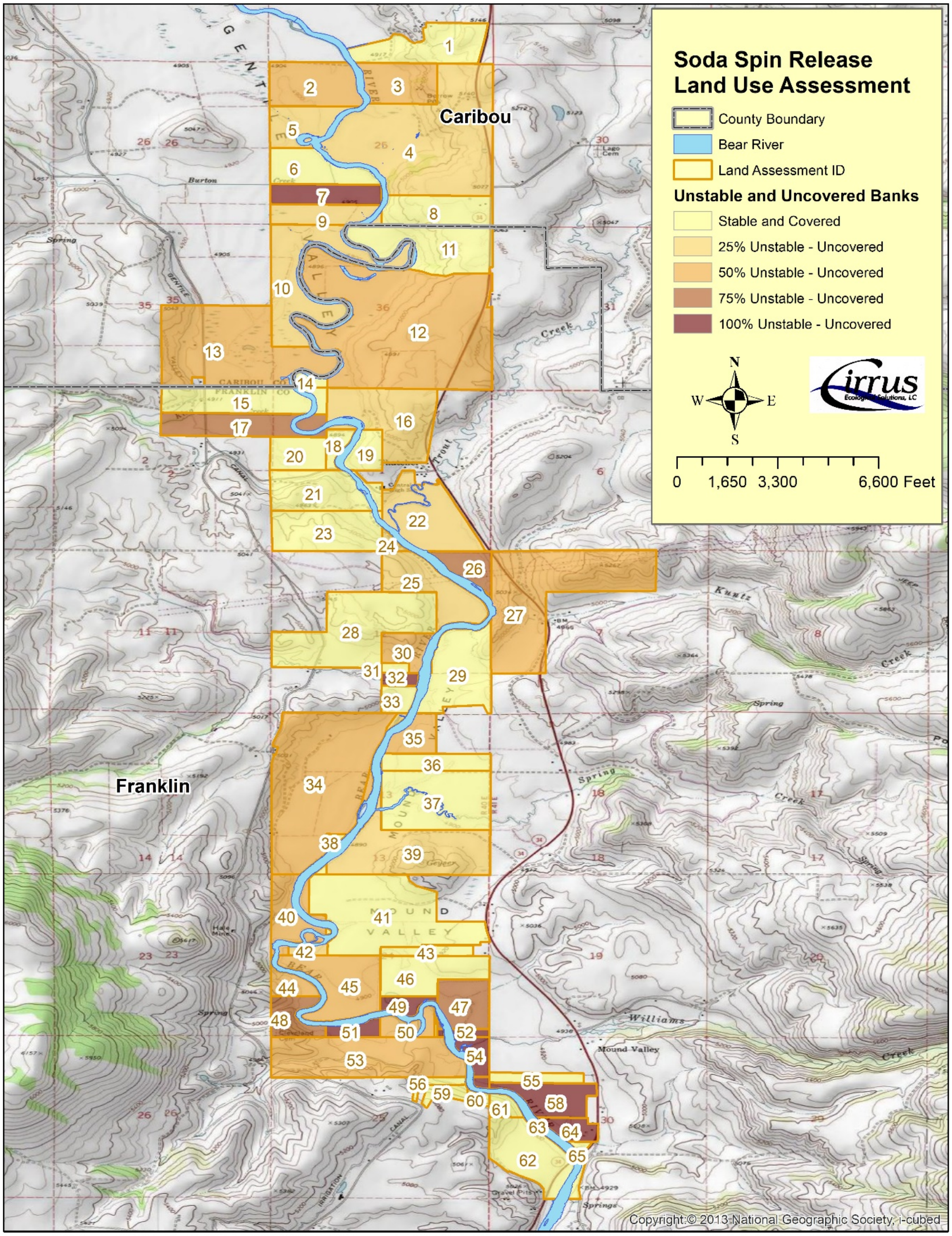

Figure 2. Land parcels that include segments of the Bear River with unstable and uncovered banks, based on 2017 survey data collected by Idaho Department of Environmental Quality.

