NOTE FOR INTERNET VERSION: For Appendices A, B, and C, please contact Layna Goodman, U.S. Army Corps Of Engineers at 206-764-5523 or layna.a.goodman@usace.army.mil. Appendix D is downloadable via its own link under Kootenai Flats Agricultural Seepage Study at:

WWW.NWS.USACE.ARMY.MIL/ERS/DOC_TABLE.CFM

Upper Columbia Basin Alternative Flood Control NEPA EIS

Kootenai Flats Seepage Analysis

Bonners Ferry, Idaho

for

U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

by

HDR ENGINEERING, INC.

August 2003

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1. INTRODUCTION

1.1. Background

Pursuant to section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, the US Army Corps of Engineers (Corps), and the Bureau of Reclamation (Bureau) are preparing an environmental impact statement (EIS) on operational alternatives for the conservation of threatened and endangered species of fish listed for protection under the Endangered Species Act. These two agencies are joint lead agencies for EIS preparation under NEPA. Specifically, this EIS will address those operational actions for Libby, Hungry Horse, and Grand Coulee Dams identified by the National Marine Fisheries Service and the US Fish and Wildlife Service as Reasonable and Prudent Alternatives in their Biological Opinions (BiOps) both dated December 21, 2000. Those BiOps call for the Corps and the Bureau to undertake various actions at their 14 main Federal Columbia River Power System (FCRPS) dams to assist in recovery of fish species listed under the Endangered Species Act in the Columbia River basin. Among those actions is implementation of an alternative flood control strategy, called variable discharge (variable Q, or VARQ), required at Libby and Hungry Horse Dams. As an effect of VARQ flood control at the headwaters projects, Grand Coulee Dam would provide more flood storage space in years with average to slightly-below-average runoff forecasts. Other actions that would be addressed in the EIS include release of high spring flows from Libby Dam to benefit white sturgeon spawning, incubation, and larval survival.

All three reservoirs are storage reservoirs. Libby and Hungry Horse are on headwater tributaries to the Columbia River, the Kootenai and South Fork Flathead, respectively, while Grand Coulee is on the mainstem Columbia. Libby is a Corps project, and Hungry Horse and Grand Coulee are Bureau projects. VARQ is a flood control operation plan that reduces wintertime reservoir drawdown at Libby and Hungry Horse for floodwater storage compared to existing operation, and provides better assurance of reservoir refill in summer, to meet multiple water uses. While VARQ flood control does not specifically provide for fish flow releases, it does help assure that there is water available to provide for a pulse of water for sturgeon in the spring.

Information received at the public scoping meetings and from other sources, indicated that work to evaluate the impacts of waterlogging in the Kootenai Flats area would be necessary in order to address potential impacts from operations of Libby Dam that include VARQ flood control and fish flows. In August 2001, the Corps contracted with HDR, Inc. to assist the Corps and Bureau in preparing this evaluation of impacts from waterlogged areas to support the EIS.

The evaluation presented in this report on three areas (1) potential causes of impacts to agricultural production related to high river stages, (2) agricultural practices that have been affected by high river stages, and (3) present and past agricultural activities related to high river stage conditions.

1.2. Purpose and Scope

The “Kootenai River Flooding and Erosion Study, Bonners Ferry, Idaho – Investigation of Federal Interest” report, dated July 2000, generally identified two problems in the study area: 1) Waterlogging from the river during periods of higher flows in the river saturate agricultural land making it unusable and 2) Erosion along the banks of the river is threatening to breach the existing levee system. The purpose of this report is to provide additional information on agricultural impacts resulting from waterlogging during periods of elevated river stages. The following tasks were included in this scope of work:

- Identify acreage of potentially affected crops.
- Determine historical timing and magnitude of high water table or soil moisture conditions.
- Identify management practices for anticipated future periods of high river flows.
- Obtain available soil data relevant to anticipated future high water or high soil moisture conditions.
- Identify crop yield changes predicted by growers in the valley.
- Assess historical crop impacts due to high water levels and soil moisture conditions that are the result of high river flows by interviewing growers to obtain relevant information, such as location of affected areas, and dates of impact to crops and farming activities, performing visual examinations of fields and soils, searching publicly available information, documenting observations of foundation waterlogging, high soil moisture content, wet field conditions, or water-stressed crops.
- Map areas historically affected by high water levels.
- Correlate the reported changes in crop yields with high flows and precipitation.
- Identify farming practices during high water table and soil moisture conditions, including but not limited to: actions currently being taken for high river flow periods, locations of existing drain systems and pump stations, pumping schedules and flow rates, recent and projected improvements in drainage and pumping facilities, and anticipated changes in agricultural practices due to potential future high river flow conditions.

This information was collected primarily from field interviews with growers in the valley, but also relied on information presented in previous reports and information that could be obtained from other agencies such as the Natural Resources Conservation Service (NRCS) and the U.S. Geological Survey (USGS).

2. STUDY AREA DESCRIPTION

2.1. Location

The study area encompasses areas adjacent to the Kootenai River from approximately five miles upstream from Bonners Ferry, downstream to the Canadian border (See Plate 1). Levees have been constructed along both sides of the Kootenai River for about 50 miles from a point upstream from Bonners Ferry to the U.S./Canada border. Land use in this area is mostly agricultural, separated into 14 drainage districts totaling approximately 35,000 acres. Each drainage district is separated by cross levees and gravity drains. Pumping facilities are used to transport surface and ground water back into the river.

2.2. Geology

The Kootenai River downstream from Bonners Ferry, Idaho, occupies a glaciated trough that subsequently contained glacial Lake Kootenay as the continental glacier lobe retreated northward during the last phases of the most recent ice age. Glacial retreat was accompanied by reduction of lake size as the west arm outlet became ice free. Fine sands, silts, and glacial lake sediments underlie the valley floor. The west side of the valley has steep rocky slopes rising to tall peaks above 6,000 feet elevation. Cascading creeks drain the mountains and empty abruptly across alluvial fans along the west valley side. The valley's east side is bordered by a glacial terrace forming a plateau about 550 feet above the river, largely underlain by glacial lake and ice contact sediments. The Kootenai River upstream from Bonners Ferry flows in a valley that was eroded through terraces of glacial sediment into structurally controlled bedrock canyons.

In contrast to the river upstream from Bonners Ferry, the lower Kootenai River is in a weakly aggrading valley where any erosion is incidental to the river depositing more sediment in maintaining its gradient across Kootenai Flats. The Kootenai River has formed a system of natural levees along its meandering course and along the tributary creeks where they merge with the river. These natural levees are a result of periodic floods scouring and laterally eroding the main channel. The excess sediment is lifted up and over the riverbanks where it is rapidly deposited as the river spreads out beyond its banks. As the sediment spreads out and forms the levee, it begins to fill in the tributary outlets. As this main channel levee is commonly 15 feet higher than the adjacent flood plain, it can significantly impede tributary drainage. Even with such high relief, occasionally larger floods will overcome the current levee and reroute the river channel. This was a common occurrence prior to the construction of Libby Dam.

The valley floor is a nearly flat surface where the natural levees form the only relief other than a couple of isolated bedrock outcrops. The lowest places on this valley floor are at its lateral edges. The highest parts of the valley floor are in the middle of the segment. The river has formed a natural levee system noticeably broader upstream from Copeland where greater aggradation has been necessary in order for the river to establish a graded profile. The lateral extent of the levee deposits indicates the portion of the flood plain that has been occupied in the past by river channels. Although it is possible that earlier levees and relic levees may in time have been obliterated, it is more probable that the post-glacial Kootenai River has never occupied those portions of the valley not characterized by natural levee deposits. The low areas remained poorly drained because the natural levees inhibited tributaries from entering the Kootenai River. During floods, sediment was transported upstream along tributary creeks forming levees along their banks. As the flood passed, this tributary congestion further retarded drainage of the low areas of the flood plain. Over the years, periodic flooding of these low areas outside the natural levee system has resulted in deposition of thin layers of overbank silt and peat over the glacial lake sediments.

2.3. Soils

The soils in the Kootenai River Valley are predominantly silts and sands deposited by the Kootenai River. The soils have developed from limestone deposits in the upper Kootenai River Watershed. The growers interviewed during this work identified the soils in the valley as silts, silty loams, peat, clay, sands, and gravels. Based on information obtained from the growers, the make up of the valley floor is very complex. Materials deposited from side drainages tend to be more gravels and sands that lie within larger areas of peat, clay, and silts. The organization of soils has been further complicated by earth moving activities of some of the growers to fill in lower lying areas. Growers have reported that there are gravel and sand lenses that underlay the valley floor at irregular intervals and play a significant role in the flow of groundwater.

Several of the growers noted that the now abandoned routes of side drainages across the valley floor can be seen in many aerial photographs and are typically areas where they experience a combination of seepage from the river and ground water flows coming from the sides of the valley. These side drainages have been re-routed and channeled to consolidate or protect agricultural land, but the sands and gravels deposited in the old channels play a part in waterlogging effects throughout the valley.

The NRCS has identified approximately forty different soil types within the valley floor. Detailed information for the soils found in the Valley is included in Appendix B and Plates 1 through 5 in Appendix A. The plates present a map of these soil types and the areas affected by waterlogging that were identified during this effort. The primary soil types are as follows (Gondek, 2003):

Bane loamy fine sand - This soil is composed of 85 percent Bane loamy fine sand with 15 percent - 5 percent Farnhamton soils, and about 10 percent areas of scattered boulders at the heads of alluvial fans; the stream channel is subject to change as a result of channel plugging by debris during spring runoff. This soil is typically found on recent alluvial fans at the mouths of canyons along the west side of the Kootenai River flood plain.

Crash-Artnoc complex - This soil is composed of 50 percent Crash silt loam and 30 percent Artnoc silt loam with 20 percent - 10 percent included areas of Wishbone soils, and 10 percent Caboose soils. This soil is typically found on north-facing terrace slopes (Crash) and on northwest and east-facing terrace slopes (Artnoc).

DeVoignes-Ritz association - This soil is composed of 45 percent DeVoignes mucky silt loam 35 percent Ritz silt loam with 20 percent - 15 percent included areas of

Schnoorson soils and 5 percent areas of Pywell soils. This soil is typically found in depressions and swales on the Kootenai River flood plain (DeVoignes) and occupies the low terraces and ridges (Ritz).

Farnhamton silt loam - This soil is composed of 90 percent Farnhamton silt loam with 10 percent - included areas of Ritz soil and small areas in some areas in some river bends where the surface layer is fine sandy loam. This soil is typically found on neutral levees parallel to the Kootenai River and along some tributary streams.

Pend Oreille-Idamont association - This soil is composed of 45 percent Pend Oreille sandy loam and 30 percent Idamont silt loam with 25 percent - 15 percent included areas of Treble gravelly sandy loam; 5 percent is Kriest soils, and 5 percent is Rock outcrop and small stony areas. This soil is typically found on glaciated mountainsides – north and east-facing.

Porthill silt loam, 0 to 12 percent slopes – This soil is composed of 85 percent Porthill silt loam with 15 percent - 10 percent included areas where slopes are 12 to 20 percent and 5 percent areas of Rubson silt loam where slopes are 3 to 12 percent. This soil is typically found on high terraces in the northern part of the survey area.

Pywell muck, 0 to 1 percent slopes – This soil is composed of 90 percent Pywell muck with 10 percent included areas of DeVoignes soils. This soil is typically found in basins and depressions in stream bottoms.

Pywell-DeVoignes complex, 0 to 1 percent slopes – This soil is composed of 70 percent Pywell muck and 30 percent DeVoignes mucky silt loam. This soil is typically found in basins and depressions in stream bottoms.

Ritz-Schnoorson complex, 0 to 2 percent slopes – This soil is composed of 55 percent Ritz silt loam and 45 percent Schnoorson silty clay loam. This soil is typically found on low terraces and ridges on the Kootenai River flood plain (Ritz) and in basins and swales in the Kootenai River flood plain (Schnoorson).

Rock outcrop-Pend Oreille-Kriest complex, 0 to 2 percent slopes – This soil is composed of 45 percent Rock outcrop, 30 percent Pend Oreille sandy loam, and 15 percent Kriest gravelly sandy loam with 10 percent included areas of Idamont soils and 5 percent areas of Treble soils. This soil is typically found on low terraces and ridges on the Kootenai River flood plain (Rock Outcrop) and in basins and swales in the Kootenai River flood plain (Pend Oreille).

