Technical Memorandum

Bowers Rock State Park Alternatives Analysis

Oregon State Parks · Calapooia Watershed Council · PGE · Meyer Memorial Trust

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1 Project Background

The Calapooia Watershed Council, with funding provided by the Meyer Memorial Trust and Portland General Electric (PGE), retained River Design Group, Inc. (RDG) to prepare an existing conditions review and alternatives analysis for improving ecological and hydrologic function at Bowers Rock State Park (BRSP). Managed by the Oregon Parks and Recreation Department (OPRD), the approximate 568.1 acre BRSP property on the Willamette River floodplain includes natural floodplain and stream channels, mined gravel pit ponds, and leased agricultural land. The Little Willamette River, BRSP gravel pit pond, and the East Slough and West Slough are the primary waterbodies of interest on the property. Figure 1-1 includes a vicinity map showing the location of BRSP in relation to Albany, Oregon.

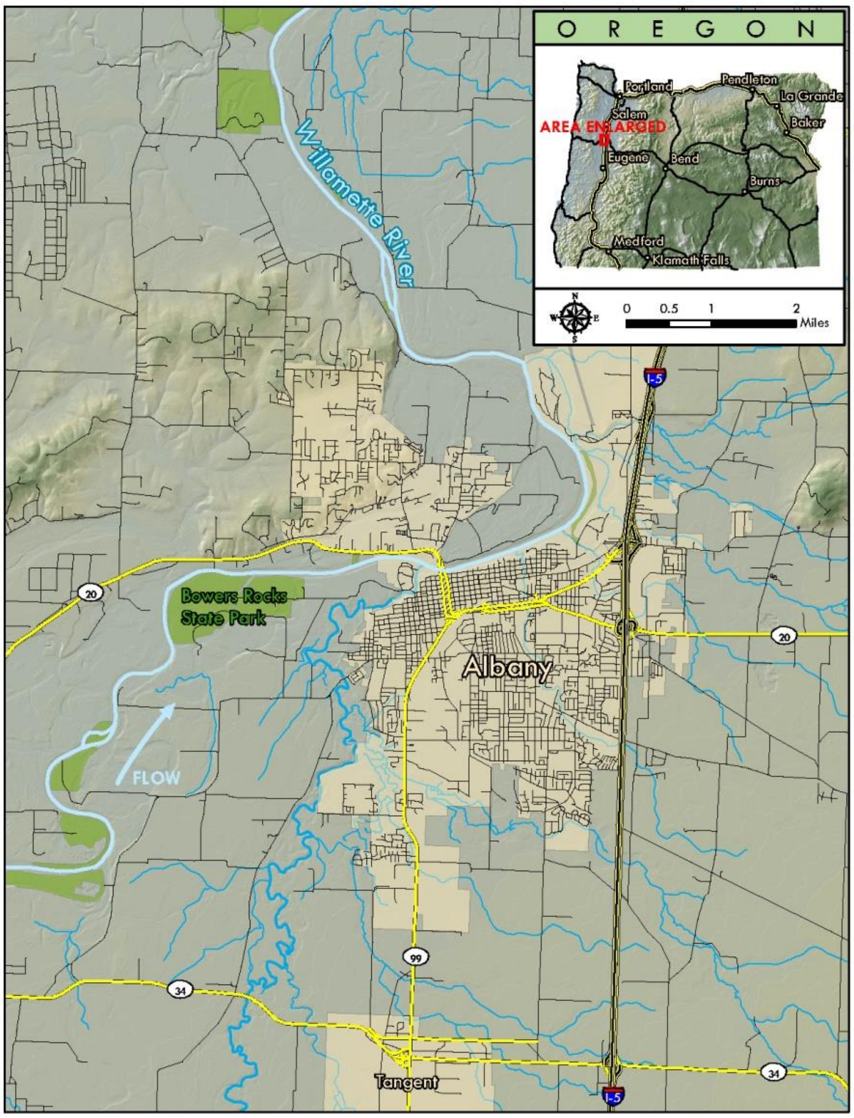

Figure 1-1. Vicinity map for Bowers Rock State Park near Albany, Oregon.

1.1 Location and Context

BRSP was authorized through the Willamette River Greenway Act of 1973. The park was to be one of the Willamette Greenway state parks that was planned to have more developed services than other greenway properties (D. Wiley, OPRD, personal communication). Willamette River Greenway parks were located along the Willamette River near population centers to allow easy access to water-oriented recreation in a natural setting. The parks were established with the expectation that as the human population in the Willamette Valley increases, park use will increase as residence seek local outdoor activities in natural areas. Bowers Rock (the park was originally referenced as Bowers Rocks) was established to accommodate regional recreation needs for the Corvallis/Albany section of the Willamette River and to maintain the natural values of the area for future generations (OPRD 1989).

Historical Floodplain Condition

Historical maps and air photos were reviewed to assess floodplain conditions in the vicinity of what would become the BRSP gravel pit. Figure 1-2 includes the 1852 General Land Office map. Notes on the map in the vicinity of the future BRSP relate to the dense underbrush and overflow at high water. Highlighted vegetation included cottonwood (Balm of Gilead) and maple. Hydrographic features included the Little Willamette River and other side channels near the future BRSP gravel pit.

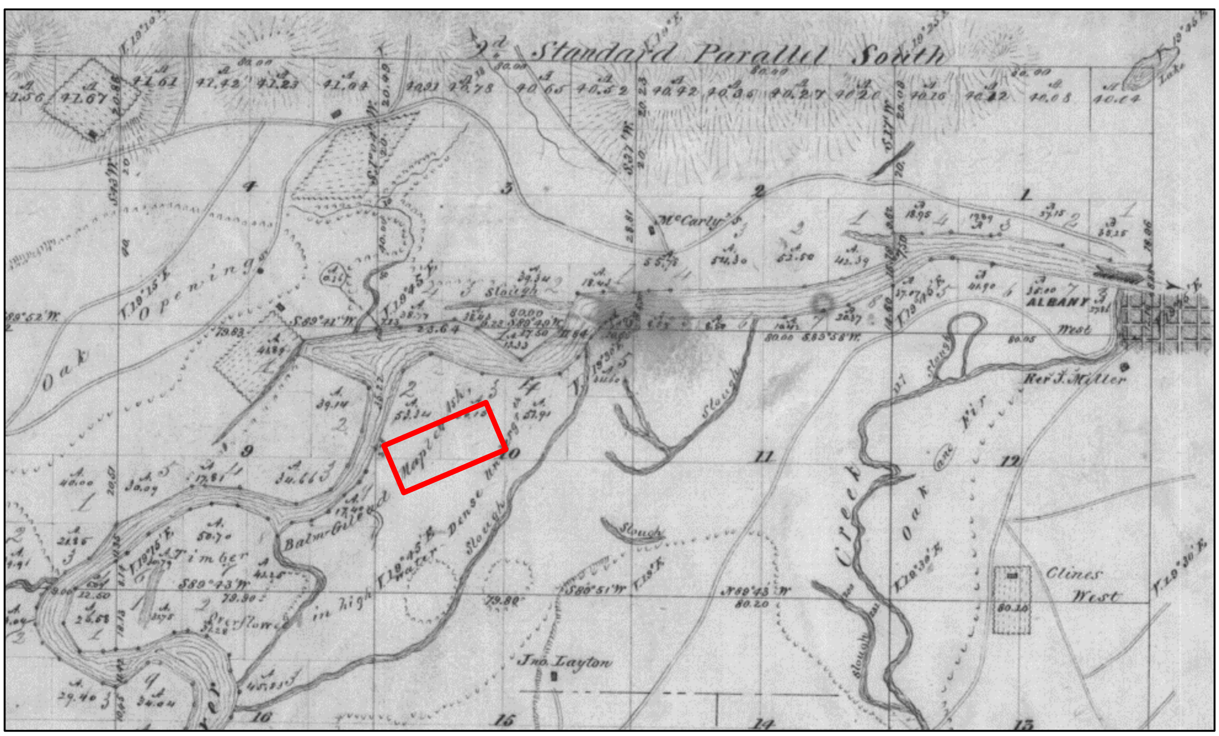

Figure 1-2. The 1852 GLO map showing the future BRSP gravel pit location (red box) and other features of the Willamette River floodplain.