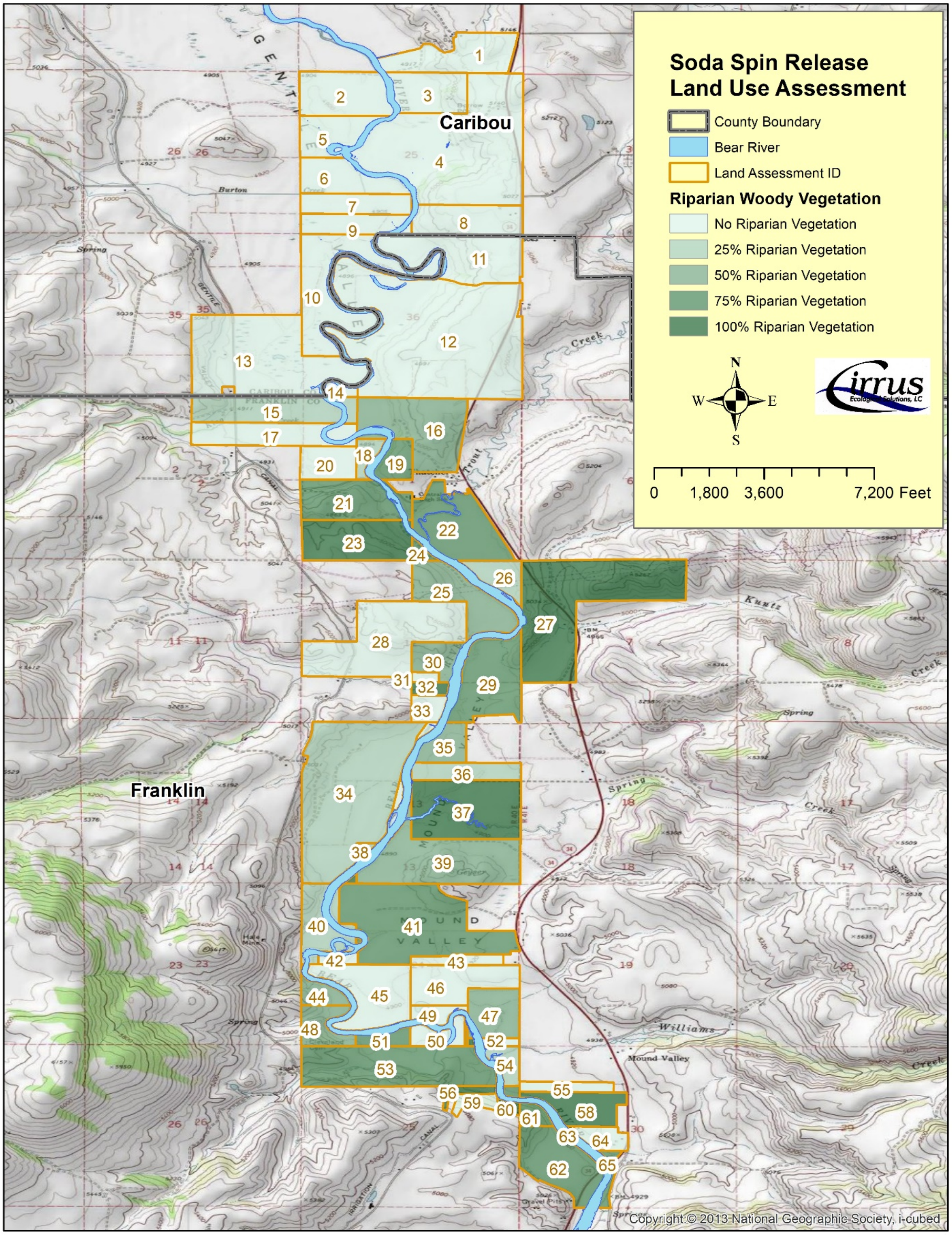

Figure 3. Land parcels that include segments of the Bear River with riparian vegetation, based on 2017 survey data collected by Idaho Department of Environmental Quality.