Rock outcrop-Pend Oreille-Kriest complex, 5 to 65 percent slopes – This soil is composed of 45 percent Rock outcrop, 30 percent Pend Oreille sandy loam, and 15 percent Kriest gravelly sandy loam with 10 percent included areas of Idamont soils and 5 percent areas of Treble soils. This soil is typically found on the barren bedrock exposures on glaciated mountain slopes (Rock Outcrop), on glaciated mountainsides, northerly aspect (Pend Oreille), and on glaciated mountainsides, southerly aspect (Kriest).

Rock outcrop-Treble complex, 5 to 65 percent slopes – This soil is composed of 55 percent Rock outcrop and 30 percent Treble gravelly sandy loam with 15 percent - 5 percent included areas of Kriest soils, 5 percent Idamont soils, and 5 percent Pend Orielle soils. This soil is typically found barren bedrock exposure on glaciated mountainsides (Rock Outcrop), and on glaciated southwest facing mountainsides (Treble).

Rubson silt loam, 0 to 12 percent slopes – This soil is composed of 90 percent Rubson silt loam with 10 percent - 5 percent included areas of Rubson silt loam on 12 to 20 percent slopes, and a 5 percent a complex of Selle fine sandy loam and Elmira loamy sand. This soil is typically found on broad glaciolacustrine terraces.

Rubson-Porthill association, 0 to 12 percent slopes – This soil is composed of 75 percent Rubson silt loam and 20 percent Porthill silt loam with 5 percent included areas of Rubson silt loam on 12 to 20 percent slopes. This soil is typically found on broad glaciolacustrine terraces.

Schnoorson-Ritz association, 0 to 1 percent slopes – This soil is composed of 60 percent Schnoorson silty clay loam and 40 percent Ritz silt loam. This soil is typically found in basins, depressions, and swales in the Kootenai River flood plain (Schnoorson) and on low terraces (Ritz).

Seelovers silt loam, less than 2 percent slopes – This soil is composed of 75 percent Seelovers silt loam with 25 percent - 10 percent included areas of Rubson soils; 5 percent DeVoignes soils; 5 percent Bane soils; 5 percent Stein soils; 2 percent Pywell soils (also included are small areas where gravel and cobbles are between depths of 20 to 40 inches). This soil is typically found on stream bottoms.

Selle fine sandy loam, 0 to 7 percent slopes –This soil is composed of 90 percent Seele fine sandy loam with 15 percent - 10 percent included areas of Elmira soils and 5 percent Rubson soils. This soil is typically found on glaciolacustrine terraces.

Selle-Elmira complex, 0 to 20 percent slopes - This soil is composed of 60 percent Selle fine sandy loam and 40 percent Elmira loamy sand. This soil is typically found on terraces - nearly level to gently sloping (Selle) and on terraces - nearly level to hilly or duny (Elmira).

Stein cobbly silt loam, 0 to 12 percent slopes – This soil is composed of 75 percent Stein cobbly silt loam with 25 percent - included areas of Stein gravelly silt loam (also included are small areas where the surface layer is less than 15 percent gravel or cobbles and small areas where slopes are more than 12 percent). This soil is typically found on high glacial terraces.

Stein-Pend Oreille association, 0 to 35 percent slopes – This soil is composed of 75 percent Stein gravelly silt loam with 25 percent - Pend Oreille sandy loam cobbly areas included. This soil is typically found on glacial moraines in valleys (Stein) and on glaciated mountain slopes (Pend Oreille).

Wishbone-Caboose complex, 45 to 75 percent slopes - This soil is composed of 60 percent Wishbone silt loam and 20 percent Caboose very fine sandy loam with 20 percent - 10 percent included areas of Artnoc soils, 10 percent Crash soils in small areas where slopes are short and range from 20 to 45 percent, and some areas where slopes are 75 to 110 percent. This soil is typically found on terraces.

The following soils are listed as hydric for the State of Idaho by the NRCS: DeVoignes, Ritz, and Pywell.

2.4. Meteorology

Several of the growers described a delicate balance that occurs in the valley between higher stages in the river and rainfall events. Many of the growers related advice that has been passed down from previous generations that relates timing of particular farming activities to one or more physical conditions in the valley. An example is looking for the existence of snow in a particular location on one of the nearby mountains. Another example is receiving the right amount of moisture at the right time. Too much, too little, too soon or too late can make the difference between 60-80 bushels per acre versus 100-120 bushels per acre. The economic effect is significant. Each of these examples point out the multifaceted relationship between farming and precipitation in the valley. In some years the growers hope for more rain, while in other years the soil waterlogging from various sources causes significant adverse impacts to crops.

The growers indicated the valley gets approximately 20 to 24 inches of rain annually. This number fits well with information from the National Weather service in the following table. The average maximum temperature for May through September is approximately 77 degrees (F) and the average minimum temperature for the same period is approximately 46 degrees (F).

Table 1: Monthly Climate Summary for Bonners Ferry from 1971 to 2000

BONNERS FERRY, IDAHO													
1971-2000 Monthly Climate Summary													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	33.2	39.6	49.6	60.2	69.2	75.7	83	83.1	72.2	57.2	40.2	33.4	58.2
Average Min. Temperature (F)	20.4	24.4	29	34.3	41.2	47.2	50.4	49.3	41.6	33.9	27.2	21.7	35.2
Average Total Precipitation (in.)	2.64	1.85	1.52	1.45	1.71	1.63	1.08	1.04	1.18	1.71	3.01	2.89	21.72

The following two graphs present the average temperature over the year and the average daily precipitation. The growing season is relatively short and that a majority of the precipitation occurs in the winter as snowfall. The growers pointed out that temperature is a limiting factor in the types of crops that can be grown in the valley and that the interaction between waterlogging and precipitation could occur at nearly any time of the year. Many of the areas that were identified by the growers as being affected by waterlogging are areas where waterlogging raises the ground water table sufficiently to inhibit drainage after a rain. The combination of these two factors typically caused greater impacts than did either waterlogging or rainfall alone. In a low precipitation year, a high water table may aid growers by providing root moisture.

Chart 1: Average Annual Temperature for Bonners Ferry

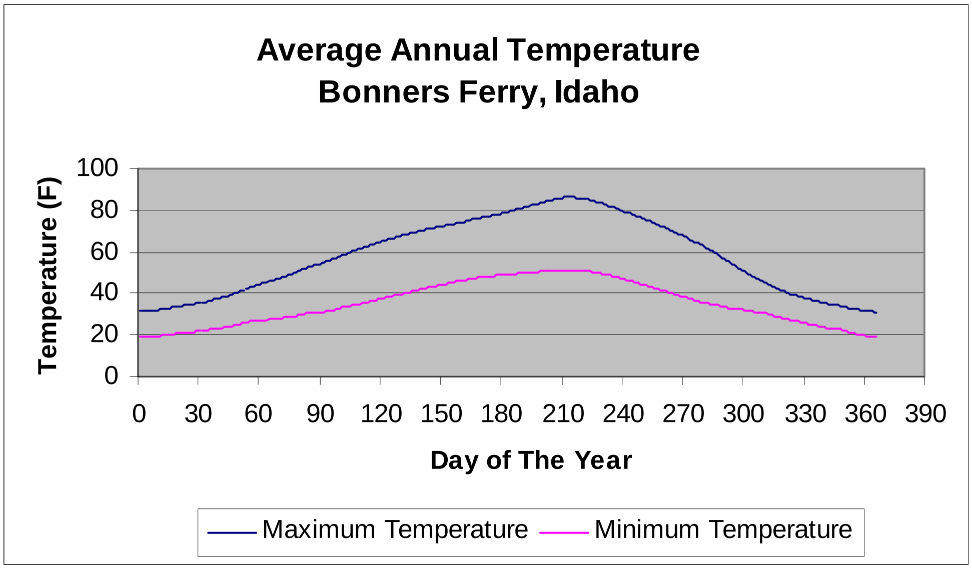
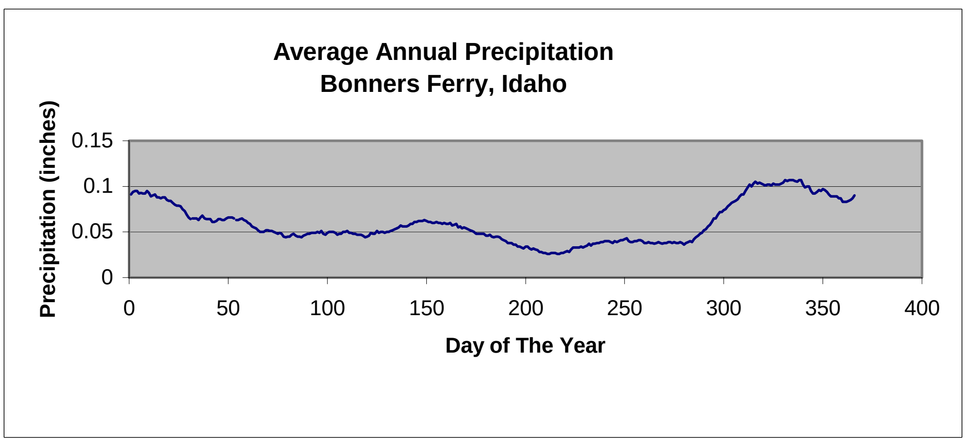


Chart 2: Average Annual Precipitation for Bonners Ferry



2.5. <u>Agriculture</u>

From the first time farming was attempted, the control of flooding has been an issue in the Kootenai Valley. The primary focus of efforts to control or eliminate the flood threat was construction of manmade levees to supplement the natural levees on the banks of the Kootenai River. Much of this activity took place in the 1920's when the growers organized themselves into drainage districts to provide the administrative structure necessary to manage the efforts. In addition to controlling flooding through the construction of levees, the majority of the land outside of the natural levees tended to be poorly drained and boggy so the farmers dug drainage canals and pumped water to drain the land. Local interests alone accomplished the maintenance, repair, and modification of the levee system until 1948. Between 1948 and 1974 the Corps of Engineers participated in repairing the levees after damaging flood events. Throughout these years, the tendency of the river to change its banks through erosion was restricted by frequent levee repair and placement of bank protection. The completion of Libby Dam , in the mid 1970's, provided sufficient flood control to make maintenance of the levees significantly less important and efforts at continued bank protection have been limited. The drainage districts continue to maintain the ditch and pump systems.

For a number of years after the construction of Libby Dam, the growers stated they did not experience significant problems with either flooding or waterlogging from the river. Since the early 1990's, Libby Dam has provided flows intended to protect and recover of endangered species. Since 1995, Libby Dam has also provided flows designed to benefit listed bull trout and a number of salmon species. The growers have indicated that the duration and magnitude of fish flows adversely impacts farm operations in a number of ways, including loss of crops and/or reduction in crop yields. Agricultural impacts in the Kootenai Valley between 1994 and 1997 have been estimated as follows (McGrane, 1998):

- 1994 – River stage 1753.4 feet. No agricultural losses reported.
- 1995 – River stage 1758.5 feet. $120,000 in crop losses over 600 acres.
- 1996 – River stage 1763.4 feet. $1.3 million in crop losses over 7,000 acres.
- 1997 – River stage 1764.7 feet. $1.4 million in crop losses over 8,000 acres.

Note: River stage is a maximum 30 day average (the highest 30 day average river elevation experienced during the summer months).