The State of Oregon acquired a series of air photos (see Attachment A) as part of the Greenway appraisal process. OPRD provided the air photos to RDG for review. Although most of the provided photos did not include photo dates, most of the photos predated the onset of BRSP gravel pit development in 1975, and were associated with both low flow and high flow events. The photos illustrate the floodplain conditions prior to and during gravel pit development. Figure 1-3 provides a high flow, predevelopment photo and a photo at the start of gravel pit development during low flow. The air photo series highlight the higher elevation of the ground surface that would ultimately be developed into the BRSP gravel pit.

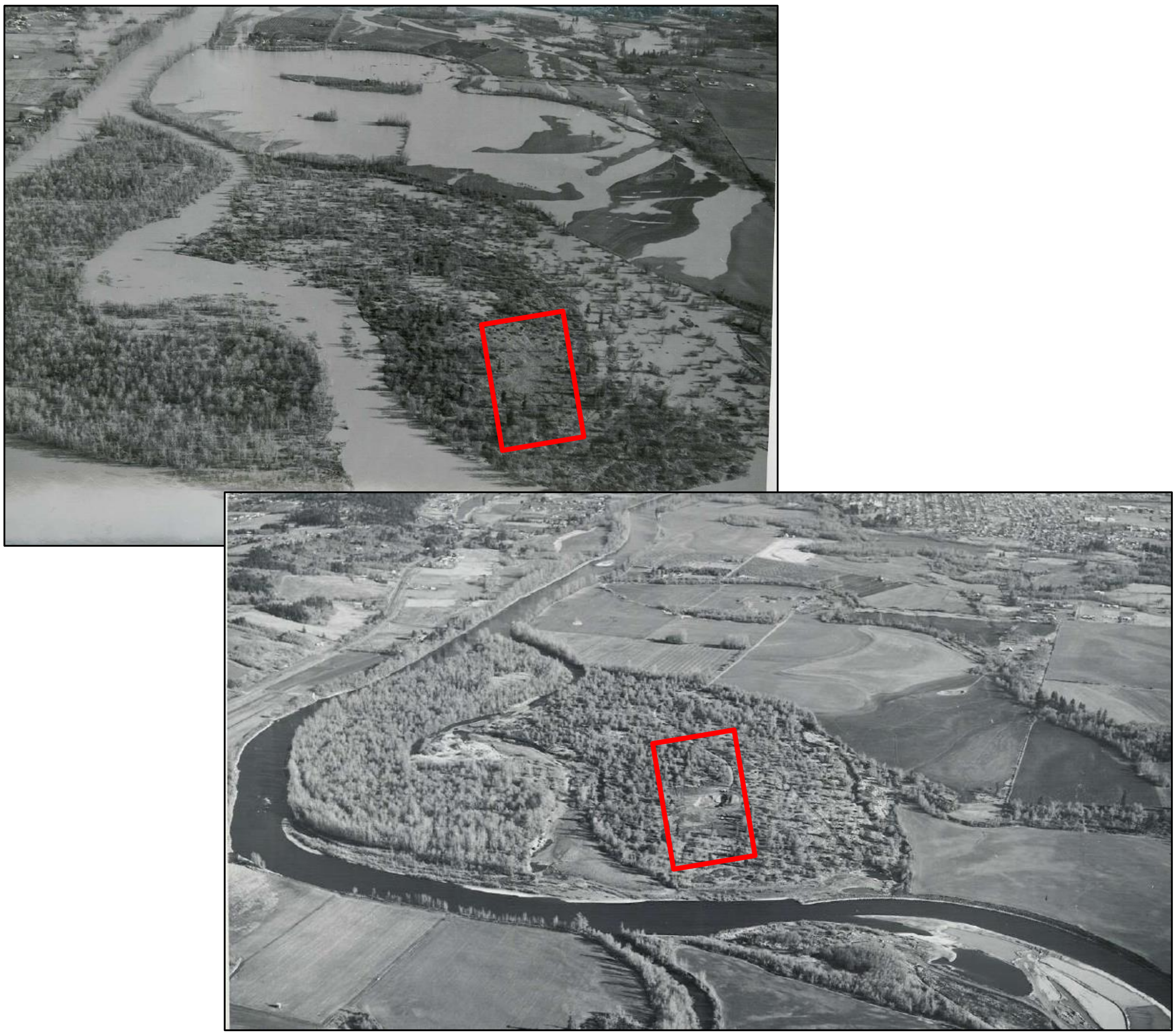

Figure 1-3. A pre-1975 air photo (top) shows the historical floodplain prior to gravel pit development and during a high water event. The lower photo shows the same area at the start of gravel pit development in 1975 or 1976 during low flows.

BRSP Gravel Pit Pond History

The BRSP gravel pit pond (site identification 22-0067) was initially developed by Hub City Sand & Gravel under lease on the E.M. Edholm property. The planned excavation site was expected to cover 50 acres (DOGAMI 1976a) and was to have a rectangular form 950 ft wide and 2,150 ft long and mined to a depth of 40 ft. With 3:1 side slope, the pit would have had a 25 ft setback from the property line (DOGAMI 1976a). Based on a surface acreage of 46.89 ac and a pit bottom area of 31.497 acres, the total volume of excavation was 2.6 million cubic yards. With a per ton weight of 1.6 tons per cubic yard, the anticipated pit production was 4.2 million tons (DOGAMI 1976). The DOGAMI memo noted that there would be an approximate 25% loss of material to meet reclamation requirements. The more conservative expected total production amounted to 1.95 million cubic yards resulting in 3.12 million tons of sand and gravel. A typical cross section of the proposed pit noted the original ground elevation as 202 ft (NAVD29), the projected water level at 192 ft, and two measurements that noted planned for noting excavation depths of 182 ft and 172 ft. A bench was planned for an elevation of 186 ft, 6 ft under the base water surface elevation (DOGAMI 1975a).

While the Edholm property was planned for eventual incorporation into the Willamette River Greenway at the time of Mrs. Edholm's passing (DOGAMI 1975b), Mrs. Edholm retained the mineral rights which she gave to the Scheler family upon her death. The 1975 on-site inspection report noted that the site could be mined to 30 ft deep, although there was the potential to mine to a depth of 40 or 50 ft, if the gravels were satisfactory and the equipment capable (DOGAMI 1975b). The pond that would result from the gravel pit development was highlighted as a "…recreational fish site, specifications to be according to the Parks Division of the Transportation Department of the State of Oregon" (DOGAMI 1975b).

BRSP gravel pit development began in 1975 and by December of 1976, the surface mining area had a footprint of approximately 6.3 acres (DOGAMI 1976b). The mined area was comprised of two distinct pits, the first pit was a loam excavation area of approximately 0.4 acres. The second pit was the major gravel pit and at the time was excavated to a depth of 15 to 18 ft and was approximately 1.25 acres in extent. Overburden and loam had been removed from the 6.3 acre mining area. The entire 50 acre mining site had been circumscribed by a cleared bulldozer trail approximately 20 ft wide, with all vegetation cleared to mineral soil (DOGAMI 1976b).