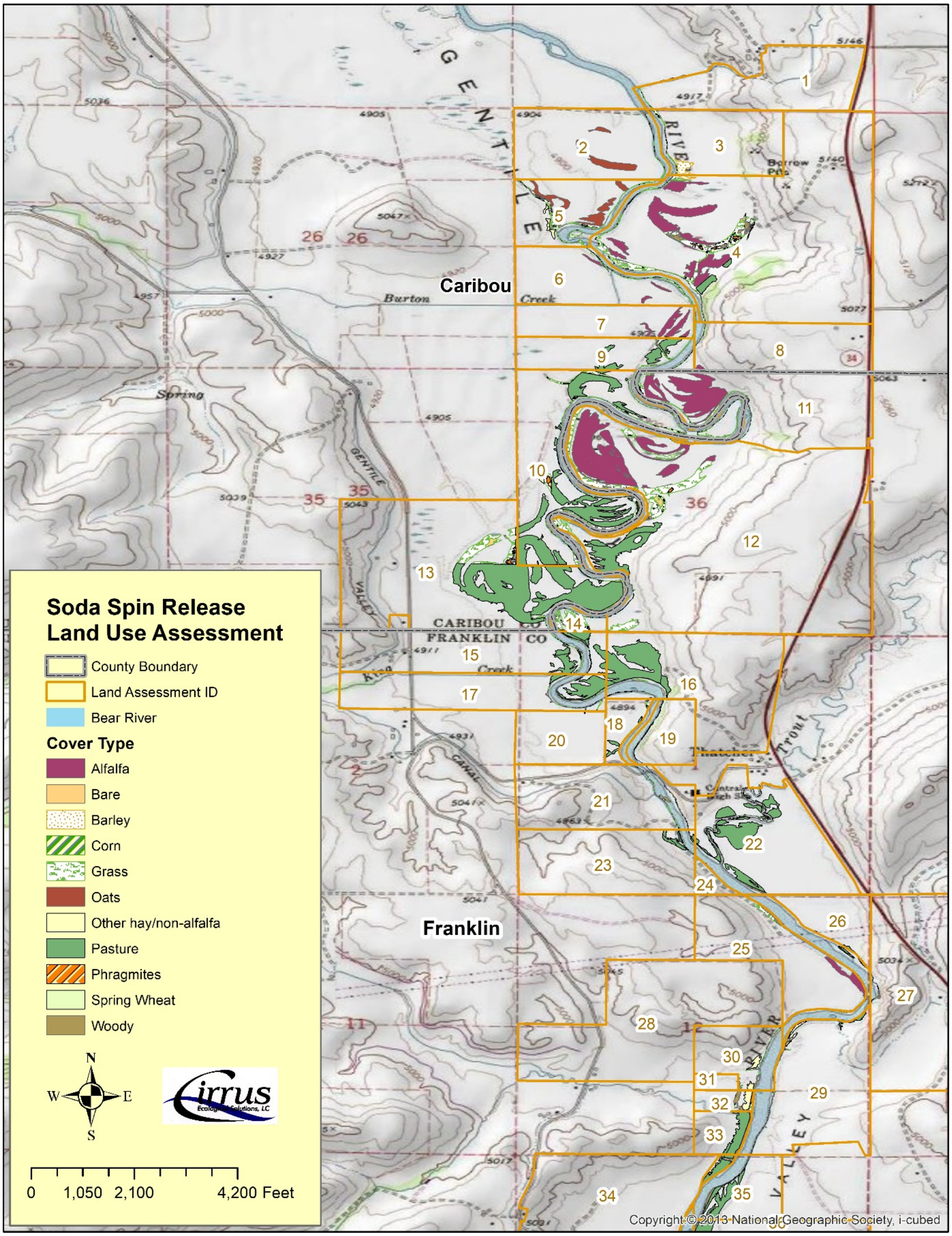

Figure 4. Land cover type in areas of inundation (Caribou County) resulting from a spinning reserve release of up to 2,600 cfs from Soda Dam.