Reaction to these impacts by the growers have been somewhat varied but have not resulted in significant changes in the types or acreages of crops being grown in the Valley. Within the valley, approximately 35,000 acres could be farmed, although the number of acres available for farming is being reduced by the development of wildlife areas on the west side of the valley. According to Farm Service figures, since 1998 an average of approximately 30,000 acres has been involved with farm operations (including Conservation Reserve Program or CRP lands). In 1998 the number of acres being farmed was approximately 28,500 and in 2002 the number of acres being farmed reached approximately 32,000. The following annually harvested crops are grown in the valley :

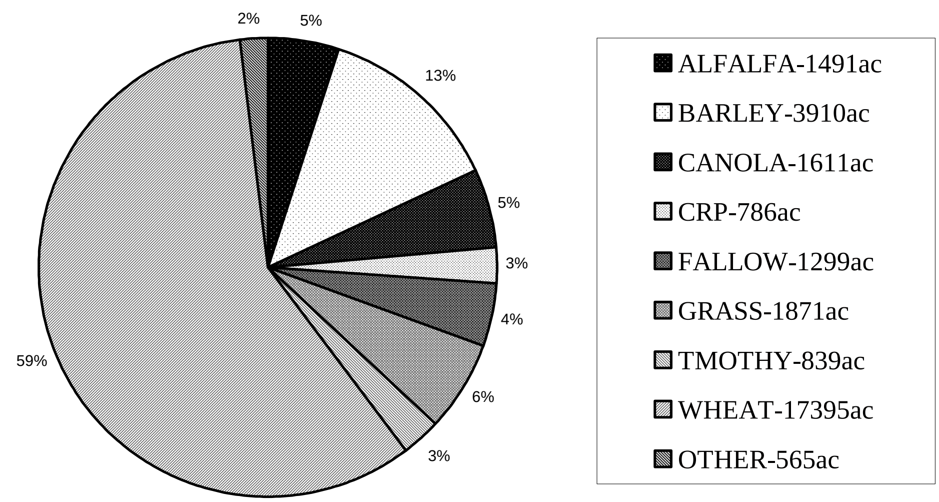
Alfalfa	Barley	Canola	Brome	Timothy
Bluegrass	Mustard	Oats	Peas	Soybeans
Wheat				

In addition, Elk Mountain Farms grows hops on two separate farms. Backwoods Farm grows approximately 1200 acres of hops on the west side of the valley in Drainage

District 16 and the Tavern Farm grows another 550 acres near the Canadian border in Drainage District 8.

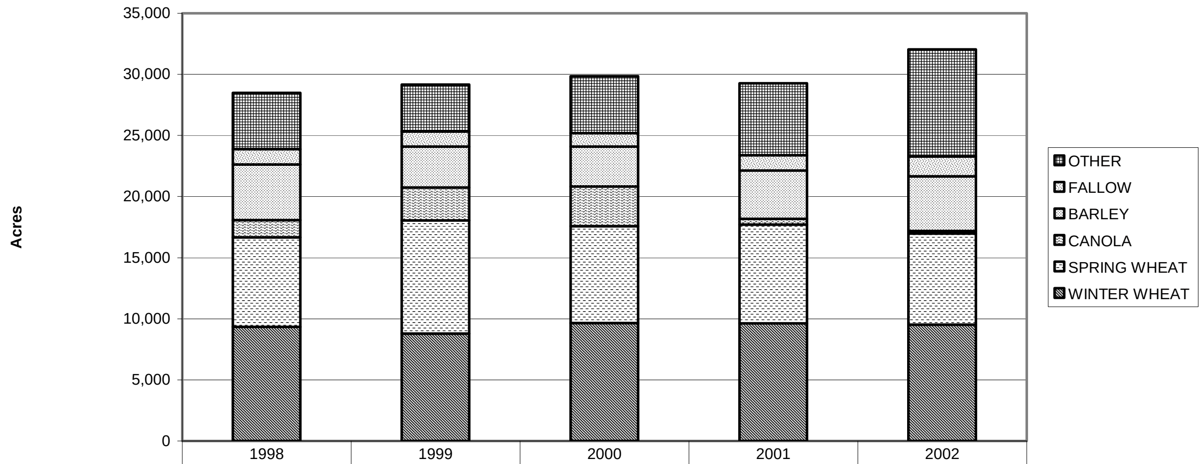
On average, wheat, barley, alfalfa, canola, and grass make up nearly 90% of the crops grown in the valley (Chart 3, Farm Service Bureau, 2003). It is worth noting that lands within the CRP and those left fallow are included in the data.

Chart 3: Average Annual Acres per Crop



Crops are rotated from season to season and from year to year but the approach to crop rotation is consistent regardless of what plan the growers are using. A majority of the planning around crop rotation is centered on the fact that winter wheat provides a significant income for many of the growers. Some of the growers will follow the harvest of winter wheat by planting either barley, canola or another appropriate crop while others allow the land to lay fallow over the summer. A majority of the growers indicated that crop rotation was primarily based on an individual determination that the rotation crop would be either profitable or at least allow them to "break even". Year to year there are some minor changes in the total acres being planted of any single crop, but the total acreages being grown are relatively consistent (Chart 4, Farm Service Bureau, 2003). The drop in canola production since 2000 was identified by the growers as a response to market influences.

Chart 4: Crop Type Acreages for 1998 - 2002



	1998	1999	2000	2001	2002
OTHER	4,615	3,838	4,651	5,893	8,763
FALLOW	1,248	1,248	1,101	1,265	1,637
BARLEY	4,556	3,325	3,258	3,950	4,461
CANOLA	1,407	2,711	3,243	471	221
SPRING WHEAT	7,335	9,263	7,923	8,085	7,443
WINTER WHEAT	9,338	8,781	9,658	9,617	9,533

Year

2.6. Hydrology and Hydraulics

The Kootenai River, throughout the study area, meanders across the valley floor, and bends in the river have a tendency to migrate laterally and downstream over time. The Kootenai River below Bonners Ferry is depositional in nature with only minor areas of erosion. The river formed a system of natural levees along its meandering course and along the tributary creeks where they merge with the river. These natural levees are typically 10 to 15 feet higher than the adjacent flood plain. Because these natural levees are higher than the flood plain, the tributary outlets have been blocked, preventing the areas behind the levees from draining. This has lead to chronically wet and therefore poorly drained soils.

The water level in Kootenay Lake affects the stage in the Kootenai River within the boundaries of the Study Area. Kootenay Lake levels are restricted in accordance with the requirements of the 1938 International Joint Commission (IJC) Order on Kootenay Lake. Under the terms of the Order, Corra Linn Dam is allowed to raise the level of Kootenay Lake to increase hydropower production to levels higher than the natural levels that occurred prior to 1938. Increased lake levels are permitted during all periods of the year except during the period of high snowmelt runoff. During the high snowmelt runoff period, lake levels are required to be lower than those which would have occurred prior to 1938. The minimum amount of the reduction is defined by the 1938 Order. Reduction of lake levels is possible because channel capacity at the natural lake outlet hydraulic control point, Grohman Narrows, was increased by dredging as required by the 1938 IJC Order.

At the time of Libby Dam construction in the early 1970's, the flood stage on the Kootenai River was set at an elevation of 27.0 feet at the Bonners Ferry gage (1770 feet, mean sea level, MSL). Levee evaluation field work done in 1995 and 1996, and water surface profiles generated for Preliminary Analysis Report (McGrane, 1998) concluded that overbank flooding would occur at river stages lower than elevation 1770 feet. A new flood stage for the Kootenai River valley as measured at the Bonners Ferry gage was determined to be elevation 1764.0 feet (MSL). The new flood stage is based on the premise that prolonged river stages in excess of elevation 1764 feet will eventually result in levee failure, and subsequent overland flow. The river level reached 1763.4 feet in 1996, and 1764.7 feet during 1997. Crop losses due to soil waterlogging occurred in 1996 and 1997. Erosion occurred in both years, but overbank flooding from the Kootenai River did not. Seasonal runoff in both 1996 and 1997 was substantially greater than average and the high flows and stages in the Kootenai River resulted from a combination of high local inflows and flood control operations of Libby Dam.

Agricultural impacts occur from standing water and high groundwater, beginning when the Kootenai River is well below flood stage. For river stages greater than elevation 1755 feet, gravity drainage of some fields is no longer possible, and pumps need to be employed. Growers have experienced several circumstances where the drainage system has been overwhelmed. The conditions where this occurred vary from late winter / early spring high river elevations coupled with high surface runoff over saturated ground to unexpected high river levels to severe rain events over a short period of time. Adverse impacts due to high groundwater include the inability to seed land, delayed seeding and resultant reduction in crop yield, and crops that drown before harvest. The Idaho State University Agriculture Extension Agent in Bonners Ferry documented the following history of agricultural impacts due to elevated groundwater levels (Harp, 2001; McGrane, 1998) and many of the growers have indicated a general agreement with these numbers.

Year	Max. Stage (feet)	No. Days over 1755 feet	Quantity of Acreage Affected	Crop Loss ($)
1994	1753.4	0	0	0
1995	1758.5	42	600	120,000
1996	1763.4	23 days (10 Apr-2 May) 60 days (15 May–14 July	7,000	1.3 million
1997	1764.7	69	2,000 reduced yield, 5,000 lost, 1,000 not seeded	1.44 million

Previous studies published by the Corps of Engineers have developed a maximum 30-day Average Stage vs. Crop Damage relationship based on observed water levels in 1994-1997 (McGrane, 1998). Maximum 30 day aver is the highest 30 day average river elevation experienced during the summer months. This relationship assumes that crop damage from groundwater is dependent on the highest 30-day average river elevation experienced during the summer months (usually May-June).

Max 30 Day Average Stage	Crop Loss
1755	$0
1756.89	$120,000
1761.08	$1,300,000
1762.57	$1,440,000
1763.0	$1,500,000

Expected average annual agricultural losses were computed for the 30 day average stage using the Corps of Engineers' Hydrologic Engineering Center computer program, Expected Annual Flood.

The major tributaries entering the valley floor have been leveed to prevent flooding of the ground adjacent to these drainages. When the river stage is high, water backs up into these drainages as they cross the valley floor causing waterlogged effects in areas adjacent to the levees surrounding these tributary streams. Some smaller tributaries have not been leveed but are typically intercepted by the drainage ditch system at the edge of the valley and routed to a pumping station.

3. DATA COLLECTION

3.1. <u>Methods</u>

In cooperation with Mr. Dave Wattenbarger, the former extension service agent in Boundary County, a preliminary contact list of growers in the valley was developed. The growers on the list were then contacted by phone to inform them of and invite them to a meeting at the Bonner's Ferry extension service. This meeting served as a means of obtaining the names of growers in the Kootenai River Valley, property boundaries, and agricultural information that would be part of an effort to identify and characterize the relationship between soil moisture content and yield reduction. The week prior to arrival of the field data collection teams in Bonners Ferry and during the time when the data collection teams were in the field, the growers were contacted to arrange a time when the teams could meet with them to discuss impacts from waterlogging on ground they are farming. Further development of the contact list and the establishment of appointments with the growers continued while the teams met with growers to collect field data.

Baseline data collected prior to field data collection included USGS topographic maps, 1998 USGS aerial photographs, and 2002 Corps of Engineers aerial photographs. Field data collection was accomplished in two teams, each consisting of two members. When the team met with the growers, they first described the interview process and intention of the data collection to the grower. Then, the team recorded the grower's input regarding current and past experience with the agricultural areas with which they were familiar. Information collection focused on the identification of areas farmed, the soil type of these areas, the determination of crops grown currently and in past years, the grower's assessment of waterlogging impacts in relation to river stages, and the discussion of the existing drainage and pumping system. The growers were also asked to identify the approximate extent of areas affected by waterlogging on aerial photographs.

After the initial interview, the team attempted to document past and current waterlogged areas in the field. The method employed to document waterlogged areas varied according to field accessibility and size. Whenever possible, the team encouraged the grower to accompany them in the field to ensure that the dimensions of waterlogging areas were documented as accurately as possible. These areas were then measured in the field under the direction of the grower, as his schedule and time frame permitted. When the grower was unavailable as a guide, teams used delineated aerial photographs and topographic maps to locate and document dimensions of affected areas identified by the grower. The team also used physical evidence to locate the waterlogging areas including, but not limited to: discoloration of plants, wet soils, stunted crop growth, lack of crop growth, apparent locations of temporary drainage ditches, standing water, and deep impressions in the soils from farm equipment. The approximate center point of each area was obtained using a handheld GPS. Length and width dimensions were measured by means of a range finder.

For large waterlogging areas, GPS points located at the edges of the affected area were used to describe the extent of the area. A center point and dimensions were later calculated from this information. Accessibility limitations were present in situations of recent chemical applications or limited availability of the grower. In some situations, a return visit was conducted to gather the desired information. If a return visit was not possible, the location and dimensions of affected areas were deduced from grower indications and evidence available on aerial photographs.

3.2. Process Limitations

There were some conditions limiting the information that could be collected during this effort. Those factors are as follows:

- The river stage this year peaked at approximately 1757 feet in Bonners Ferry and was only at this level for approximately two weeks. Therefore, minimal evidence of impacts from waterlogging was available in the field.