Gravels at the site were overlain with an average of 2 to 4 ft of loam. Initially, much of the loam was marked for commercial sale. Loam was eventually stockpiled for pond reclamation although loam continued to be sold at least through 1985 (DOGAMI 1985).

The 1985 site inspection report noted the continued development of the BRSP gravel pit. At the time of the inspection, the pond was extended in a southern direction and was approximately 900 ft long. The northeast cell was approximately 600 ft long and was being backfilled with concrete and asphalt to the original grade as part of the bond requirement (DOGAMI 1985). The report noted that gravels were removed to a depth of 20 ft wherein a clay lense was encountered. Although the inspection did not include a map, the narrative suggested the gravel pit was more than half developed by 1985 as 22.25 acres had yet to be developed at the time of the report. Gravel was removed in cells to facilitate water management during gravel extraction. Once the site was fully developed, the roads and dikes that divided the pit into cells, were to be removed so that “one large recreation lake is left upon completion of mining” (DOGAMI 1985).

A 1989 DOGAMI memo following a meeting with Mr. Beil (former Hub City Sand & Gravel owner and project manager) reviewed the discussion between DOGAMI and Mr. Beil. The conversation focused on Mr. Beil’s preference to continue developing the gravel pit past the 1991 lease expiration. Mr. Beil suggested that if his lease was terminated in 1991, he would complete only the minimal amount of reclamation as required by law. Rather than the larger recreation lake sought by OPRD, Mr. Beil stated that he would leave a series of five acre ponds with 3:1 slopes (DOGAMI 1989). The memo noted “[Mr. Beil] is adamant that he wants to stay on the property after 1991. That there is gravel below the current mine depth that remains to be excavated.” (DOGAMI 1989). Another important point noted in the memo was that if Mr. Beil was allowed to continue developing the site after 1991, the gravel removal royalties would generate money to develop BRSP. OPRD countered this notion with the realization that royalties would go to the State’s general fund and would not be directed towards BRSP development. The memo ended with DOGAMI acknowledging Mr. Beil had backfilled the eastern extent of the pond with asphalt and concrete with the expectation that OPRD intended a future parking area at the entrance to the gravel pit pond (DOGAMI 1989).

In 1991, Bob Beil filed a complaint concerning continued access to the gravel pit pond (DOGAMI 1991). Hub City’s easement through the Scheler property was not renewed and Mr. Beil requested the consent of OPRD to construct a new haul road through the State’s property. The new haul road required filling an existing gravel pond on the southern boundary of the State’s property adjacent to the Scheler property. Fill material came from the north side of the pond. At the time of the pond filing, DOGAMI noted that the former gravel pit was not defined as a natural water way because it was a gravel extraction pond and there was not a free and open connection to waters of the state. The DOGAMI correspondence culminated in the suggestions that the Oregon Department of State Lands had proposed revising regulations concerning gravel ponds and was considering regulating gravel ponds as natural waterways (DOGAMI 1991).

By the 1993 inspection report, the site consisted of four to five large excavation cells and gravels were being removed from the northeastern cell at the time of the inspection (DOGAMI 1993). Mr. Beil indicated that he had discussed with OPRD the possibility of creating an open egress from the gravel pits into Coon Creek, a tributary to the Little Willamette River (DOGAMI 1993). Mr. Beil expected this plan would improve the water quality in the ponds and DOGAMI recommended pursuing the option. OPRD had reservations about the channel modification to Coon Creek as OPRD was concerned about the potential for capturing the Willamette River through the pit. Mr. Beil suggested constructing a berm at the west end of Coon Creek to help prevent river diversion. DOGAMI also recommended installing riprap where Coon Creek meets the Willamette River to address potential erosion (DOGAMI 1993). These plans were never implemented.

Hub City Concrete was purchased by Morse Bros. in 1995 and the gravel pit operation was promptly closed by Morse Bros. (Bob Beil, personal communication, May 5, 2014). The operational permit for the gravel pit was closed in April 2003 (DOGAMi 2003).

Other BRSP Features of Interest

Gravels excavated from the BRSP pit were processed at a plant site located 1 mile from the pit, on the Snyder property at the southern boundary of State-owned property (Figure 1-4). The plant site was located in a prior mined area previously permitted by Albany Sand & Gravel (DOGAMI 1984). Two sloughs (currently referenced as East Slough and West Slough) located adjacent to the OPRD pond were used as a water source and settling basin for gravel washing. These sloughs were previously impacted by gravel extraction and were referenced as dead-end areas (DOGAMI 1975). The ultimate plan for the gravel processing area which included a 2-3 acre lake at the time of BRSP gravel pit development, was a 30 acre lake which would have also been included in the Greenway.

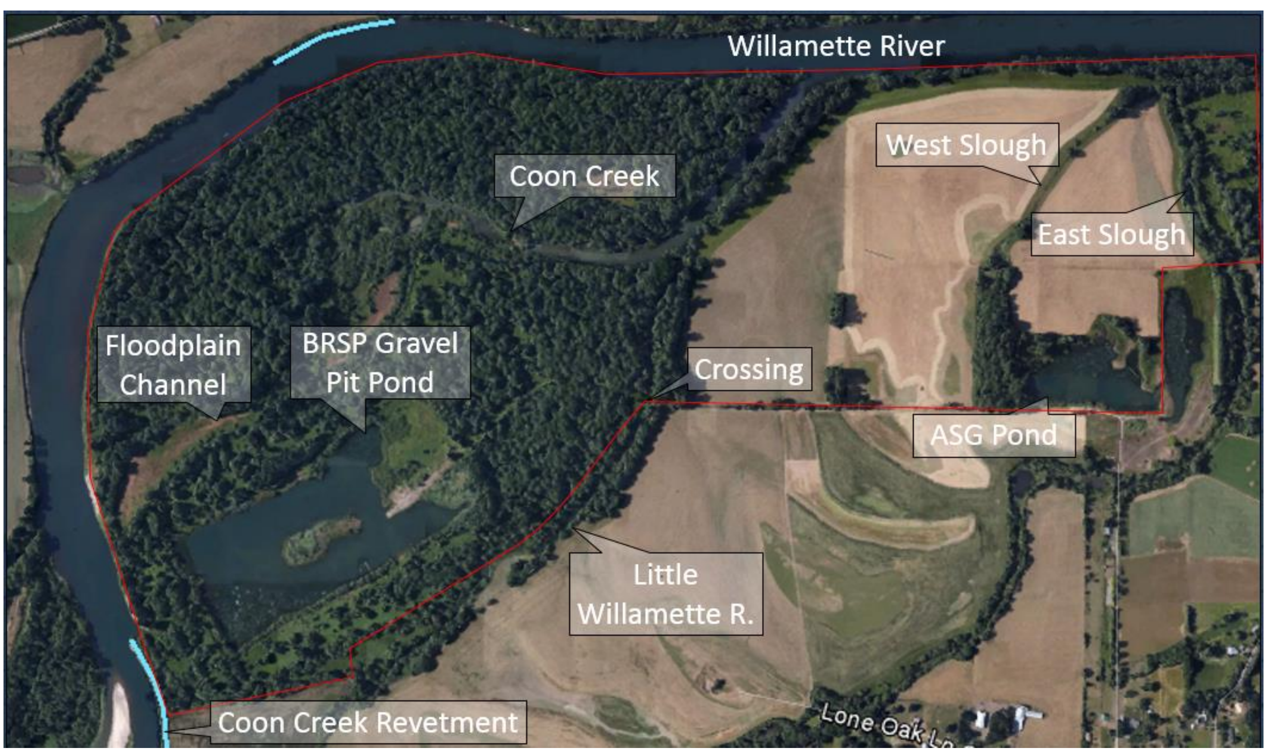

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Figure 1-4. The BRSP gravel pit pond and other features of interest. Many of these other features were important landmarks for processing the gravel that was developed in the BRSP gravel pit.