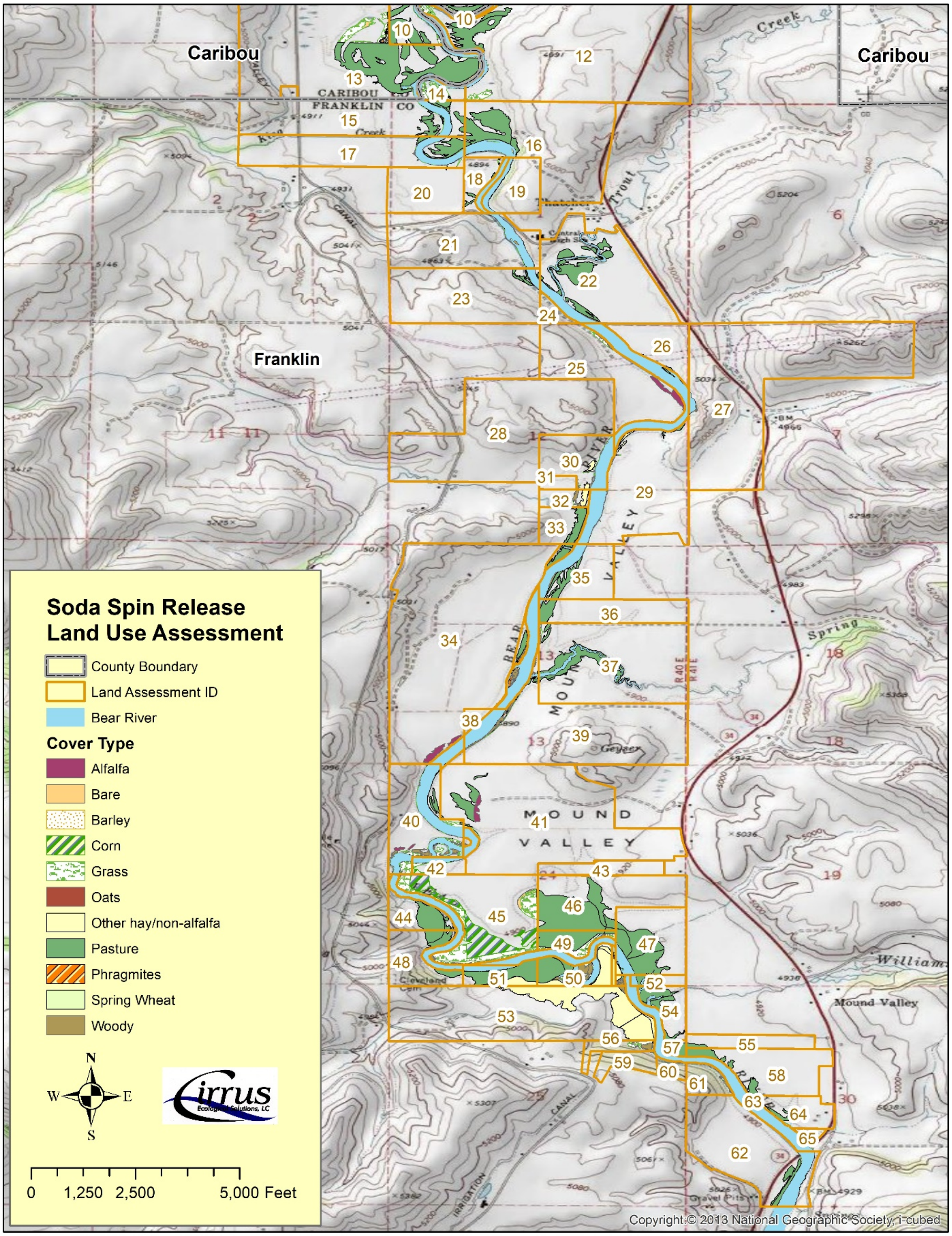

Figure 5. Land cover type in areas of inundation (Franklin County) resulting from a spinning reserve release of up to 2,600 cfs from Soda Dam.

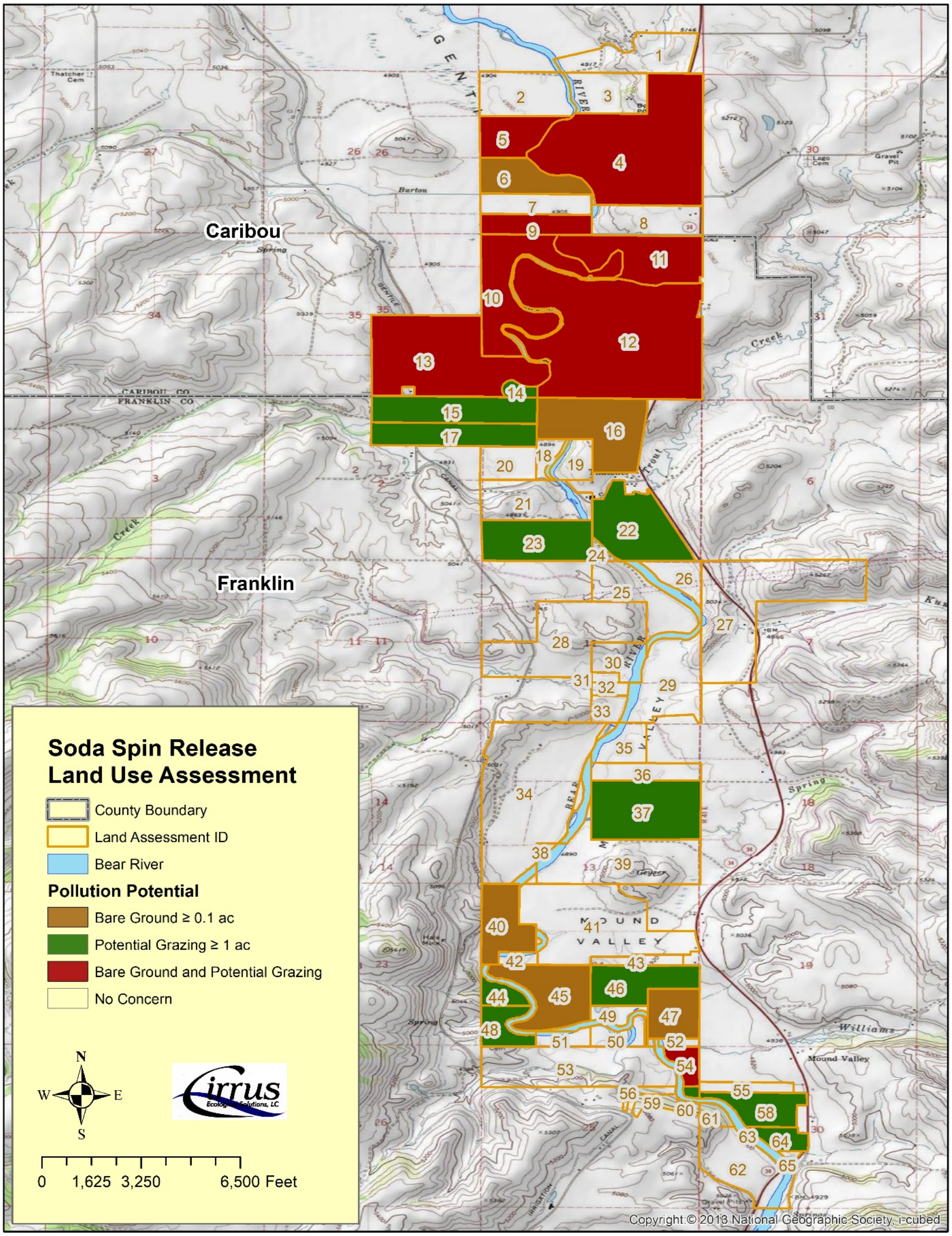

Figure 6. Land parcels with potential to degrade water quality following a spinning reserve release of up to 2,600 cfs from Soda Dam.

APPENDIX B: TABLES 2 – 4.

Table 2. Bear Riverbank stability survey results (IDEQ 2017a) for all land parcels with inundation during a spinning reserve release (2,600 cfs).