- Rain during three to four days of the fieldwork significantly increased the difficulty of differentiating between increased soil moisture from high river levels and increased soil moisture from precipitation.

- Some of the growers tend to minimize the perceived impacts of waterlogging and dismiss it as a common problem that they must overcome.

- A limited amount of time was allotted to collecting data from each grower to ensure that the teams covered as many of the growers as possible over a two-week period. Despite working longer hours than anticipated it was impossible to collect all of the information that each grower had.

- Some of the growers were extremely busy and could only offer the team a limited amount of time. In those cases, the team concentrated on documenting areas that the grower identified as being impacted by waterlogging.

3.3. Grower Information

The field work covered approximately 90% of the valley and over 30 individuals were contacted during the process. Because some of the contacted growers farm a piece of ground jointly with other growers, data was collected from only 25 growers. Two individuals (Roger Myers who operates a aerial application service and John Figgins who provides fertilizer application and soil analysis services) are not growers but were contacted because of their familiarity with crops and growing conditions in the valley. Information from all of the individuals contacted has been included in this report. The location of ground being farmed by the growers is presented in Appendix A, Plates 6 through 10. The boundaries shown on these plates are intended to describe the approximate extent of a growers operation and should not be interpreted to accurately represent property or lease boundaries. The list of growers and other individuals who were contacted during the collection of field data include:

Chris Amoth	Dallas Amoth	Victor Amoth	Ed Atkins
Julian Busher	Larry Copeland	Randy Day	Roy Day
Steve Day	Tim Dillon	Ernie Dirks	Greg Dirks

Kendal Dirks	Pat Dirks	Joe Figgins	John Figgins
Terry Howe	Craig Hubbard	Mike Hubbard	Wesley Hubbard
Tom Iverson	Lynn Jantz	Merl Jantz	Tom Koehn
Bill Michalk	Roger Mortar	Roger Myers	Bob Olson
Butch Palmer	Larry Peterson	Bob Vicaryous	Gary Wittgenstein

4. WATERLOGGING IMPACTS

4.1. General Conditions

During discussions with the growers, a number of items were identified that relate to waterlogging impacts. Those items are as follows:

1 Several of the growers addressed erosion of levees and identified locations where the levees have been and continue to be adversely affected by erosion. The point was made that while impacts from waterlogging were important, failure of the levees could mean that an entire district is inundated. The growers also pointed out that the Drainage Districts do not have the financial resources necessary to repair the levees.

2 The growers clearly indicated that there is a relationship between high groundwater levels and precipitation that impacts crops. They described this relationship in two general ways. There are instances where high ground water levels had already increased soil moisture content significantly in an area so that when rainfall occurred infiltration of rainfall was severely restricted. They also described observations of areas remaining wet for longer periods of time after a rainfall event when ground water levels are high. High ground water levels can reduce the soil infiltration capacity enough that even small amounts of rainfall will result in standing water that will drown out crops. It was not possible differentiate between the two factors under the field conditions at the time of the site visit.

3 The areas documented by the team attempted to represent the maximum extent of impacts as recalled by the grower or identified in the field. These areas correspond to the impacts that could be anticipated if the river stage was held at 1764 feet for about three-weeks. The team could not accurately identify the extent of impacts where the effects such as a partial reduction in yield might occur. Based on growers' observations, approximately 25% of the identified waterlogged areas would show some impact if the river stage was held at 1758 feet for approximately three weeks.

4 The growers indicated that even if the river stage reached an elevation of 1764 feet at Bonners Ferry, they would see minimal impacts from waterlogging if the river remained at that level for a week or less and then dropped to a stage at or below 1758 feet. If the stage at Bonners Ferry exceeds 1758 feet for two weeks, growers would start to see some impacts from waterlogging, and if the duration were increased to three weeks or more the impacts would be significantly greater.

5 Drainage districts were formed to maintain the levees, drainage ditches and pump stations. Most of the districts have concentrated on intercepting groundwater using either permanent or temporary ditches in the fields, then running the water in open ditches to a pump plant to be pumped to the river. These systems appear to have been set up to primarily address the local flowage from the surrounding mountains or precipitation. The growers have noted that with higher sustained flows in the river, seepage from the river become the predominant contributor to waterlogging.

6 In several of the Drainage Districts, the restoration of wildlife habitat on some parcels has included removal of the drainage ditches that intercepted the smaller tributaries. At these locations, shallow water ponds have formed along the edge of the valley that appear to remain year round. In one such case, the grower estimated that each year the ground adjacent to the pond that is too wet to farm increases in extent by approximately 100 feet laterally. It is not clear if the water surface of the pond is increasing in size each year or if the increase results from the subsurface effects from the pond. Nor is it clear what the potential interaction is between the shallow pond and river stages.

7 There is evidence of crop loss (stunted growth and/or plant discoloration) in a number of locations where the ground surface appears to have a relatively low moisture content.

8 Based on observations made by local farmers in the period of time since the construction of Libby Dam, many areas that have had problems with waterlogging are being planted with crops that are more tolerant of higher soil moisture contents, but even in these areas there is evidence of crop loss due to elevated ground water levels.

9 The effects of waterlogging include crop loss resulting from ponded water, reduced yields caused by high soil moisture content, high soil moisture content that prevents farm equipment from traveling over the ground, increased costs associated with working around affected areas, and loss of investment when areas are affected after the application of fertilizers and pesticides. The growers estimated costs of $100 to $150 per acre to grow a crop to maturity and harvest. They estimated the return on that investment at approximately $200 per acre.

10 Based on observations made during this field trip, the location of approximately 70% of the areas affected by waterlogging is somewhat tied to elevation, but there does not seem to be a good correlation between waterlogging and the distance from the river. For the remaining 30% of the areas, the geologic structure of the valley floor seems to play a much more important role. These areas appear to occur at the tops of high spots where there are gravel or sand layers near the surface, along the route of an abandoned drainage channel, at the end to gravel lenses, etc.

11 Areas that cannot be sprayed because equipment cannot be driven across waterlogged areas can harbor disease and insects. These areas will re-infect the remainder of the crop and cause increased costs when the grower is forced to re-apply chemicals to the remainder of the field.

12 Often, the farmers are forced to operate with a buffer zone around the areas of waterlogging to avoid becoming “stuck” in the mud. This results in the loss of portions of the crop outside the waterlogged area.

13 In general terms there is evidence that the southern part of the valley has more gravels and sands which results in a much quicker response of ground water level to changes in river stage than is experienced in the northern portions of the valley where the soils are typically silts and clays.

14 A number of locations were identified where the grower has decided to grow a grass crop in an area where either the water table is higher. This may be due to impacts from waterlogging, areas where surface runoff tends to collect, or some combination

of these factors exists. These fields are typically associated either with the production of grass hay or grass seed. Production of grass for seed is typically done under pre-arranged contracts that dictate that the plants be no older than 3 or 5 years to protect the quality of the seed. In either case there is a limit to the number of years that a grass crop can be left in a field. When these crops are removed the ground is somewhat difficult to work due to the existence of grass “clumps” that do not break down easily. The growers typically leave the field fallow for at least part of a year to give them time to break down the “clumps”. Typically these areas are returned to a grass but may be planted with another crop for a short time. This rotation does not appear to impact the overall percentages of crops being grown significantly as was seen in Chart 4.

15 Most growers were reluctant to pursue alternative crops that would be more tolerant of high moisture conditions. Reasons range from the cost of purchasing new equipment that would be required for a crop that is significantly different from what they are growing now, to memories of past efforts that have failed. For example, attempts have been made to grow rice in the valley, but the crop was lost to birds, leaving a negative experience that is easily recalled by the growers. None of the growers were opposed to using alternative crops that would be more tolerant of higher moisture contents, but it would likely require clear evidence that the crop will be profitable before the growers would be willing to participate.

16 The tenacity and optimism of the growers plays a role in how growers farm likely waterlogged areas. There are areas in the valley where the growers have identified a high potential for impacts to the crop at that location from waterlogging, but the surrounding field exhibits either no such problem or a limited impact from high soil moisture. In some cases, the growers have elected to plant these areas despite the probability of either reduced yields, loss of crop, or increased operating costs. Reasons given for planting these areas vary from determining that diverting equipment around the area would cost more in increased fuel costs than the potential loss of crop, to a belief that the conditions in some years will be sufficient to get a harvestable crop from the area.

17 The growers noted that there is a complex network of subsurface “drainages” formed by gravels and sands that were deposited by either tributary drainages of the Kootenai River or by the Kootenai River. These subsurface features appear to have significant influence over where and how quickly waterlogged areas respond to a change in the river stage. In some instances, these “drainages” are located on ridges across the valley floor and tend to create wet spots on what appears to be the higher elevations in the valley. If the river stage is held high enough for a sufficient duration, ground water from these higher locations will flood adjacent lower areas.

18 Except for a few selected locations, there has been little variation in the crops grown over the last 10 years. The growers attributed this fact to economic influences. For example, crops must generate enough return to provide the growers with an acceptable income. Also, switching to new crops must be able to cover the costs associated with reconfiguring equipment to handle the new crop.

4.2. Affected Areas

Waterlogged areas can be divided into two subareas: primary and secondary areas. The primary area is one which has chronic waterlogging impacts. Visible identifiers would be standing water and/or little to no crops. The secondary area is the area surrounding the primary area. It may be identified by diminished crop growth (0-100%), weeds, or wet soil or combinations.

Areas that are affected by waterlogging were identified throughout the study area. Over 150 locations with a total area of approximately 2000 acres were identified, located and mapped. The identified locations and their areas are shown in Appendix A on Plates 11 through 15. A summary of the areas by drainage district is as follows:

District	Area (acres)
1	287.9
2	42.8
3	184.9
4	104.4
5	4.9
6	98.4
8	231.5
9	65.1
10	148.4
11	203.6
12	23.3
13	117.4
15	26.1
16	442.3
N/A	9.7
Total	1,990.7

Table 1. Acreage of Waterlogged Areas by Drainage District

Based on the limitations of the work, it is likely that secondary areas were missed that would show impacts from waterlogging if higher stages in the river were to occur and remain high over a period of at least 3 weeks. In addition, the primary areas identified are those that would be most seriously affected by higher river stages over extended durations but they do not necessarily include the secondary areas which will surround the primary areas. These secondary areas would likely add significant acreage to the totals.

4.3. Pumping Costs

The growers provided cost information for the pump stations for some of the Districts and Elk Mountain Farms. This information confirmed work previously completed by Aaron Harp (Harp, 2001). The growers suggested that using the information that had been previously provided to Harp would fairly represent the current conditions. The approximate location of the pumping stations and drain ditches are shown in Plates 17-21**.**

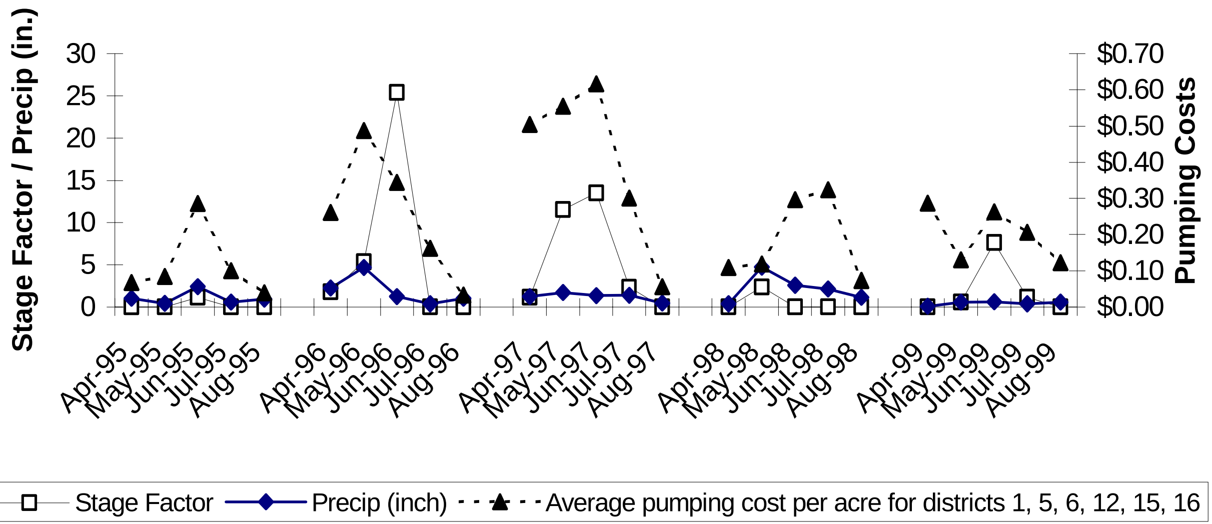
The pump systems begin to pump in response to higher water levels in the drainage ditch systems behind the levees. Those higher water levels can be caused by either waterlogging from elevated stages in the river, precipitation runoff, or a combination of both. The growers indicated that sustained duration of higher river stages has a direct bearing on pumping costs. The following graphs present the relationship between pumping costs in some of the districts, river stage and duration, and precipitation. While the growers related several instances of winter snow melt that forced them to operate the pumping station, the graphs have been restricted to the summer months of April through August when crops are typically more susceptible to damage. The combination of elevation and duration of elevated river stages was identified by the growers as a primary factor in how much they would have to use the drainage system pump stations each year. To help depict the impact of both elevation and duration of river stages, a stage factor. The stage factor was derived by multiplying the number of days the stage in the river exceeded a particular elevation by that elevation and then dividing by a number (such as 100) to allow the data points to be more easily compared to precipitation and pumping cost data in the following chart.

$$SF = N*H/100$$

where SF is the stage factor
N is the number of days in a year (for the years 1995 - 1999) was at a particular river elevation H

H is the river elevation above which effects are seen. This was broken into 1 ft intervals i.e. 1755, 1756 through 1764. For example, river elevations from 1755.0 through 1755.9 were all counted as 1755, 1756.0 - 1756.9 is counted as 1756. The first two digits were dropped i.e. “1755” became “55” to simplify the calculation.