2 Hydrologic Analysis

The following sections evaluate the effects of flood control operations on the Willamette River and summarize the U.S. Geological Survey (USGS) stream gage at Albany; the gage used in the BRSP existing condition analysis and site recommendations. The Albany gage was used to characterize river flows and stage for the BRSP because of its long period of record, its consistent stage-discharge relationship, and its close proximity to the project site.

2.1 Willamette Basin Hydrology

The Willamette River is highly regulated by 13 dams including 11 flood control dams and 2 reregulating dams (although Foster Dam serves partially as a re-regulating dam for the larger upstream Green Peter Dam) that affect the natural flow of water in the Willamette River Basin (OWRD 1991; Rounds 2010). In reviewing the history of flood control operations in the Willamette River Basin, three river management periods were delineated:

- Pre-1942: Historical or Pre-regulation period
- 1943 to 1968: Dam Construction period
- 1969 to Present: Regulated period

Table 2-1 includes a list of the dams upstream from the Albany area and their date of completion. Flood control operations have had a profound effect on the Willamette River hydrograph. Runoff retention and later release from flood control reservoirs effectively reduces flood peaks while increasing base flows relative to the historical condition.

Table 2-1. Flood control dams located in the Willamette Basin upstream from the USGS Albany gage.

Dam Name	Location	Year Completed	Height (ft)	Storage (acre-ft)	Upstream Dams
Blue River Dam	Blue River	1969	270	89,500	
Cottage Grove Dam	CF Willamette River	1942	95	32,900	
Cougar Dam	SF McKenzie River	1963	452	219,000	
Dexter Dam	MF Willamette River	1954	93	NA	Lookout Point, Hills Creek
Dorena Dam	Row River	1949	145	77,600	
Fall Creek Dam	Fall Creek	1966	180	125,000	
Fern Ridge Dam	Long Tom River	1941	44	116,800	
Hills Creek Dam	MF Willamette River	1961	304	355,500	
Lookout Point Dam	MF Willamette River	1954	276	455,800	Hills Creek

Table 2-2 includes a breakout of the average annual peak discharge for the Historical, Dam Construction, and Regulated periods. Over time, the magnitude and variability of annual peak flows have been reduced and simplified. At the Albany gage, the average annual peak flow is now about half what it was historically, and the regulated 2-year return interval discharge is approximately 65% of the historical, pre-dam 2-year discharge.

Table 2-2. A comparison of the average annual peak discharge for the Willamette River at the Albany gage for the three river management periods. The 2-year discharge for the Historical and Regulated periods is included for comparison.

River Management Period	Average Annual Peak Discharge (cfs)
Historical Period - Pre-Dams (1861 to 1942)	124,215
Dam Construction Period (1943 to 1968)	109,352
Regulated Period - Post-Dams (1969 to 2013)	66,336
Historical Period 2-year Discharge	106,409
Regulated Period 2-year Discharge	64,591

Figure 2-1 shows annual peak flows for the Willamette River recorded at the Albany gage station (USGS #14174000). The Albany gage was used to calibrate stage discharge relationships for the hydrologic analysis for the BRSP project area. Annual peak flow data have been continuously monitored at the Albany gage since 1877. As flow data preceded the Dam Construction period which began in 1943, peak flow comparisons can be made over the 133 years the gage has been operational. Metering peak flows has reduced flood impacts to human infrastructure and enabled occupation and development of the Willamette River floodplain. However, it has also resulted in a reduction of inundated habitat and channel complexity, negatively affecting habitats that support native species and juvenile fish that rely on low velocity, vegetated habitats for winter-time rearing.

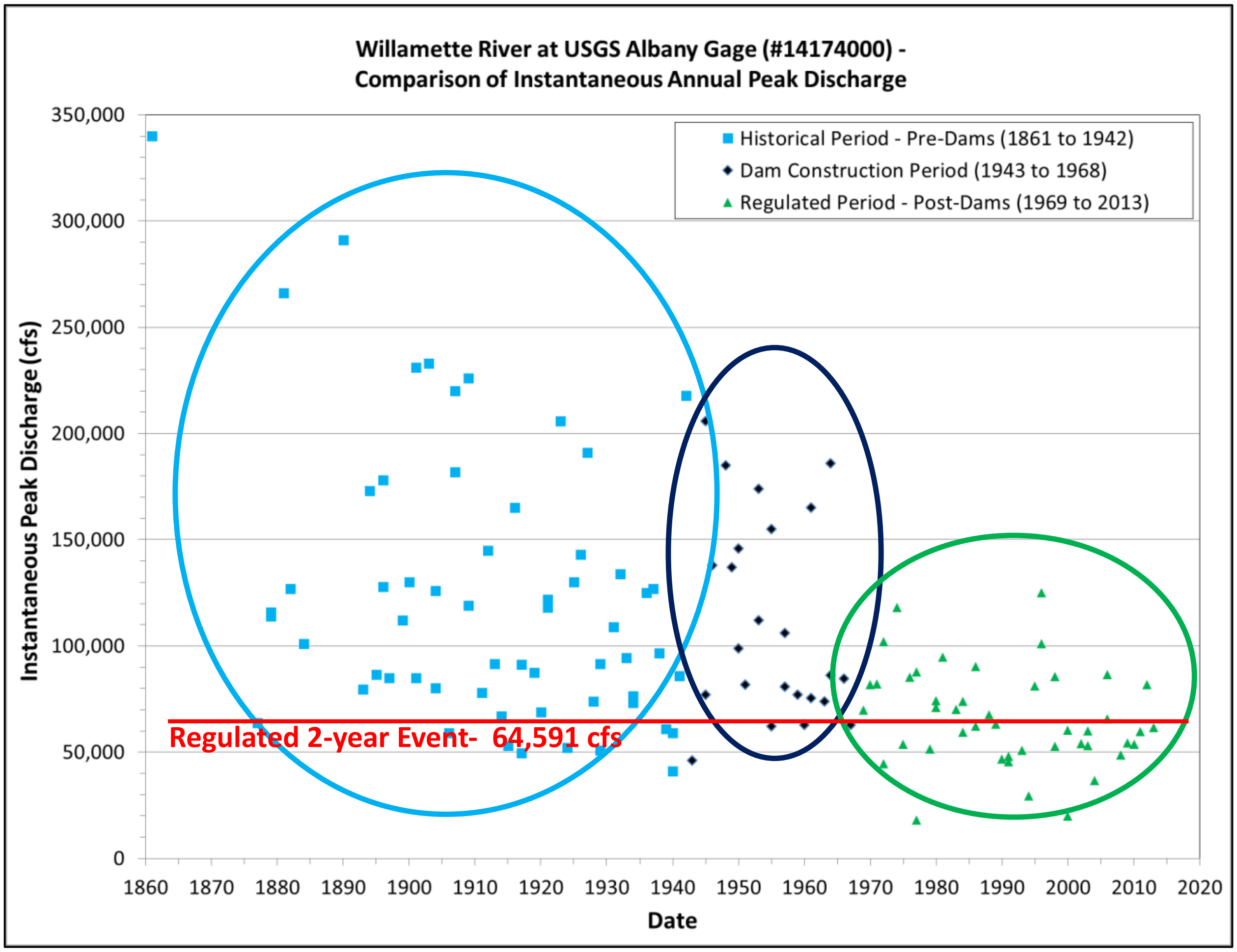


Figure 2-1. A comparison of annual peak flows at the Albany gage on the Willamette River from 1892 to 2013. The three primary river management periods are highlighted. The actual regulated 2-year discharge at the Albany gage is included for illustration. The USACE target 2-year discharge at the Albany gage is 69,500 cfs.