Parcel Number	Total Bank Length (ft)	Riparian Woody Vegetation	Unstable Banks	Uncovered Banks	Channel Stabilization Effort	Unstable-Uncovered Bank
1	504	0%	0%	0%	0%	0%
2	1,555	0%	60%	40%	40%	40%
3	1,457	0%	40%	40%	20%	40%
4	4,686	0%	8%	8%	38%	8%
5	2,925	0%	20%	20%	0%	20%
6	2,222	0%	0%	0%	43%	0%
7	679	0%	100%	100%	0%	100%
8	556	0%	0%	0%	50%	0%
9	1,784	0%	14%	14%	43%	14%
10	9,966	0%	23%	23%	43%	23%
11	4,161	0%	0%	0%	43%	0%
12	10,854	10%	33%	43%	13%	33%
13	3,498	0%	33%	44%	0%	33%
14	1,289	0%	0%	25%	25%	0%
15	2,337	29%	29%	0%	0%	0%
16	2,121	38%	38%	13%	0%	13%
17	3,281	0%	56%	56%	0%	56%
18	1,573	33%	0%	0%	0%	0%
19	1,530	75%	0%	25%	0%	0%
20	0	0%	0%	0%	0%	0%

Table 2. Bear Riverbank stability survey results (IDEQ 2017a) for all land parcels with inundation during a spinning reserve release (2,600 cfs).						
Parcel Number	**Total Bank Length (ft)**	**Riparian Woody Vegetation**	**Unstable Banks**	**Uncovered Banks**	**Channel Stabilization Effort**	**Unstable-Uncovered Bank**
21	3,191	80%	0%	0%	20%	0%
22	1,623	75%	25%	25%	0%	25%
23	932	100%	0%	0%	0%	0%
24	1,163	80%	20%	20%	20%	20%
25	4,572	50%	21%	7%	7%	7%
26	2,320	17%	83%	67%	0%	67%
27	748	100%	33%	33%	0%	33%
28	13	0%	0%	0%	0%	0%
29	4,293	64%	21%	0%	0%	0%
30	1,465	50%	33%	33%	0%	33%
31	0	0%	0%	0%	0%	0%
32	435	100%	100%	100%	0%	100%
33	951	0%	0%	0%	0%	0%
34	1,253	18%	45%	27%	0%	27%
35	1,622	60%	40%	40%	0%	40%
36	612	33%	33%	0%	0%	0%
37	501	100%	50%	0%	0%	0%
38	870	25%	25%	0%	0%	0%
39	3,099	50%	10%	10%	10%	10%
40	7,178	21%	46%	36%	0%	36%
41	1,615	67%	0%	0%	33%	0%

Table 2. Bear Riverbank stability survey results (IDEQ 2017a) for all land parcels with inundation during a spinning reserve release (2,600 cfs).

Parcel Number	Total Bank Length (ft)	Riparian Woody Vegetation	Unstable Banks	Uncovered Banks	Channel Stabilization Effort	Unstable-Uncovered Bank
42	982	0%	25%	25%	0%	25%
43	0	0%	0%	0%	0%	0%
44	2,037	50%	33%	33%	0%	33%
45	5,098	0%	44%	44%	0%	44%
46	0	0%	0%	0%	0%	0%
47	1,434	43%	57%	57%	0%	57%
48	1,915	43%	71%	71%	0%	71%
49	1,814	0%	83%	83%	0%	83%
50	3,306	0%	0.50	50%	0%	50%
51	1,406	67%	100%	100%	0%	100%
52	268	0%	100%	100%	0%	100%
53	1,525	83%	33%	33%	0%	33%
54	1,718	33%	100%	100%	0%	100%
55	0	0%	0%	0%	0%	0%
56	241	100%	0%	0%	0%	0%
57	727	75%	100%	100%	0%	100%
58	1,655	100%	88%	88%	0%	88%
59	107	0%	0%	0%	0%	0%
60	630	100%	0%	0%	0%	0%
61	1,299	86%	0%	0%	0%	0%
62	4,698	86%	0%	0%	0%	0%

Table 2. Bear Riverbank stability survey results (IDEQ 2017a) for all land parcels with inundation during a spinning reserve release (2,600 cfs).						
Parcel Number	**Total Bank Length (ft)**	**Riparian Woody Vegetation**	**Unstable Banks**	**Uncovered Banks**	**Channel Stabilization Effort**	**Unstable-Uncovered Bank**
63	286	100%	100%	100%	0%	100%
64	1,007	0%	100%	100%	0%	100%
65	543	67%	0%	0%	33%	0%
Grand Total (ft)	128,130					