Chart 5: Monthly Stage Factor and Pumping Costs



While there does appear to be a correlation between higher river stages and increase pumping costs, the graph also depicts the complex relationship between precipitation, river stage, and pumping costs. Several of the growers indicated that the broad variety of factors that affect the amount of time that pump stations are operated will make it difficult to develop a correlation between any single factor and pumping costs.

5. DISTRICT INFORMATION

The following is a compilation of the information that was obtained from the growers during the field visits. District areas and average elevation was obtained from USGS mapping. Soils information is a combination of information obtained from the growers and NRCS soils data.

5.1. District 1

General Information

The district lies west of Bonners Ferry on the south side of the Kootenai River and contains approximately 3,900 acres. The average elevation of the ground in the District is approximately 1755 feet. Four growers in this district farm a majority of these acres.

Soils

Where high ground water levels occur, the soil is typically a sandy loam, but the growers did note a few problems in areas with clay soils.

Crops

The growers are currently raising spring and winter wheat, timothy hay and barley. One of the growers will leave some ground in summer fallow, especially when replacing a grass crop. One of the growers rotates winter wheat and barley but does not grow much spring wheat. Several of the growers raise timothy hay in locations where there are poorly drained, wetter soils. All of the growers indicated that they are growing the same crops and using the same rotations that they have used for many previous years.

Effects of Waterlogging

The growers have seen several visual indicators of impacts from waterlogging. In most crops, the plants will turn yellow because nitrogen is released from waterlogged soils. They noted that waterlogging has retarded the growth of timothy hay enough to cause a difference in the height of the plant by one foot or more when compared to timothy hay that has not been impacted.

The growers indicated that grain crops impacted but not destroyed by waterlogging will typically suffer a 25 - 30% yield reduction. In addition, crops impacted by waterlogging will take longer to mature and commonly have light, low quality, small kernels. Wild oats and weeds grow well areas impacted by waterlogging. The presence of wild oats and weeds in grain crops will lower the yield and quality of the crop.

The growers also identified impacts that are operational in nature. They stated that it takes more time to work areas with waterlogging since the tractors sink into the soil and the additional time and effort raises fuel costs. In badly impacted areas, growers will avoid farming the area altogether, increasing time / fuel requirements since the grower is then faced with more “corners” in the field. When working impacted areas, the equipment will cause more compaction of wet soils, which can adversely affect the growth of the plants. Weed growth is more prolific in areas affected by waterlogging, requiring repeated application of herbicides. It is often difficult or impossible to operate equipment across areas with waterlogging and since aerial application of chemicals is less effective than ground application, growers have found it difficult to control weeds or insects in fields impacted by waterlogging.

The following table identifies the areas that were identified during the field work as having impacts from waterlogging:

Table 2: District 1 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D1LC10C	548515.00	5391207.00	1304	90	0	2.7
2	D1LC11C	548321.00	5391205.00	0	0	1271	14.6
3	D1LC12	548449.00	5391664.00	450	780	0	4.0
4	D1LC13	548468.71	5391401.06	450	195	0	2.0
5	D1LC1A	547901.00	5393605.00	0	0	1104	11.0
6	D1LC2	548015.00	5392805.00	0	0	1560	21.9
7	D1LC3	547958.00	5393205.00	0	0	1340	16.2
8	D1LC4	548936.00	5392799.00	0	0	829	6.2
9	D1LC5	549131.00	5393013.00	0	0	1080	10.5
10	D1LC6	548370.00	5392562.00	396	105	0	1.0
11	D1LC7	548532.00	5392242.00	405	1266	0	11.8
12	D1LP1	544801.35	5393138.38	1698	1581	0	61.6
13	D1PD1	548037.00	5392804.00	0	0	750	5.1
14	D1PD2	548031.00	5392231.00	0	0	852	13.1
15	D1PD3	547907.00	5391303.00	600	750	0	10.3
16	D1PD4	547303.50	5391101.83	1320	2640	0	95.9
						Total:	287.9

Drainage System

There are few temporary ditches that are installed by the growers on an annually basis. The permanent ditches contain water year round, but are only pumped when either waterlogging or surface runoff occur in sufficient volumes to fill the drainage ditches. The ditch capacity is insufficient during high river levels. One section of the ditch near the Deep Creek pump station is a culvert that was installed because the soils in this area were too unstable to permit the construction of a large deep ditch. The growers identified this culvert as the primary limitation in the capacity of the drainage system. One of the ditches in this District intercepts several boils that contribute significant amounts of flow to the ditches. There was some flow coming from these boils during this visit to the site.

There are two pump stations in the District. The first one, a lift station, has a 15 HP and a 60 HP pump. The Deep Creek station has two 60 HP pumps and a 35 HP pump. The 35 HP pump in the Deep Creek station runs constantly when the river is up. The growers only turn the pump stations on when they identify a need to reduce water elevations in the fields. Once the pumps are activated, their operation is controlled by float switches.

River Stage vs. Impacts

The growers indicated that during prolonged periods, several weeks or more, of higher river stages, waterlogging will wipe out barley and wheat crops. Timothy will probably survive, but the waterlogging could impact the growth of the crop. The growers described the relationship between rainfall and waterlogging from higher river stages in several ways. They noted that if the elevated river stages occur during a year of little rain, growers can tolerate high water a little longer but impacts from waterlogging will occur much sooner if year has been wet. They stated that if the river stage at Bonners Ferry is sustained at 1764 feet, crops can withstand two weeks if no heavy rains occur. The growers noted that the water levels in the river this year (approximately 1757 feet for several weeks) had little impact. Typically, impacts from waterlogging are apparent after 3-4 days of higher river stages and after 7-10 days, boils appear in fields. The growers suggested that increased flows and therefore higher stages in the river during November would cause minimal problems, while elevated stages any time during the spring (May - June), will likely result in impacts from waterlogging.

5.2. <u>District 2</u>

General information

This district lies east of Bonners Ferry, on the north side of the Kootenai River. Two growers farm a majority of the district which is approximately 1,200 acres. The average elevation of the ground in the district is approximately 1,765 feet.

Soils

Soils within the district are primarily peat and glacial silts. One grower had two pits excavated and found silt and gravel lenses at about 16 feet below grade. The exact location of these pits could not be determined. In one of the pits, the gravel lens contained a variety of material sizes from small cobbles (6" minus) to sand. The other pit revealed a layer of uniformly graded pea gravel (¼" to ½"). Each of these pits quickly filled with water to approximately the same elevation as the water surface in the river (as estimated by the grower). Where waterlogging occurs within the district, the soil is typically a silty loam to a silty clay loam, but the growers did note a few problems in areas with sandy loam soils

Crops

Growers are raising winter and spring wheat, barley, alfalfa hay, timothy hay and soy beans for sale. A peas / oats mix is being raised for silage. Timothy hay is raised in areas which are typically constantly affected by waterlogging. One grower keeps some of his inundated ground as pasture for cattle. One grower rotates wheat and barley but any changes made to crop type grown are driven by market prices.

Effects of Waterlogging

Growers have identified discoloration, lower yield and poor quality as some indicators of inundated crops. Poor quality plants lack kernel "plumpness", often suffer from higher disease rates and generally produce lower test weights. Discolored crops are visually unappealing which also lowers their price. Growers also noted that their operational costs in areas affected by waterlogging increase as they may be required to rework and replant the ground (requiring more fuel and time). It also causes more damage to current crops as the farmer must drive over "healthy" areas to get access to inundated ones. Sometimes the waterlogging is so severe, it must be avoided altogether resulting in lost production.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 3: District 2 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D2BM1	554311.66	5395502.07	366	339	0	2.8
2	D2BM10	553562.00	5395027.92	732	60	0	1.0
3	D2BM11	553883.26	5394988.66	192	90	0	0.2
4	D2BM12	553869.80	5394823.54	240	180	0	1.0
5	D2BM12A	554234.27	5394811.34	150	54	0	0.2
6	D2BM13	553033.03	5394745.01	57	546	0	0.7
7	D2BM13A	553152.25	5394882.01	48	477	0	0.5
8	D2BM14	553516.37	5394596.93	582	288	0	1.9
9	D2BM15	553682.32	5394538.28	45	540	0	0.6
10	D2BM16	553752.39	5394599.18	90	1050	0	2.2
11	D2BM17	554472.91	5394792.61	225	105	0	0.5
12	D2BM2	553997.00	5395597.43	117	1200	0	3.2
13	D2BM2A	554018.08	5395539.19	120	396	0	1.1
14	D2BM3	553535.06	5395452.27	465	114	0	1.2
15	D2BM3A	553819.05	5395345.85	72	324	0	0.5
16	D2BM4	553263.79	5395508.73	0	0	330	2.0
17	D2BM5	553066.68	5395569.48	1005	57	0	1.3
18	D2BM6	552926.66	5395309.35	0	0	486	2.1
19	D2BM7	553191.07	5395270.10	0	0	198	0.7
20	D2BM8	553044.17	5395148.45	588	60	0	0.8
21	D2BM9	553594.00	5394944.00	0	0	0	3.9
22	D2TI2	551348.00	5394943.00	1500	414	0	14.3
						Total:	42.8

Drainage System

The district has permanent ditches and a pump station. Flow in the ditches is typically seen in the spring. The pump station operates off a float switch once it has been manually energized. It is turned on in the spring if the drainage into the ditches is faster than gravity drainage out or if the river stage is higher than the gravity outlets. The ditches and pump station have been sufficient to move from the ditches and back to the river. One grower did indicate that the current ditch configuration is old and needs to be updated based on current practices.

River Stage vs. Impacts

One grower is losing land as the river cuts into his field. He has lost approximately one acre already and expects to lose another acre by the end of summer 2003. He cites one of the problems as quickly raising and lowering river levels as a major factor.

The other grower in the district has experienced two problems related to waterlogging. The first is a field of bluegrass where waterlogging problems have prevented them from harvesting the field. The ground has been so wet that it has prevented the grower from burning the field to clean up the problem. The second is an incident that occurred last year when the river stage was high. They had been able to drive tractors across lower sections of the fields where they had assumed a tractor might get stuck and then got the tractor stuck in a wet spot at the highest location in the field. They attributed the waterlogging at this location to groundwater flowing through the subsurface formation from the river.

5.3. District 3

General Information

District 3 lies west and north of Bonners Ferry, on the west side of the Kootenai River. It is directly north of the Kootenai National Wildlife Refuge (formerly District 7). One grower farms the approximately 1,100 acres in the district. The average elevation of the ground in the district is approximately 1765 feet.

Soils

Where waterlogging occurs, the soil is typically a silty loam to a silty clay loam.