A flood frequency analysis was completed for the Historical and Regulated periods to assess how return interval floods have changed with regulation. Flood frequency results for the Albany gage are included in Table 2-3.

Table 2-3. A comparison of flood frequency analysis for the Historical (1861-1942) and Regulated (1969-2013) periods.

Return Period (years)	1861 - 1942 (cfs)	1969 - 2013 (cfs)
100	370,780	130,151
50	316,169	120,253
20	250,608	106,642
10	205,201	95,703
5	162,410	83,789
2	**106,410**	**64,591**
1.25	71,949	49,409
1.11	59,360	42,818
1.05	50,956	37,981
1.01	38,838	30,213

Figure 2-2 includes a comparison of average mean annual hydrographs from the three river management periods at the Albany gage. The hydrographs show the lower average mean daily discharge in the February to June period, and higher base flows from July through October associated with the Regulated period. This pattern illustrates the dampened peak flows and higher base flows derived through flood control operations.

A flow duration analysis was completed for the USGS Albany gage in order to better understand the frequency and duration of high flow events on the Willamette River during the Regulated period. Mean annual flows for the Regulated period were used to complete the flow duration analysis. Table 2-4 includes the flow duration data. Figure 2-3 includes the flow duration curves for the USGS Albany gage.

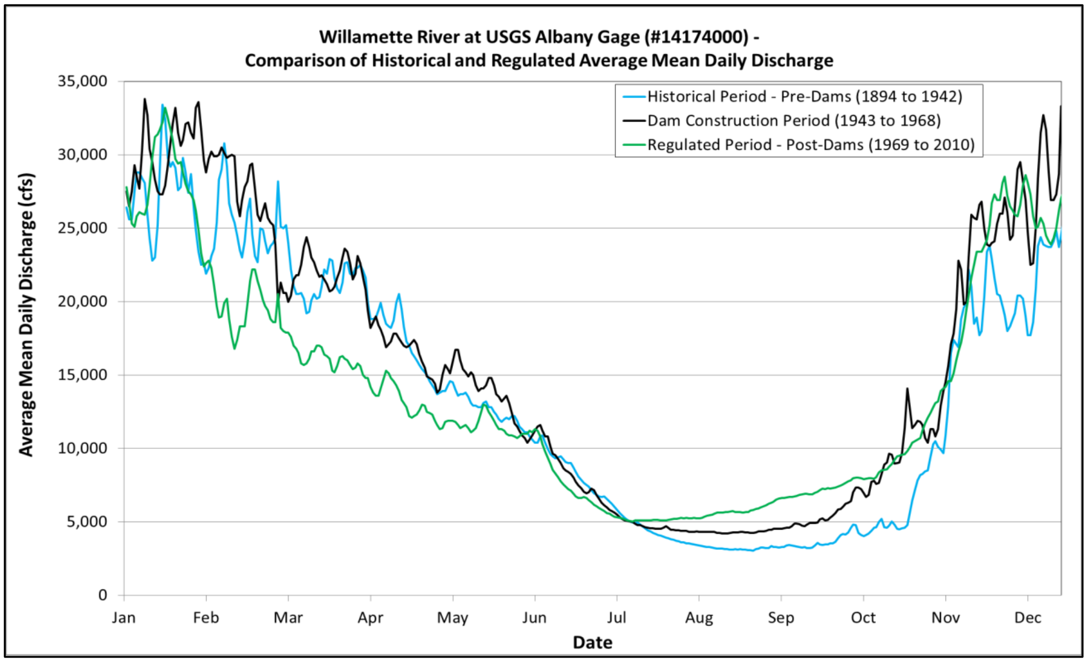


Figure 2-2. A comparison of average mean annual hydrographs for the Willamette River from 1894 to 2010. The three primary river management periods are highlighted. The graph illustrates lower peak flows and higher base flows characteristic of the Regulated period relative to the Historical and Dam Construction periods.

Table 2-4. Flow duration data for the USGS Albany gage over the regulated period of record (1969 – 2013).

Percent of Time Exceeded	Equivalent Number of Days	Albany Gage Discharge (cfs)	Albany Gage Height (ft)*
99	361	3,980	2.33
95	347	4,530	2.66
90	329	4,970	2.92
80	292	5,630	3.28
50	183	9,100	4.99
25	91	15,700	7.7.0
15	55	23,100	10.25
10	37	30,870	12.64
5	18	43,200	16.00
2	7	54,300	18.72
1	4	61,300	20.30
0.1	0.4	63,671	20.82

*Gage heights based on USGS rating tables accessed April 2014.

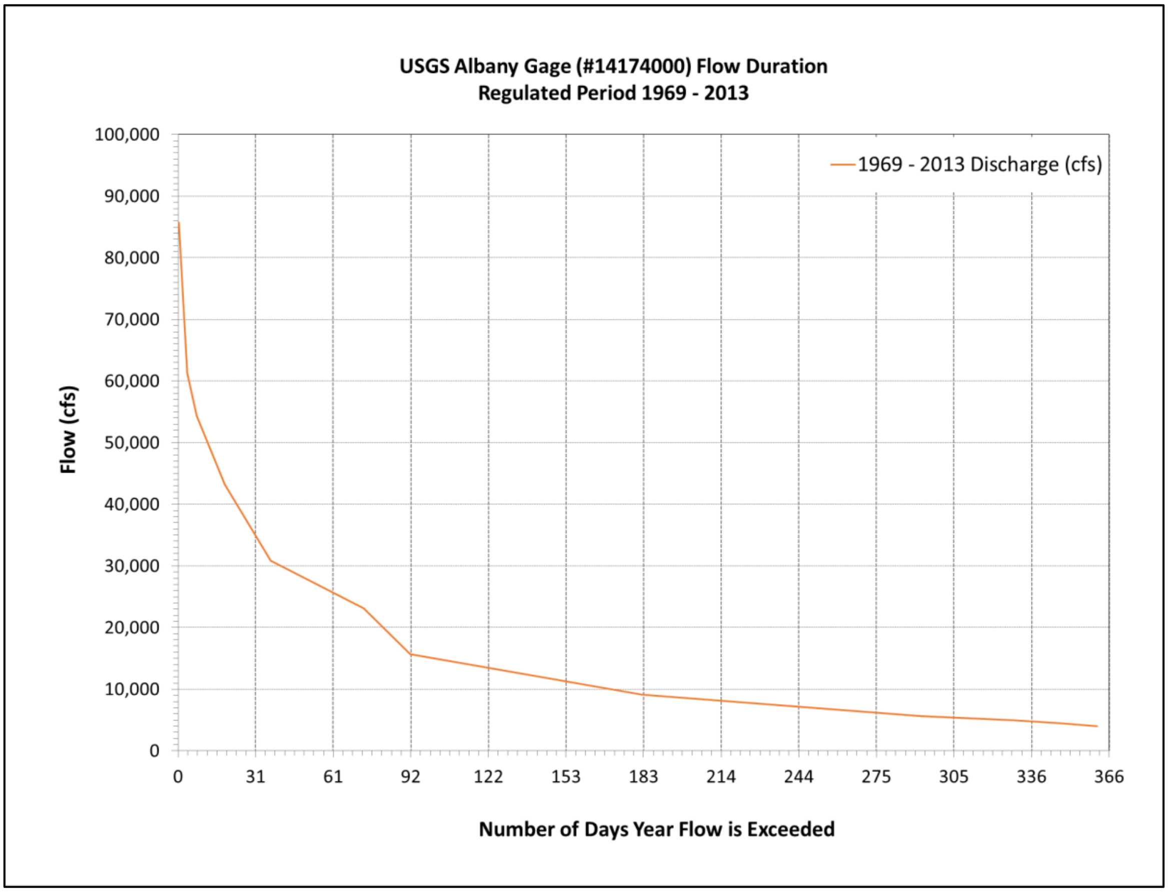


Figure 2-3. The USGS Albany gage flow duration curve based on the regulated period (1969 - 2010).