Table 3. Land cover types covered by inundation in each parcel during a spinning reserve release of 2,600 cfs.													
Land Assessment ID	**Inundation Area (ac)**	**Alfalfa**	**Bare**	**Barley**	**Corn**	**Grass**	**Oats**	**Other hay /non-alfalfa**	**Pasture**	**Phragmites**	**Spring Wheat**	**Woody**	**Grand Total**
0	5.3	<0.05	0.8	-	-	1.2	-	<0.05	0.4	1.1	-	1.7	5.3
1	0.1	-	<0.05	-	-	0.1	-	-	-	<0.05	-	<0.05	0.1
2	3.4	-	<0.05	-	-	0.2	3.1	-	-	0.1	-	0.1	3.4
3[W]	1.6	-	<0.05	1.1	-	0.3	-	-	-	0.1	-	0.1	1.6
4[P]	25.5	13.9	0.3	0.3	-	7.9	-	-	1.3	0.8	-	1.0	25.5
5	7.8	-	0.5	-	-	1.9	4.6	0.6	-	0.1	-	0.1	7.8
6	1.5	0.8	0.1	-	-	0.6	-	-	-	<0.05	-	<0.05	1.6
7	3.0	2.8	<0.05	-	-	0.1	-	-	0.1	<0.05	-	<0.05	3.1
8	0.4	0.3	<0.05	-	-	0.1	-	-	-	<0.05	-	<0.05	0.4
9	4.6	<0.05	0.1	-	-	0.4	-	-	3.9	<0.05	-	0.1	4.6
10	27.9	-	0.7	-	-	4.4	-	-	21.4	0.6	0.4	0.3	27.9
11[P]	14.4	12.5	0.2	-	-	1.5	-	-	-	0.1	-	0.1	14.4
12	45.3	21.7	0.6	-	-	13.5	-	-	8.9	0.4	-	0.3	45.3
13	40.6	-	1.5	-	-	4.2	-	-	34.6	0.3	-	<0.05	40.6
14	3.1	-	<0.05	-	-	2.8	-	-	0.2	0.1	-	0.1	3.2
15	5.3	-	<0.05	-	-	0.3	-	-	4.9	0.1	-	<0.05	5.3
16	12.5	-	0.1	-	-	0.1	-	-	12.0	0.1	-	0.1	12.5
17	5.1	-	<0.05	-	-	0.3	-	-	4.2	0.1	-	0.4	5.1
18	0.9	-	<0.05	-	-	0.2	-	-	0.7	<0.05	-	0.1	0.9
19	0.3	-	-	-	-	<0.05	-	-	-	0.2	-	0.1	0.3
20	0.0	-	-	-	-	<0.05	-	-	<0.05	<0.05	-	-	<0.05
21	0.8	-	<0.05	-	-	0.2	-	-	<0.05	0.1	-	0.5	0.8
22	12.7	-	<0.05	-	-	0.2	-	-	11.1	0.3	-	1.0	12.8

Table 3. Land cover types covered by inundation in each parcel during a spinning reserve release of 2,600 cfs.													
Land Assessment ID	**Inundation Area (ac)**	**Alfalfa**	**Bare**	**Barley**	**Corn**	**Grass**	**Oats**	**Other hay /non-alfalfa**	**Pasture**	**Phragmites**	**Spring Wheat**	**Woody**	**Grand Total**
23	1.2	-	-	-	-	<0.05	-	-	1.2	<0.05	-	0.1	1.3
24	0.0	-	-	-	-	<0.05	-	-	-	<0.05	-	<0.05	<0.05
25	3.3	1.8	<0.05	-	-	0.7	-	-	-	<0.05	-	0.7	3.3
26	0.5	-	<0.05	-	-	<0.05	-	-	0.3	<0.05	-	0.2	0.6
27	0.1	-	<0.05	-	-	<0.05	-	-	-	<0.05	-	0.1	0.2
28	0.0	-	-	-	-	<0.05	-	-	-	<0.05	-	-	<0.05
29	2.2	-	<0.05	-	-	0.2	-	0.5	0.5	0.2	-	0.9	2.2
30	1.6	-	<0.05	-	-	0.3	-	0.8	-	<0.05	-	0.5	1.7
31	<0.05	-	-	-	-	-	-	-	-	<0.05	-	<0.05	<0.05
32	2.0	-	-	-	-	0.2	-	0.9	-	0.2	-	0.7	2.0
33	3.8	-	<0.05	-	-	<0.05	-	-	3.2	<0.05	-	0.6	3.9
34	1.9	1.8	<0.05	-	-	0.1	-	-	<0.05	<0.05	-	0.1	2.0
35	4.2	-	<0.05	-	-	<0.05	-	-	3.7	0.1	-	0.4	4.2
36	2.8	-	<0.05	-	-	<0.05	-	-	2.7	<0.05	-	0.1	2.9
37	9.8	-	<0.05	-	-	0.1	-	-	9.3	<0.05	-	0.3	9.8
38	0.1	-	<0.05	-	-	<0.05	-	-	-	<0.05	-	0.1	0.1
39	3.2	-	<0.05	-	-	0.5	-	-	0.5	0.7	-	1.4	3.2
40	8.3	0.4	0.1	-	<0.0 5	4.4	-	-	1.4	0.2	-	1.8	8.3
41[P]	5.9	1.1	<0.05	-	-	0.3	-	-	4.4	<0.05	-	0.1	5.9
42[P]	1.0	-	<0.05	-	0.4	0.5	-	-	-	<0.05	-	0.1	1.1
43	0.0	-	-	-	-	-	-	-	<0.05	-	-	-	<0.05
44	6.8	-	<0.05	-	-	0.2	-	-	6.5	<0.05	-	0.2	6.9
45[P]	34.6	-	1.4	-	17.1	15.3	-	-	0.3	0.1	-	0.4	34.6