Crops

The grower is currently raising barley and wheat in rotation. In areas he knows to be wet, he raises timothy due to its tolerance for higher soil moisture tolerance. The grower has also added bluegrass as it is also quite tolerant to high soil moisture tolerant. The grower's decision concerning rotation of grain crops is based on current market prices.

Effects of Waterlogging

The grower has seen several physical signs of waterlogging effects on crops and the land. The plants are discolored and are yellow in color. The kernels are shriveled and lighter. More weeds tend to grow which crowd out plants and lead to a lower yield. Often the grower will have to rework the impacted areas later in the season. He has additional time, effort, fuel, seed, chemical costs, etc. to accomplish this. This also delays his harvest date which in turn delays his fall planting. These delays increase the risk of bad weather and not getting a crop in at all.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 4: District 3 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D3SD1	543141.00	5401298.00	4410	1225	0	124.0
2	D3SD2	543154.00	5402135.00	0	0	700	8.8
3	D3SD3	543158.00	5402276.00	0	0	700	8.8
4	D3SD4	543864.00	5401809.00	3588	525	0	43.2
						Total:	184.9

Drainage System

The grower uses a series of drainage ditches and a pump station. Part of the ditch system is permanent and the other is changed depending upon the needs for the year. Water starts to appear in the ditches in February through March from snow melt. It drains by gravity until the river stage is higher than the gravity drain. Once the gates are closed, the pump station will remove water from the ditches and pump it into the river. The pumps are automatic and controlled by float switches. The grower stated that even with a system of annual and permanent ditches, the current drainage system is inadequate to handle all the water that enters the drainage system.

River Stage vs. Impacts

The grower noted that when the river elevation is at 1757 feet, there is some impact. He also noted that if the water stays high for longer than four days, impacts will be seen. The amount of time before impacts occur is shorter if there is runoff from the mountains in addition to high river stages.

5.4. District 4

General Information

District 4 is approximately half way between Bonners Ferry and the Canadian border on the east side of the Kootenai River. The district is approximately 2,700 acres in size with three growers there raising crops. One of the growers also farms on the nearby (southward) “Castillo Tract”. The site of the former town of Copeland is on the eastern edge of this district. The average elevation of the ground in this district is approximately 1760 feet.

Soils

Where waterlogging occurs, the soil is typically a silty clay loam. The growers did note some waterlogging problems that they associated with underlying gravel lenses and old routes of drainage channels where the channels had crossed the valley floor in route to the river.

Crops

The growers in this district raise winter and spring wheat with canola being used as a rotation crop. One grower did not raise canola in the past and is now trying it as a rotation crop.

Effects of Waterlogging

The growers have seen several effects due to waterlogging. They range from direct crop effects such as limited growth where plants are shorter and discolored. The affected crop overall generally has fewer plants per acre resulting in less yield. Growers have also experienced complete destruction in some areas. Operational impacts from waterlogging include stuck equipment, having to wait for areas to "dry" before entering the area with equipment, and having to rework waterlogged areas to control pests or weeds.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 5: District 4 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D4CA1	543511.00	5402042.50	1956	435	0	19.5
2	D4DA1ABC	544520.00	5415303.00	556	1111	0	14.2
3	D4DA2C	543023.26	5415234.00	210	1140	0	5.5
4	D4DA3C	545419.12	5410538.88	1200	1200	0	33.1
5	D4DA4	545872.00	5410108.00	0	0	0	0.0
6	D4DA4C	546002.00	5410305.00	0	0	0	32.1
7	D4DA4D	545734.00	5409088.00	0	0	0	0.0
8	D4DA4E	545628.00	5410235.00	0	0	0	0.0
9	D4DA4F	545981.00	5409095.00	0	0	0	0.0
						Total:	104.4

Drainage System

The grower in this district also use pumps and ditch system to drain excess water. The main pump house at Brush Creek has two 40 HP pumps. These are automatic pumps which are operated by float switches. Two additional PTO tractor pumps were recently added which can be moved and used as necessary. These help keep up with flows when the river elevation is too high to allow any gravity drainage. Pumps are typically turned on by the end of March to early April but this is highly dependent upon the flow in Brush Creek. It may be turned on earlier if growers see that the ditches are not draining.

Flow in the drainage ditches can start to show up in January if they experience an early thaw but significant flows in the drainage ditches starts in March. Higher flows are usually done by early to mid June. The ditch system is adequate for the flows but growers do maintain their ditch system.

River Stage vs. Impacts

The growers have noticed that high river stages are starting to affect the levees. They are seeing sloughing and erosion on the edges. They also noted that waterlogging effects takes about one day to show up in the fields after the river stage increases. In about one week, the wheat / barley crops are either damaged or killed. Crop impacts are dependent on the temperature and the amount of sunshine at the time waterlogging occurs.

The growers indicated, that higher river stages in the winter will have the least effect on crops. When the river stage is elevated for an extended period of time and then brought down quickly, this causes problems. The least effects are felt when the river goes up and down over a short period of time (several days).

5.5. District 5

General Information

District 5 is on the east side of the Kootenai River, directly north of District 11. Fleming Creek empties into this district. It is one of the smaller districts, covering about 950 acres with two growers farming a majority of the district. The average elevation of the ground in this district is approximately 1,761 feet.

Soils

Where waterlogging occurs, the soil is typically a mucky silt loam.

Crops

The grower in this district raises winter and spring wheat with barley or canola for rotation crops. Areas known to be typically wet are planted with timothy hay as it has tolerance for wetness that grain crops do not. The growers may not continue to grow timothy as raising a good crop requires the grower to burn the stubble after harvest. There is now a charge per acre for burning which may eliminate timothy as a viable crop due to cost. In addition to crop rotation, one of the growers fallows some areas to improve the yield in the following year. This grower noted that grain crops can be grown in waterlogged areas if the river stages stay constant and that while river stages were elevated but constant in the 1970's, river stages does not stay constant.

Effects of Waterlogging

When plants are impacted, they start to turn yellow and eventually die. These affected crop areas have a lower yield due to lower plant densities, weeds and insect infestations. The waterlogged areas contain more insects and weeds as spray equipment cannot access the impacted areas. Reworking impacted areas increases costs, labor and causes more damage to the current crop.

This grower would like to continue to grow timothy but as noted above, growers are now being charged to burn fields. One of the growers state that if he cannot burn, he plans on fallowing his fields instead of raising timothy.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 6: District 5 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D5LP1	545863.00	5403310.00	0	0	162	0.5
2	D5LP2	545977.62	5403428.23	252	519	0	3.0
3	D5LP3	543844.91	5403420.68	162	87	0	0.3
4	D5LP4	546250.25	5402099.43	819	60	0	1.1
						Total:	4.9

Drainage System

The drainage system for this district consists of a series of permanent ditches and a pump station by gravity. The ditches in this district always contain water and are constantly being drained or pumped. The pumps are automatic and operate on float switches once they have been manually energized. The grower determines when to turn the pumps on based upon the river elevation. Once the pumps are on, they will run pretty constantly but are not always capable of keeping up with the flow coming from the drain ditches. When the river level is at or above 1754 feet, the gates on the gravity drain are closed and the pumps are used to control the ditch water level. In a wet year, the grower noted that the ditch capacity is exceeded.

River Stage vs. Impacts

When the river elevation is at 1755 feet, grower starts to see standing water in the fields. If river levels are left high for 2-3 weeks, significant impacts will be seen in the fields. One of the growers noted that in a dry year, when the plants are growing i.e. (winter crops in late winter through spring; spring crops in late spring through summer), high river levels will impact the crops less.

5.6. <u>District 6</u>

General Information

This district is one of the northern most districts. It is located on the east side of the Kootenai River and covers approximately 5,600 acres. Currently three growers farm in this district. The average elevation of ground in this district is approximately 1,758 feet.

Soils

Where waterlogging occurs, the soil is typically a silty loam to a silty clay loam.

Crops

Growers in this district raise winter wheat, malt and feed barley, canola, timothy seed, alfalfa hay and mustard. Two years ago, a grower raised spring wheat but quit due to high fertilizer costs. The growers reported using barley, timothy or lentils as a rotation crop. They change the crop types and rotation based on disease control and to manage soil nutrients.

Effects of Waterlogging

The growers have reported seeing discoloration (yellow plants), staining and stunted growth as visible indications of waterlogging effects on crops. They also report "shriveled heads" (an indication of shallow roots) as another sign of waterlogging effects. The growers have experienced complete crop loss in some years and commonly losses of up 50% yield from waterlogging impacts. Other indicators of waterloggings are poorly formed heads of grain crops which will not produce grains (seed).

During a wet spring, growers will avoid the waterlogged areas and then come back after they have dried out to try and rework or replant them later. The waterlogging also causes equipment (seeders, discs, sprayers) to get stuck or generate large ruts in fields. Since the spraying equipment cannot access the waterlogging areas, weeds and insects will typically grow and thrive in these locations.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 7: District 6 Waterlogged Areas

	Point	**Easting**	**Northing**	**Length (ft)**	**Width (ft)**	**Diameter (ft)**	**Area (ac)**
1	D6BO6	539133.21	5419630.86	198	78	0	0.4
2	D6SD1	540156.00	5419881.00	1320	413	0	12.5
3	D6SD10	542553.00	5418764.00	0	0	495	4.4
4	D6SD11	542828.00	5419589.00	363	825	0	6.9
5	D6SD12	543033.00	5419693.00	908	330	0	6.9
6	D6SD13	543078.00	5420161.00	413	743	0	7.0
7	D6SD14	542606.00	5420439.00	0	0	198	0.7
8	D6SD15	542347.00	5420353.00	248	248	0	1.4
9	D6SD16	542417.00	5420602.00	330	165	0	1.3
10	D6SD2	541899.00	5419093.00	495	1568	0	17.8
11	D6SD3	541528.00	5418725.00	330	165	0	1.3
12	D6SD4	541488.00	5418529.00	330	165	0	1.3
13	D6SD5	541645.00	5418337.00	660	248	0	3.8
14	D6SD6	541465.00	5418095.00	0	0	413	3.1
15	D6SD7	541368.00	5417863.00	363	825	0	6.9
16	D6SD8	541721.00	5417903.00	248	248	0	1.4
17	D6SD9	542397.00	5418204.00	0	0	660	7.9
18	D6TD1A	539071.00	5420391.00	324	180	0	1.3
19	D6TD2	537970.00	5420756.00	660	300	0	4.5
20	D6TD3	537101.00	5421079.00	366	240	0	2.0
21	D6TD3A	537259.00	5421182.00	423	90	0	0.9
22	D6TD4	537365.00	5421006.00	600	90	0	1.2
						Total:	94.7

Drainage System

This district uses ditches and pumps to control water. Growers report that water is in the ditches all the time but that it is mostly due to upland flow from the creeks and surface runoff. The drainage system has been adequate to contain flows. These growers also have a maintenance program where the ditches are cleaned out annually by excavating.

Growers in the area typically refer to their pumps either by the horsepower (HP) or by the diameter of the discharge pipe. Growers in this district use the latter reference. There is no real correlation between horsepower and pipe diameter.

The pumping system is a combination of automatic and manual controls. One float switch controls an 8" pump, the other three pumps are manual: 16" electric, 20" electric and 24" diesel. These pumps operate all year round as necessary when conditions prevent use of the gravity drain or when the capacity of the gravity drain is inadequate. They have left the gravity drain gates open as late as June 1st but typically will close them by May 1st.

River Stage vs. Impacts

The growers said that most crop loss occurs when the river levels are high and there is significant amounts of surface runoff. One grower noted that when the river stage is at approximately 1760 feet, groundwater starts to flow in from the river to the area under the fields being farmed. At 1761 feet, the groundwater flows start to impact fields and crops. Another grower had the general observation that the river must be "fairly high" for any damage to occur. Growers experience impacts after the river level is high for one week.

One grower suggested that high river stages in the spring and lower river stages in the summer would cause the least impact. Another grower said that higher river stages in June causes the least impacts as field work is done. High flows in April and May were identified by the growers as the worst case scenario as these conditions are most likely to result in getting the equipment stuck and limiting the land that can be farmed.

5.7. <u>District 8</u>

General Information

District 8 is the northern most district, on the east side of the Kootenai River. It is approximately 1,600 acres in size with two growers in the district. The average elevation of ground in this district is approximately 1,750 feet.