The flow duration data and the rating table information were used to assess existing and potential floodplain inundation frequency and duration at BRSP. As an example of how the flow duration curve can be used, the Willamette River extensively inundates the floodplain at BRSP at approximately 55,000 cfs. The Albany gage's flow duration curve suggests 54,300 cfs is exceeded less than 2% of the year, or approximately 7 days per year on average. This information is useful for evaluating floodplain habitat conditions and assessing the potential for modifying existing floodplain elevations for restoration actions.

2.2 Inundation Mapping

ArcGIS tools were used to simulate potential areas of floodplain inundation within BRSP. A LiDAR dataset was used to create the underlying topographic surfaces for the project areas and water surface elevations were modeled to inundate floodplain surfaces under a regulated 2-year flow (Figure 2-4). The regulated 2-year flow was selected as a frequent flow that has ecological importance for fish inhabiting the upper Willamette River system. The resulting inundation layer provides a useful tool for identifying potential floodplain restoration areas, locating possible obstructions to river-floodplain habitat interaction, and to assist with locating possible floodplain refugia habitats for native fish species including federally-listed spring Chinook salmon. The inundation mapping is not meant for floodplain managers or regulatory agencies for floodplain management.

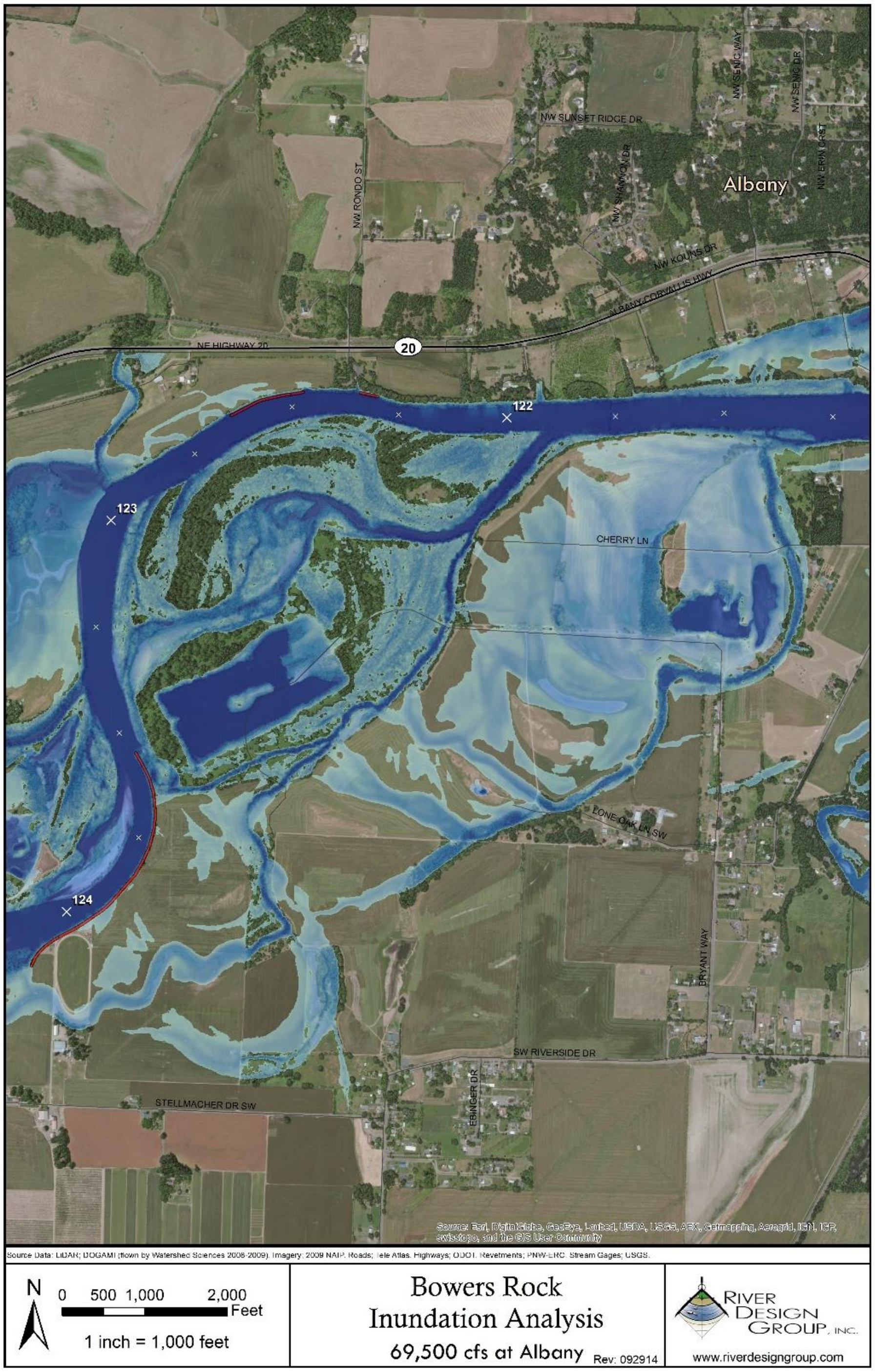


Figure 2-4. The 2-year flow inundation map prepared for BRSP. The modeled inundation level represents a discharge of 69,500 cfs as measured at the USGS gage at Albany, OR.

Aerial photography taken by Eagle Digital Imaging, Inc. on January 28, 2012 during flood conditions (Figure 2-5) was used to calibrate the 2-year inundation model. The flood air photo for the BRSP shows similar results as predicted by the inundation mapping.

Figure 2-5. Aerial photograph of the BRSP area taken on January 28, 2012. The USGS Albany gage registered approximately 69,200 cfs during air photo acquisition. USACE revetments are noted by the red lines.

2.3 Hydrologic Summary

In summary, flood control operations have reduced flood magnitudes while also increasing summer time base flows beneficial for irrigation, industrial water availability, dilution of municipal and industrial discharges, and recreation. Hydrographic modifications have influenced the magnitude of return interval events, such as the 2-year flow, and have influenced geomorphic and ecological function in the Willamette River corridor. For areas of the Willamette River floodplain such as BRSP, regulated flows have resulted in less hydrologic interaction between the river and floodplain surfaces. Historically, the Willamette River regularly inundated the BRSP floodplain, creating diverse, dynamic habitats. Under the current flow regime, the floodplain is inundated less frequently and higher elevation ground features such as the landform surrounding the BRSP gravel pond, are rarely inundated relative to historical conditions. This diminished hydrologic interaction affects native fish, aquatic and riparian habitat formation, and leads to a simpler river corridor.

3 Willamette River Fish Community

3.1 Ecological Framework

Inundated river floodplains provide diverse aquatic habitats for fish and other vertebrates. In many rivers, native fish species are adapted to having seasonal access to refuges where they can find shelter spawn, rear, and forage, and foraging habitats (Junk et al. 1989; Bayley 1991; Sommer et al. 2004; Colvin et al. 2009). In Pacific Northwest rivers, where most flooding typically coincides with the onset of less favorable conditions characterized by cold water temperatures and decreasing photo period in winter, inundated floodplain habitats provide fish with low velocity habitats that may also be more productive than the mainstem channel. Similarly, groundwater-influenced floodplain habitats provide warmer temperatures that may also support a more substantial forage base relative to the mainstem river (Giannico and Hinch 2007).