Table 3. Land cover types covered by inundation in each parcel during a spinning reserve release of 2,600 cfs.													
Land Assessment ID	**Inundation Area (ac)**	**Alfalfa**	**Bare**	**Barley**	**Corn**	**Grass**	**Oats**	**Other hay /non-alfalfa**	**Pasture**	**Phragmites**	**Spring Wheat**	**Woody**	**Grand Total**
46	25.0	-	-	-	-	<0.05	-	-	25.0	-	-	-	25.0
47	17.1	-	0.1	-	-	0.1	-	0.6	16.3	<0.05	-	<0.05	17.1
48	5.2	-	<0.05	-	-	0.2	-	-	5.0	<0.05	-	<0.05	5.3
49	13.2	-	<0.05	-	-	3.3	-	-	9.9	<0.05	-	0.1	13.2
50	17.6	-	<0.05	-	-	1.7	-	6.6	6.5	0.1	-	2.7	17.6
51	12.2	-	-	-	-	0.3	-	2.7	9.2	<0.05	-	<0.05	12.2
52	2.3	-	<0.05	-	-	<0.05	-	-	2.3	-	-	-	2.3
53	27.2	-	<0.05	-	-	0.3	-	26.5	<0.05	<0.05	-	0.3	27.2
54	5.7	-	0.1	-	-	<0.05	-	-	5.6	<0.05	-	-	5.7
55	0.8	-	-	-	-	-	-	-	0.8	-	-	-	0.8
56	1.9	-	<0.05	-	-	1.1	-	<0.05	-	<0.05	-	0.8	2.0
57	3.0	-	<0.05	-	-	0.1	-	-	2.9	<0.05	-	<0.05	3.0
58	4.6	-	<0.05	-	-	0.2	-	-	4.3	<0.05	-	<0.05	4.6
59	0.1	-	-	-	-	<0.05	-	-	-	<0.05	-	0.1	0.1
60	0.2	-	-	-	-	<0.05	-	-	-	0.1	-	0.1	0.2
61	0.7	-	-	-	-	0.1	-	-	-	<0.05	-	0.6	0.7
62	3.3	-	<0.05	-	-	0.2	-	-	2.8	0.1	-	0.1	3.3
63	0.4	-	-	-	-	<0.05	-	-	0.3	<0.05	-	0.1	0.5
64	1.6	-	<0.05	-	-	0.3	-	-	1.3	<0.05	-	<0.05	1.7
65	0.2	-	-	-	-	0.1	-	-	-	<0.05	-	0.1	0.2
Grand Total	452.9	57.1	6.2	1.3	17.5	70.7	7.7	39.1	229.7	5.2	0.4	17.9	453.8

[P] Parcel includes center pivot sprinkler system in the area of inundation.

[W] Parcel includes wheel line sprinkler system in the area of inundation.

Table 4. Potential water quality impacts from areas with potential water quality impacts for each land parcel with inundation.									
Land Assessment ID	**Unstable-Uncovered Bank**	**Riparian Woody Vegetation**	**Bare**	**Erosion Hazard**	**Pasture**	**Grass**	**Other hay/ non-alfalfa**	**Total potential grazed area (ac)**	**Runoff potential**
1	0%	0%	<0.05	Moderate	-	0.1	-	0.1	High
2	40%	0%	<0.05	Moderate	-	0.2	-	0.2	High
3	40%	0%	<0.05	Moderate	-	0.3	-	0.3	High
4	8%	0%	0.3	Moderate	1.3	7.9	-	9.2	High
5	20%	0%	0.5	Moderate	-	1.9	0.6	2.5	High
6	0%	0%	0.1	Moderate	-	0.6	-	0.6	High
7	100%	0%	<0.05	Moderate	0.1	0.1	-	0.2	High
8	0%	0%	<0.05	Moderate	-	0.1	-	0.1	High
9	14%	0%	0.1	Moderate	3.9	0.4	-	4.4	High
10	23%	0%	0.7	Moderate	21.4	4.4	-	25.8	High
11	0%	0%	0.2	Slight	-	1.5	-	1.5	High
12	33%	10%	0.6	Slight	8.9	13.5	-	22.4	High
13	33%	0%	1.5	Moderate	34.6	4.2	-	38.9	High
14	0%	0%	<0.05	Slight	0.2	2.8	-	3.0	High
15	0%	29%	<0.05	Slight	4.9	0.3	-	5.2	Moderate
16	13%	38%	0.1	Slight	12.0	0.1	-	12.2	Fair
17	56%	0%	<0.05	Slight	4.2	0.3	-	4.6	Moderate
18	0%	33%	<0.05	Slight	0.7	0.2	-	0.8	Fair
19	0%	75%	-	Moderate	-	<0.05	-	0.0	Fair
20	0%	0%	-	Slight	<0.05	<0.05	-	0.0	Fair
21	0%	80%	<0.05	Moderate	<0.05	0.2	-	0.2	Moderate
22	25%	75%	<0.05	Slight	11.1	0.2	-	11.3	High

Table 4. Potential water quality impacts from areas with potential water quality impacts for each land parcel with inundation.