Soils

Where waterlogging occurs, the soil is typically a silty clay loam to a mucky clay loam.

Crops

Growers primarily raise winter and summer wheat. They will typically raise barley, canola and clover as rotation crops. Last year, one grower did not raise canola due to low market prices. Barley is seen as a better rotation crop for the money. In areas where waterlogging is a problem, one grower prefers to leave the ground as pasture rather attempting to farm it.

Effects of Waterlogging

Growers have reported seeing limited height, discoloration, differences in crop maturity levels and complete destruction (especially with grain crops) as typical impacts from waterlogging. Growers noted that grass is more waterlogging tolerant. One grower leaves some of his more chronically wet ground as pasture.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 8: District 8 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D8LJ1	535603.66	5424776.98	1152	1428	0	37.8
2	D8LJ2	535133.79	5424960.06	807	684	0	12.7
3	D8LJ3	535648.16	5422914.86	99	252	0	0.6
4	D8LJ4	538346.64	5423617.39	1440	276	0	9.1
5	D8LJ5	537925.29	5423231.01	306	396	0	2.8
6	D8SD1	535936.00	5424199.00	0	0	450	3.7
7	D8SD10	536928.00	5425718.00	7339	800	0	134.8
8	D8SD2	536432.00	5424958.50	810	1620	0	30.1
						Total:	231.5

Drainage System

The drainage system consists of a series of permanent ditches and a pump station with one pump. Growers will start to see flow in the ditches starting in February to March. They will start up the pumping system around June 1 as it is a manually operated pump. The growers have an maintenance program where they maintain and dig out the ditch network. Even with this maintenance, they have noted that the ditch system is not adequate to handle high runoff and high river levels.

River Stage vs. Impacts

Grower have noted that seeps occur pretty quickly in the fields after the river level comes up. One grower suggested that the river level be held constant each year to minimize waterlogging impacts.

5.8. <u>District 9</u>

General Information

This district is half way between Bonners Ferry and the Canadian border, immediately north of the Copeland bridge. Kerr Lake is located near the middle of the district. One grower farms this district which is approximately 1,200 acres in size. The average elevation of ground in this district is approximately 1,755 feet.

Soils

Where waterlogging occurs, the soil is typically a silty clay loam.

Crops

The grower in this district raises spring and winter wheat. The wheat crops are rotated through fields. Once spring wheat has been harvested in the fall, winter wheat will then be planted. This winter wheat crop will be harvested the following summer and the land left to fallow until early spring when the spring wheat is planted. This grower does not grow other crops.

Effects of Waterlogging

The grower has noticed several waterlogging impacts to his crops. He has seen discoloration or yellowing of plants when they are impacted by waterlogging. He has also noted that the crop height is stunted and crop quality is reduced as plants have shallow roots and shriveled heads. The grower has also experience complete crop destruction since wheat cannot handle inundation. Operational impacts experienced by the grower include being unable to move equipment on field when it is wet as it causes severe rutting or the equipment gets stuck.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 9: District 9 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D9VA1C	542315.00	5415925.12	240	640	0	3.5
2	D9VA2C	542511.00	5415978.84	160	720	0	2.6
3	D9VA3C	543421.00	5416784.00	1953	60	0	2.7
4	D9VA4C	542398.50	5416325.50	360	1782	0	14.7
5	D9VA5C	542402.00	5416434.00	300	1787	0	12.3
6	D9VA6C	542405.50	5416638.50	300	1794	0	12.4
7	D9VA7C	542413.00	5416802.50	300	1717	0	11.8
8	D9VA8AC	542282.00	5416792.75	287	60	0	0.4
9	D9VA8BC	543390.50	5416720.50	1461	60	0	2.0
10	D9VA9C	543398.00	5416529.50	579	75	0	1.0
11	D9VA4A	542129.00	5416290.00	0	0	300	0.8
12	D9VA5A	542135.00	5416383.00	0	0	300	0.8
						Total:	65.1

Drainage System

This drainage system has permanent ditches and a pump. The gravity drain system gate is closed when the river stage reaches about 1750 ft. The grower noted that the time of year when he begins to see water in the ditches depends upon how long the levels are kept high and if rain occurs during this same time. At this point, he says the ditch system has been adequate to handle the flows.

The district pump system consists of one automatic pump, operated on a float switch and a manual portable pump (PTO tractor drive). The portable pump is moved and operated where and when needed. The automatic system is turned on when the river level is higher than the gravity drain. If the river level comes up too quickly, the portable pump is added as necessary.

River Stage vs. Impacts

The grower noted that when the river elevation is at 1757 feet, the river does not cause waterlogging problems. If the river elevation is 1761 or higher, it causes severe damage to the land and crops. The grower noted that the length of time the plants are impacted also plays an important role. One week is about the maximum time before impacts are seen. If it extends to three and four weeks, damage will be seen.

5.9. District 10

General Information

District 10 is the northern most district on the west side. One grower farms the land which is approximately 1,900 acres in this district. The average elevation of ground in this district is approximately 1,750 feet.

Soils

Where waterlogging occurs, the soil is typically a silty loam to a silty clay loam but the grower did note a few problems in areas with muck soils.

Crops

This grower raises winter and spring wheat with barley as a rotation crop. Grass hay is raised on the sandy ground as it is too wet initially and too dry later in the season for grain crops. This grower will keep some ground in fallow as it keeps moisture in the field and is economically beneficial. He noted that yields are better in fallowed fields. The grower makes crop changes based upon market prices. He prefers barley as a rotation crop as it comes off earlier than spring wheat and provide him with more time to plant winter wheat. He has raised soy beans, canola and oats in the past but has not continued with them as they are not as economically feasible as fallow.

Effects of Waterlogging

The grower has seen discoloration or yellowing in his crops. Waterlogged fields have lower yields because plant densities are sparse or non-existent.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 10: District 10 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	10RM10	537482.00	5418721.00	696	198	0	3.2
2	10RM11	537076.00	5418905.00	2943	858	0	58.0
3	10RM12	537888.00	5420058.00	0	0	303	1.7
4	10RM13	534909.00	5422550.00	519	234	0	2.8
5	10RM14	535410.00	5420595.00	243	90	0	0.5
6	10RM15	535037.00	5421271.00	519	180	0	2.1
7	10RM16C	535902.00	5420153.00	180	2811	0	11.6
8	10RM17	536281.00	5419826.00	621	321	0	4.6
9	10RM18	536824.00	5419150.00	681	1080	0	16.9
10	10RM1C	536994.00	5422909.00	200	4200	0	19.3
11	10RM2	538570.00	5420428.00	447	1629	0	16.7
12	10RM3	537149.00	5422892.00	60	159	0	0.2
13	10RM4	536478.00	5422640.00	240	351	0	1.9
14	10RM5	536786.00	5422651.00	0	0	252	1.1
15	10RM6	535601.00	5422398.00	0	0	474	4.1
16	10RM7	535437.00	5422412.00	0	0	366	2.4
17	10RM8	535512.00	5422408.00	60	522	0	0.7
18	10RM9	537461.00	5419138.00	60	456	0	0.6
						Total:	148.4

Drainage System

The system consists of permanent ditches. Ditches near the mountains will have flow during the spring runoff. As the river level rises, the seep areas will appear. The grower stated that the ditch network is not adequate to handle high flows.

There are two pump stations which are automatically operated by float controls. The first station has a 7.5 HP pump and the other stations has two pumps, a 30 HP and a 50 HP pump. The grower watches river level to determine when to shut the gravity drain gates and turn on the pumps.

River Stage vs. Impacts

The grower has noted that wet ground starts to appear when the river level is at 1760 feet. The seeps will show up near the river first then other will appear further from the river. If the land remains wet for a couple of weeks, crops will start to die. Grass crops are more tolerant and may survive. The grower indicated that if the ground starts to get wet at all, there will be negative impacts to crops.

5.10. <u>District 11</u>

General Information

District 11 is located to the northwest of Bonner Ferry. It is approximately 3,600 acres in size and a majority of the district is farmed by six growers. The average elevation of the ground in this district is approximately 1,761 feet.

Soils

Where waterlogging occurs, the soil is typically a silty loam to a silty clay loam.

Crops

Growers in this district are currently raising spring and winter wheat, malt barley, alfalfa hay, timothy grass (hay and seed), bluegrass, canola and potatoes. Canola and barley are the main rotation crops. timothy hay and bluegrass are grown in areas of chronic wetness. Growers in this district decide on crop changes after reviewing market prices however one grower also mentioned that time constraints also play a part.

Effects of Waterlogging

Last year growers saw a range of crops impacts from complete destruction to lower yield due to waterlogging. They indicated that waterlogging will cause crops no kernel plumpness, result in more weeds growing in impacted areas and generally result in lower test weights.

Operational impacts from waterlogged areas that are too wet to work in the spring generally cause the grower to experience greater costs and reduce efficiency of his operations, income and time. Attempts to plant later (after the areas dry out) cost more seed, chemicals, fuel, and time. Pumping costs are also higher and there is more ditch maintenance required.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 11: District 11 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	11CH1	548303.00	5394581.00	0	0	228	0.9
2	11CH2	548381.00	5395476.00	396	60	0	0.5
3	11CH3	547984.00	5396405.12	549	60	0	0.8
4	11CH4	547582.00	5397129.00	111	45	0	0.1
5	11CH5	547550.00	5397261.00	111	45	0	0.1
6	11CH6	547394.00	5396087.00	90	822	0	1.7
7	11CH7	547467.00	5395111.00	0	0	519	4.9
8	D11MH1	544713.00	5400120.00	0	0	0	125.0
9	D11TI1	546090.00	5397615.50	510	1328	0	15.5
10	D11TI1CC	547144.50	5397880.00	1290	360	0	5.3
11	D11TI3A	546061.00	5395100.00	0	0	240	0.5
12	D11TI3B	546042.00	5395260.00	450	540	0	5.6
13	D11TI4	546051.50	5395180.00	2475	720	0	40.9
14	D11TI5	543644.00	5399209.00	0	0	300	1.6
						Total:	203.6

Drainage System

The drainage system consists of temporary and permanent ditches which gravity drain into the river until the river stage comes up and then the gates are shut and the water is pumped to the river. Growers have noted that flows show up in ditches in winter or early spring. The first flows are usually due to runoff. They will make or move their drainage ditches from year to year as needed to drain their fields.

Once the pump system has been manually energized, it is automatically controlled by float switches. Last year the system managed to keep up with flows in the drain ditches because a diesel back up pump was added. This spring the system has not been operated very often.

River Stage vs. Impacts

Growers in this district did not have specific information on river stage versus impacts. One grower said that if the river level is kept high (1755 to 1757) feet for 10 days to two weeks, waterlogging impacts will be seen. Another grower noted that bringing the river level up and down quickly causes damage to the levees.

5.11. <u>District 12</u>

General Information

This district is approximately halfway Bonners Ferry and the Canadian border on the west side of the Kootenai River. It is approximately 1,600 acres and is farmed by one grower. The average elevation of ground in this district is approximately 1,760 feet.

Soils

Where waterlogging occurs, the soil is typically a silty loam but the growers did note a few problems in areas with mucky loam soils.

Crops

This grower raises winter and spring wheat with barley and canola for rotation. In areas which tend to be wet, the grower will either raise grass or keep the ground for pasture. This land is next to and downstream from the wildlife refuge. Water inundation from that land is beginning to impact the ground being farmed by this grower.

Effects of Waterlogging

The grower has experienced discoloration (yellowing plants), limited height and in some cases, complete destruction. In areas with chronic wetness, the grower has chosen to raise timothy hay or use waterlogging areas for pasture ground.

The following table identifies the areas that were identified during the field work as having waterlogged impacts:

Table 12: District 12 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D12LJ1	543411.00	5404301.00	147	231	0	0.8
2	D12LJ2	543556.00	5405098.00	498	294	0	3.4
3	D12LJ3	543697.00	5404800.66	918	222	0	4.7
4	D12LJ4	544376.00	5404555.00	60	726	0	1.0
5	D12LJ5	543339.80	5406107.46	500	700	0	8.0
6	D12LJ6	543577.56	5406634.57	180	1316	0	5.4
						Total:	23.3

Drainage System

The drainage system in this district starts flowing in winter. Although the ditch system is permanent, it is not adequate to keep up with flows. Since the wildlife refuge located directly upstream of this land has removed its levees and flooded its land, that water is beginning to flow southward onto this district.