Colvin et al. (2009) found native fish species in the Calapooia River drainage (tributary to the Willamette River southeast of the project area) are adapted to a flood-pulse-driven environment and respond to annual changes in discharge by moving into seasonally inundated habitats. Movement of native species from the mainstem channel onto the floodplain may be critical to fish survival, sheltering them from high water velocities during the coldest months (Giannico and Healey 1998a) while increasing the foraging and reproductive opportunities of some species in early spring (Sommer et al. 2004, Colvin et al. 2006, Henery et al. 2010).

In addition to anthropogenic river corridor alterations, native fish in the Willamette River Valley also interact with a host of exotic fish and amphibians including the American bullfrog (*Rana catesbeiana*) (Colvin et al. 2009). The introduction of these species began in the late 1800s, and the current list of most common introduced species includes the bullfrog and bluegill (*Lepomis* *macrochirus*), green sunfish (*L. cyanellus,* recently detected at Green Island), warmouth (*L. gulosus*), pumpkinseed (*L. gibbosus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), mosquitofish (*Gambusia affinis*), yellow perch (*Perca flavescens*), and brown bullhead (*Ameiurus nebulosus*) and yellow bullhead (*A. natalis*) (Hulse et al. 2002; Colvin et al. 2009, S. Gregory, Oregon State University, unpublished data). Common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus auratus*) have also been sampled at Green Island. These introduced species modify habitat, compete with, and/or prey upon native species.

Among the native species expected to use seasonally flooded habitats in the upper Willamette River, four are listed as threatened or endangered under the U.S. Endangered Species Act. Listed species include the Upper Willamette spring Chinook salmon, Upper Willamette River steelhead (to the Calapooia River mouth, inclusive), bull trout, and Oregon chub (USFWS 1993, 1999, proposed for delisting February 4, 2014). Juveniles of spring Chinook salmon and steelhead rear in the Upper Willamette River from several months (Chinook) to up to four years (steelhead) before outmigrating to the ocean. Rearing duration is influenced by life history strategy and stream conditions.

Numerous fish species, most of them native, inhabit the network of intermittent watercourses flowing through upper Willamette River valley agricultural fields in winter and spring (Colvin et al. 2006, Colvin et al. 2009). The seasonal habitats provided by these watercourses offer not only winter refuge, but also conditions appropriate for fish spawning and juvenile rearing. Colvin et al. (2009) found that intermittent watercourses within drainages that are more heavily forested and, because of their topography, less impacted by land use activities such as agriculture and residential development, sustained a relatively richer array of native fish species.

For exotic fish species in the Willamette River valley, winter use of intermittent watercourses is probably limited by physiological constraints resulting from the low water temperatures that prevail in these channels or developmental requirements for spawning in spring and summer (Colvin et al. 2009). Colvin et al. (2009) suggested as the flooding period in the Willamette Valley coincides with low water temperatures and the migratory response of exotic species does not occur until spring, the patterns observed in the current climate of the Willamette River valley tend to support the prediction that winter-time flooding may benefit native species to a greater extent than introduced warm water species.

3.2 Willamette River Fish Community in the Vicinity of BRSP

Fish sampling records provided by Oregon Department and Fish and Wildlife (ODFW) and Oregon State University (OSU) provide a summary of fish inhabiting the BRSP gravel pit pond and former gravel pond north of the haul road near the old gravel processing plant (Table 3-1). Table 3-2 includes a summary of fish sampled by OSU in the gravel pit pond and other waterbodies in the vicinity of BRSP (Table 3-2). Graphical comparisons are included in Figure 3-1 and Figure 3-2.

Non-native fish were more abundant than native fish in the BRSP gravel pit pond and the other gravel pit pond on OPRD property that was previously used to wash gravels during the BRSP gravel pit development. The number of native fish and native species were substantially higher in the Willamette River during summer sampling.

Sampling in Coon Creek provided the only seasonal comparison for a single water body. Numbers of native fish were substantially greater than non-native fish during the spring sampling, but only slightly greater during summer sampling. Six native species and five non-native species were found during both Coon Creek sampling periods. Coon Creek was identified as a cold water refugia that would likely be more hospitable to native fish species during the summer time when mainstem water temperatures increase (S. Gregory, unpublished data, 2010). Cold water refugia were identified as off-channel areas that had water temperatures in September 2010 that were 2 °C colder than adjacent mainstem locations. Of the 71 cold water points sampled in the 2010 inventory, five of the points were located in Coon Creek downstream of the BRSP gravel pit pond.

Table 3-1. Fish sampling results from ODFW survey of the BRSP gravel pit pond and gravel washing pond completed on April 6, 2000.

Species	Count	Percent of Sample (%)	Average Size (mm)
Largescale sucker[1]	8	11	432
Largemouth bass	5	7	177
Bluegill	54	77	87
Yellow perch	3	4	127

[1]: Native fish species

Table 3-2. OSU fish sampling results for BRSP gravel pit pond, Coon Creek, the Little Willamette River, and the Willamette River in proximity of BRSP (OSU, unpublished data, 2012).

		Individual Fish				Species			
Site	Period	# Native	# Non-Native	% Native	% Non-Native	# Native	# Non-Native	% Native	% Non-Native
Bowers Rock Gravel Pit Pond	SPR	2	371	0.5	99.5	2	6	25	75
Coon Creek	SPR	120	19	86	14	6	5	55	45
Coon Creek	SUM	58	31	65	35	6	5	55	45
Little Willamette River (Rust Prop)	SUM	15	21	42	58	4	3	57	43
Willamette River (RM 120.5)	SUM	255	7	97	3	12	4	75	25
Willamette River (RM 121.0)	SUM	270	4	98.5	1.5	13	2	87	13
Willamette River (RM 123.0)	SUM	71	0	100	0	8	0	100	0
Willamette River (RM 123.75)	SUM	20	13	61	39	6	4	60	40

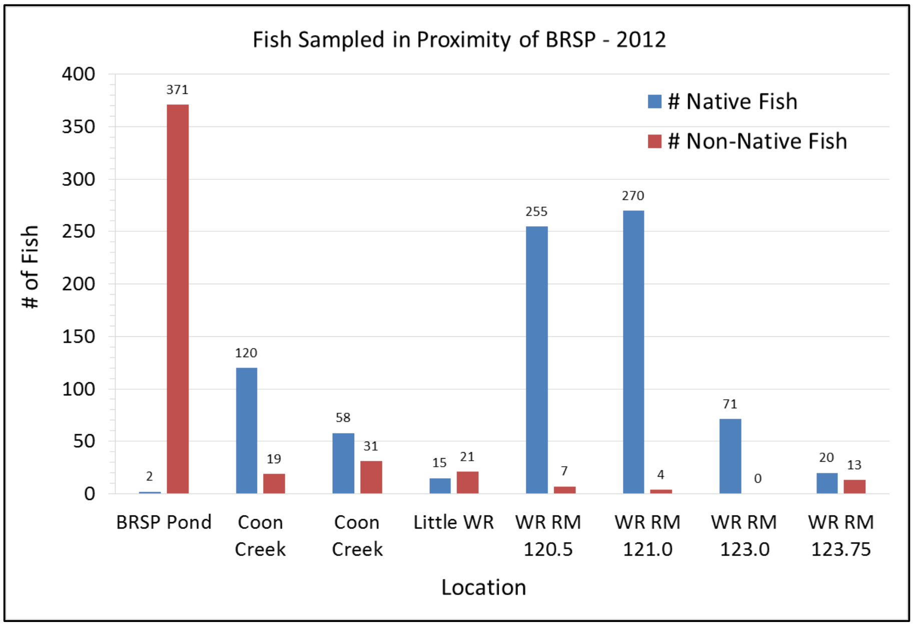


Figure 3-1. A comparison of the number of native and non-native fish sampled in proximity of BRSP in 2012 (OSU, unpublished data, 2012). Tabular data included in Table 3-2.