Land Assessment ID	Unstable-Uncovered Bank	Riparian Woody Vegetation	Bare	Erosion Hazard	Pasture	Grass	Other hay/ non-alfalfa	Total potential grazed area (ac)	Runoff potential
23	0%	100%	-	Slight	1.2	<0.05	-	1.2	Moderate
24	20%	80%	-	Moderate	-	<0.05	-	0.0	High
25	7%	50%	<0.05	Slight	-	0.7	-	0.7	Fair
26	67%	17%	<0.05	Slight	0.3	<0.05	-	0.3	High
27	33%	100%	<0.05	Severe	-	<0.05	-	0.0	High
28	0%	0%	-	Moderate	-	<0.05	-	0.0	High
29	0%	64%	<0.05	Slight	0.5	0.2	0.5	1.1	Fair
30	33%	50%	<0.05	Slight	-	0.3	0.8	1.1	Fair
31	0%	0%	-	Slight	-	-	-	0.0	Fair
32	100%	100%	-	Slight	-	0.2	0.9	1.1	Fair
33	0%	0%	<0.05	Slight	3.2	<0.05	-	3.2	Fair
34	27%	18%	<0.05	Slight	<0.05	0.1	-	0.1	Fair
35	40%	60%	<0.05	Slight	3.7	<0.05	-	3.7	Fair
36	0%	33%	<0.05	Slight	2.7	<0.05	-	2.7	Fair
37	0%	100%	<0.05	Slight	9.3	0.1	-	9.5	Moderate
38	0%	25%	<0.05	Slight	-	<0.05	-	0.0	Fair
39	10%	50%	<0.05	Slight	0.5	0.5	-	1.0	Fair
40	36%	21%	0.1	Slight	1.4	4.4	-	5.8	Fair
41	0%	67%	<0.05	Slight	4.4	0.3	-	4.7	Fair
42	25%	0%	<0.05	Slight	-	0.5	-	0.5	Fair
43	0%	0%	-	Slight	<0.05	-	-	0.0	High
44	33%	50%	<0.05	Moderate	6.5	0.2	-	6.7	High

Table 4. Potential water quality impacts from areas with potential water quality impacts for each land parcel with inundation.									
Land Assessment ID	**Unstable-Uncovered Bank**	**Riparian Woody Vegetation**	**Bare**	**Erosion Hazard**	**Pasture**	**Grass**	**Other hay/ non-alfalfa**	**Total potential grazed area (ac)**	**Runoff potential**
45	44%	0%	1.4	Slight	0.3	15.3	-	15.6	Fair
46	0%	0%	-	Slight	25.0	<0.05	-	25.0	High
47	57%	43%	0.1	Slight	16.3	0.1	0.6	17.0	Fair
48	71%	43%	<0.05	Slight	5.0	0.2	-	5.2	Moderate
49	83%	0%	<0.05	Slight	9.9	3.3	-	13.1	Fair
50	50%	0%	<0.05	Slight	6.5	1.7	6.6	14.8	Fair
51	100%	67%	-	Slight	9.2	0.3	2.7	12.2	Fair
52	100%	0%	<0.05	Slight	2.3	<0.05	-	2.3	Fair
53	33%	83%	<0.05	Slight	<0.05	0.3	26.5	26.8	Fair
54	100%	33%	0.1	Slight	5.6	<0.05	-	5.6	Moderate
55	0%	0%	-	Slight	0.8	-	-	0.8	High
56	0%	100%	<0.05	Moderate	-	1.1	<0.05	1.1	Fair
57	100%	75%	<0.05	Slight	2.9	0.1	-	3.0	High
58	88%	100%	<0.05	Slight	4.3	0.2	-	4.6	High
59	0%	0%	-	Moderate	-	<0.05	-	0.0	Fair
60	0%	100%	-	Severe	-	<0.05	-	0.0	Low
61	0%	86%	-	Moderate	-	0.1	-	0.1	Fair
62	0%	86%	<0.05	Slight	2.8	0.2	-	3.0	Fair
63	100%	100%	-	Slight	0.3	<0.05	-	0.3	High
64	100%	0%	<0.05	Slight	1.3	0.3	-	1.6	High
65	0%	67%	-	Slight	-	0.1	-	0.1	High

Table 4. Potential water quality impacts from areas with potential water quality impacts for each land parcel with inundation.									
Land Assessment ID	**Unstable-Uncovered Bank**	**Riparian Woody Vegetation**	**Bare**	**Erosion Hazard**	**Pasture**	**Grass**	**Other hay/ non-alfalfa**	**Total potential grazed area (ac)**	**Runoff potential**
Grand Total (ac)			6.2		229.7	70.7	39.1	339.6	