The pumping system consists of one station with two pumps located at Ball Creek. One of the pumps (the electric) is operated automatically with float switches and the other (a diesel) is manually controlled. These pumps operate intermittently to drain the ditches.

River Stage vs. Impacts

This grower prefers that the water be kept as low as possible to limit pump cycling. High river levels along with lots of rain will exceed the drainage system's capacity as was seen last year.

5.12. District 13

General Information

This district is on the west side of the Kootenai River, towards the northern end of the valley. It is approximately 1,300 acres in size and is farmed by two growers. The average elevation of the ground in the district is approximately 1,755 feet.

Soils

Where waterlogging occurs, the soil is typically a muck to a mucky silt loam .

Crops

Growers raise winter and spring wheat, timothy hay, canola and an oats / peas mix. Canola is the main crop for rotation. One grower raises an oats / peas mixture for silage. The growers have changed the types of crops grown due to changes in contracts for specific crops and market prices. They avoid raising barley as they have typically lost money on this crop. One grower said that oats is a good crop and tends to be more tolerant of waterlogging but it is difficult to find a buyer.

Effects of Waterlogging

One grower refuses to plant wheat in wet areas as it will not survive. The same grower will plant canola in those areas as it will grow but not necessarily thrive. Growers have seen operational impacts such as limited access to wet areas for seeding, spraying, etc. as the equipment might get stuck.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 13: District 13 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	13FO1	539436.00	5417126.00	501	183	0	2.1
2	13FO2	538644.00	5417796.00	0	0	0	89.0
3	13TK1	540202.00	5417989.00	423	708	0	6.9
4	13TK2	540265.00	5418395.00	210	60	0	0.3
5	13TK3	540335.00	5418424.00	252	189	0	1.1
6	13TK4	540751.00	5418654.00	0	0	192	0.7
7	13TK5	540488.00	5418275.00	234	60	0	0.3
8	13TK6	540406.00	5418117.00	0	0	120	0.3
9	13TK7	539917.00	5416910.00	189	264	0	1.1
10	D13TKA	539772.00	5418972.00	255	2119	0	12.4
11	D13TKB	538688.00	5428829.00	210	210	0	1.0
12	D13TKC	538862.00	5418519.00	0	0	420	1.6
13	D13TKD1	538683.00	5418714.00	75	360	0	0.6
						Total:	117.4

Drainage System

When the river stage comes up, the ditches and ponds will start to fill up. Some of the ditches collect surface drainage and can discharge to the river via a gravity drain. Once the river stage comes up, the gravity drain gates are closed and pumps are started. The ditch configuration has not changed in many years. In recent years, one of the growers has started a maintenance program by hiring an excavator to clean out the ditches. Even with this maintenance, the drainage system may be overwhelmed if a quick runoff occurs.

The pumping system consists of two pumps, a 50 HP and 35 HP operated automatically by float switches.. An additional PTO pump can be used. The growers noted that the system operates continuously during parts of the year. It is only in the last 5-10 years that constant pumping and ditch maintenance have been a problem. When high river levels for fish passage began, the growers had to install a new pump station which runs mostly in the spring. With the new pump station, the system is adequate to handle the flows as long as the pumps do not break.

River Stage vs. Impacts

One grower watches the water level at particular points on the Bonner Ferry bridge to determine when to turn on the pumps. When the river levels comes up, impacts are seen in a couple of days. Not long after that, grain crops will be affected.

5.13. District 15

General Information

District 15 is southeast of Bonners Ferry on the south side of the Kootenai River. It is farmed primarily by one grower and is approximately 1,200 acres in size. The average elevation of ground in this district is approximately 1,758 feet.

Soils

Where waterlogging occurs, the soil is typically a silt loam but the growers did note a few problems in areas with sandy loam soils.

Crops

This grower raises winter and spring wheat, canola, alfalfa hay and timothy hay for seed. Currently canola is used as a rotation crop although barley has been used in the past. The grower does not tend to change the main crops of winter and spring wheat, although market prices will dictate which rotation crop is grown.

Effects of Waterlogging

Waterlogging effects experienced in this district range from limited growth to complete destruction. Some areas of the district are constantly wet so the grower plans on little to no yield from those areas. The grower noted that the same areas are affected from year to year although the magnitude of the impacts. The grower has typically avoided wet ground by either not planting that area or replanting the area after it dries out. The grower indicated that areas that are typically wet tend to grow more weeds and wild oats than other areas.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 14: District 15 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D15KD1	556439.00	5392692.13	60	585	0	0.8
2	D15KD2	556671.85	5392905.59	90	366	0	0.8
3	D15KD3	556936.10	5392934.50	390	1701	0	15.2
4	D15KD4C	556889.50	5392258.50	736	60	0	0.0
5	D15KD5	555874.20	5392912.51	369	690	0	5.8
6	D15KD6	557912.53	5393932.64	0	0	189	0.6
7	D15KD7	555895.26	5393851.98	0	0	321	1.9
8	D15KD8	553632.53	5393262.21	60	699	0	1.0
						Total:	26.1

Drainage System

The drainage system configuration is permanent but cannot keep up with surface runoff when the drainages from the surrounding hillsides are running high. Water is seen in the ditches all year round and must be pumped to lower the water level.

The pump system consists of two pumps, a 15 HP pump which is controlled by float switches and a 45 HP which is manually operated. The small pump is operated constantly to keep up with surface drainage. When this is inadequate and the grower sees ditch water level rising, then the big pump is started. The pump system is not adequate to handle high surface runoff and high river levels at the same time.

River Stage vs. Impacts

When the river levels rises, no standing water is seen in the fields. Wet areas are consistently wet. The grower noted that high river levels coupled with lots of rain will overwhelm the drainage system.

5.14. District 16

General Information

This district in located on the west side of the Kootenai River, approximately half way between Bonners Ferry and the Canadian border. It is approximately 1,200 acres in size with one grower in this district. The average elevation of ground in this district is approximately 1,760 feet.

Soils

Where waterlogging occurs, the soil is typically a silty loam to a silty clay loam.

Crops

The only crop grown in this district is Hallertau and Saaz hops. Once a hop plant is planted, it will take four years to mature before producing a crop. A hop plant can continue to produce for up to 30 years, depending upon the variety and conditions in the field.

Effects of Waterlogging

The grower has experienced discoloration, limited growth, pest and disease problems, and complete crop loss in some cases. Plants that are weakened by the effects of waterlogging are very susceptible to disease. Disease can spread among the plants very quickly thus crop management includes removing diseased plants quickly, not treating them. The loss of a plant means a loss of revenue for four years plus the cost of replanting, additional chemical treatments, etc. Any area impacted by waterlogging will also impact a significantly larger area around if based on the normal configuration of a hops operation.

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 15: District 16 Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D16EMA1	542328.00	5412355.80	5420	2250	0	280.0
2	D16EMA2	543228.00	5411889.00	0	0	3000	162.3
						Total:	442.3

Drainage System

The grower uses a system of drain tiles, ditches and head gates. The current configuration was installed in 1998 and has not changed since that time. The ditch and tile system is adequate for infiltration from surface runoff but elevated river stages can overwhelm the drain system.

The pump system is automatically operated. The water goes through the drain tiles and into manholes. Once in the manholes, sump pumps move the water into a gravity lines which drain into a pump station. From there, the water is then pumped back into the river. These pumps are constantly operating when river level is up.

River Stage vs. Impacts

The grower has noted that a rise in the river level corresponds directly, in a shorter period of time, to a rise in the groundwater elevation due to in the gravel lenses that underlie the district.

5.15. <u>Other Growers</u>

General Information

Several growers are farming ground between District 10 and the Canadian border, on the west side of the Kootenai River. These growers are not part of a formal irrigation district. The land is approximately 390 acres in size with two growers farming the area. The average elevation of ground in the district is approximately 1,755 feet.

Soils

Where waterlogging occurs, the soil is typically a silt loam but the growers did note a few problems in areas with silty clay loam soils.

Crops

Growers in this area raise canary grass, alfalfa hay, oats, birdsfoot trefoil, barley, and spring wheat. The growers raise cattle as well.

Effects of Waterlogging

Crops waterlogging effects experienced by the grower include discoloration, limited growth, and complete crop loss. Waterlogged impacts crop quality and quantity. Lower quality hay will still be used but will not last as long (low yield). Operational impacts include prolonged farming due to wet fields. This may cause equipment to get stuck or areas to not to be farmed. It increases costs for fuel, time, work (replanting, reworking, more seed, etc.).

The following table identifies the areas that were identified during the field work as having waterlogging impacts:

Table 16: Other Growers Waterlogged Areas

	Point	Easting	Northing	Length (ft)	Width (ft)	Diameter (ft)	Area (ac)
1	D BV1	534369.00	5424345.00	0	0	90	0.1
2	JB1	534556.00	5422495.00	99	90	0	0.2
3	JB2	534551.00	5422685.00	315	810	0	5.9
4	JB3A	534272.00	5422822.00	0	0	360	2.3
5	JB6	533960.00	5423233.43	0	0	360	1.2
						Total:	9.7

Drainage System

Only one of the two growers in this area has a drainage system. It consists of some small ditches and a manually operated pump (PTO). The other grower had a drainage system but it has been inoperable for many years. The pump system operates intermittently, about two hours a day. The ditches and pumps are adequate to handle the flows.

River Stage vs. Impacts

At 1755 feet, the growers start to see an impact. At 1760 feet, the growers noted that the impact is high. At 1765 feet, the area will flood. If river levels stay up more than a day, impacts are seen especially in sandy areas. One grower stated that higher river stages could be tolerated in early to mid May. The growers have observed that the levees are starting to slough as river levels are quickly raised and lowered.

6. SUMMARY

The soils in the Kootenai River Valley are predominately silts and sands deposited by the Kootenai River. Growers in the valley identified areas of silt, silty loams, peat, clay, sands and gravels arranged in a very complex and irregular configuration. Materials deposited from tributary drainages tend to form lenses or bands of sands and gravels within the larger areas of peat, clay, and silt. The soil composition has been further complicated in some locations where growers moved soils from one location to another to fill in low lying areas.

The interaction between waterlogging and surface runoff from precipitation is difficult to define. Growers identified locations where they had noted that higher ground water elevations had reduced the infiltration capacity of the soils and caused surface runoff to pond. The growers also identified critical time periods when rainfall is needed for some portion of the ground that they are farming even though waterlogging may be impacting other nearby locations.

Approximately 30,000 acres are being farmed in the valley in any given year and another 1,700 acres is being used for hop production. On average wheat, barley, alfalfa, canola, and grass make up 90% of the crops being grown in the valley. A majority of the planning associated with crop rotation is focused on the fact that winter wheat provides a significant income for many of the growers. Minor changes in the acreage of crops being grown may occur, but the total acreage for the primary crops is relatively consistent.

The work involved contacting over 30 individual growers and collecting data from 25 different growers. The effort covered approximately 90% of the acreage being farmed in the valley, and approximately 90% of the growers.

The growers indicated that even if the river stage reached an elevation of 1764 feet at Bonners Ferry, but only remained at that level for a week or less and then dropped to a stage of 1758 feet or less, they would see minimal impacts from waterlogging. If the stage at Bonners Ferry exceeds 1758 feet for two weeks they would see some impacts from waterlogging, and if the duration were increased to three weeks or more the impacts would be significantly greater.

The effects of waterlogging problems include crop loss resulting from ponded water, reduced yields caused by high soil moisture content, soil moisture contents that are high enough to prevent farm equipment from traveling over the ground, increased costs associated with working around affected areas, and loss of investment when areas are affected after the application of fertilizers and pesticides. The growers estimated costs of $100 to $150 per acre to grow a crop to maturity and harvest. They estimated the return on that investment at approximately $200 per acre.

Areas that are affected by waterlogging were identified throughout the study area. Over 150 locations were identified, located and mapped with a total area of approximately 2000 acres. Damage from waterlogging was limited at the time of this field investigation and therefore it is unlikely that all of the areas that will be affected by waterlogging were identified. In addition, the areas identified typically correspond to the extent of that area readily visible. There will be secondary impacts such as (but not limited to) reduced yields and greater requirements for weed and pest control for an unknown distance around each of the identified areas.

7. REFERENCES

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