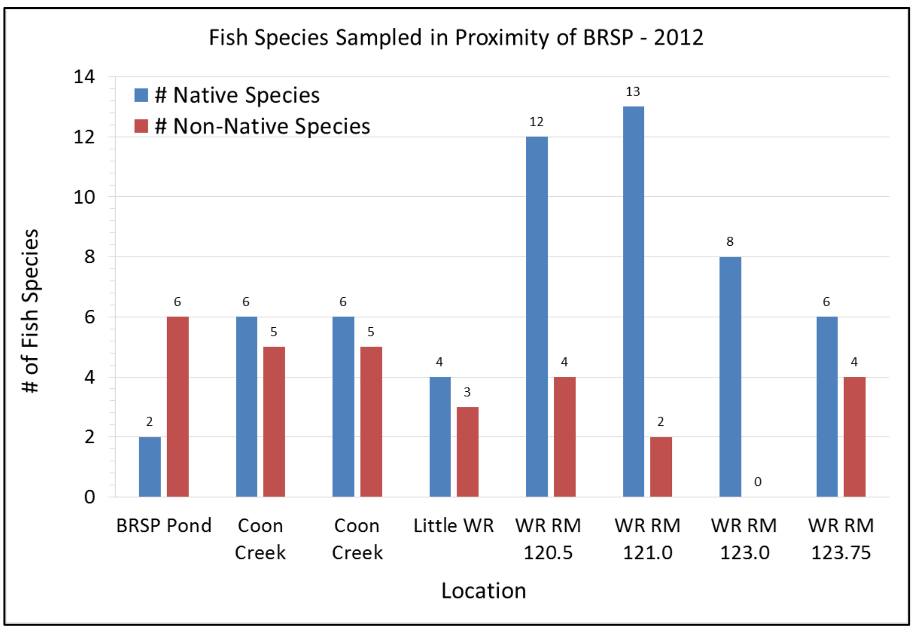


Figure 3-2. A comparison of the number of native and non-native fish species sampled in proximity of BRSP in 2012 (OSU, unpublished data, 2012). Tabular data included in Table 3-2.

3.3 Special Habitat Needs and Species Status

The following section presents the habitat needs for three native species of concern that may use inundated floodplain habitats during high water events. The species include Upper Willamette River (UWR) spring Chinook salmon (*Oncorhynchus tshawytscha*), Oregon chub (*Oregonichthys* *crameri*), and coastal cutthroat trout (*O. clarki clarki*). Juvenile UWR steelhead may also rear in the BRSP area.

Spring Chinook salmon

Rearing: Juvenile UWR spring Chinook salmon in the Willamette River Basin display diverse migratory life histories, with some individuals outmigrating as fry, et al. outmigrating the spring or fall of the following year (Schroeder et al. 2007). Like other salmonids, juvenile Chinook salmon require cold water (less than 64 °F or 17.8 °C), high dissolved oxygen levels, and deep pools for feeding and cover from predators. Juvenile Chinook prefer moderate flow with gravel and cobble substrate. While spring Chinook salmon will rear in the mainstem Willamette River, access to tributary streams and off-channel habitat to find refuge from high flows in spring is also important.

Sub-yearling fry likely originating in the McKenzie River drainage, disperse in the Willamette River and are found downstream to the Santiam River confluence with the Willamette River by late December to early January. Fry tend to be edge-oriented and use low velocity edge habitats that require minimal energy expenditure. Connected off-channel habitats are important for fry development. By mid-June to July, sub-year smolts outmigrate to the Columbia River on their way to the Pacific Ocean.

Yearling fish move out of natal areas to the Willamette River by the fall of their first year. From ODFW sampling, approximately 30% of yearling fish outmigrate in the fall and 70% overwinter in the lower McKenzie River and Willamette River. Overwintering fish typically show up in the Willamette River in the vicinity of the Santiam River confluence between September and October. These fish also move into off-channel habitats during winter high flows to take advantage of lower velocity, productive floodplain habitats. Overwintering yearling smolts outmigrate to the Pacific Ocean during spring runoff (K. Schroeder, ODFW, personal communication).

From January through May, both fish life histories inhabit the mainstem Willamette River and use connected off-channel habitats to minimize energy expenditures to maximize growth (K. Schroeder, ODFW, personal communication).

The upper Willamette River basin's evolutionary significant unit (ESU) of spring Chinook salmon was listed as threatened under the Endangered Species Act (ESA) by NOAA-Fisheries on March 24, 1999. A primary goal in the recovery process for Willamette River spring Chinook salmon is to increase off-channel rearing habitat.

Oregon chub

Oregon chub are endemic to the Willamette River basin and are typically found in off-channel habitats such as beaver ponds, oxbow channels, backwater sloughs, and flooded marshes. These habitats usually have little or no water flow, have silty and organic substrate, and have an abundance of aquatic vegetation and cover for hiding and spawning. In the last 100 years, off-channel habitats have disappeared because of changes in seasonal flows due to flood control dam operations, channelization of the Willamette River and its tributaries, and agricultural practices. This loss of habitat, combined with the introduction of non-native fish species to the Willamette Valley, has restricted the distribution of Oregon chub and led to a sharp decline in their abundance (Bangs et al. 2011).

Coastal cutthroat trout

Rearing and Adult: Juvenile and adult resident coastal cutthroat reside in both tributary streams and mainstem rivers. Cutthroat trout often inhabit very small streams with gradients up to 12 percent. Resident forms of coastal cutthroat trout typically remain in or relatively close to their natal streams. Cutthroat trout will move up and down the stream, particularly to escape warm water temperatures in the summer and into seasonal streams to escape high flows in the winter. Adult and juvenile cutthroat trout require cool water temperatures (less than 64 °F or 17.8 °C), and high dissolved oxygen levels.

3.4 Willamette River Limiting Factors

The location of BRSP within the Willamette River floodplain provides unique opportunities to benefit fish and wildlife habitat. With approximately 600 acres of land under contiguous public management, and with approximately 2 miles of Willamette River frontage, the park's position within the Willamette River network is well suited to address limiting factors that have been identified for species of concern inhabiting the mainstem Willamette River (NMFS 2008). Many of these factors are guiding tenants for restoration activities along the mainstem Willamette River. Table 3-3 and 3-4 present primary and secondary limiting factors that were identified in the 2008 Biological Opinion for the Willamette River and highlight river and land management actions that impact Willamette River species of concern. Limiting factors that could be addressed or mitigated through restoration actions at BRSP are noted.

Table 3-3. Primary threats and limiting factors for UWR spring Chinook salmon and UWR steelhead from the Willamette BiOp. Limiting factors that could be addressed through restoration actions at BRSP are shown in bold font.

Limiting Factor ID	Factor Description
5a	**Reduced macrodetrital inputs from near elimination of overbank events and separation of the river from its floodplain**
5b	Increased microdetrital inputs due to reservoirs
7h	Impaired fine sediment recruitment due to dam blockage
8a	**Impaired physical habitat from past and/or present land use practices**
10c	Reduced flow during spring reservoir filling result in increased water temperatures that lead to increased disease
10f	Altered flows due to hydropower system that result in changes to estuarine habitat and plume conditions, **impaired access to off-channel habitat**, and impaired sediment transport.

Table 3-4. Secondary threats and limiting factors for UWR spring Chinook salmon and UWR steelhead from the Willamette BiOp. Limiting factors that could be addressed through restoration actions at BRSP are shown in bold font.

Limiting Factor ID	Factor Description
4a	**Competition with hatchery fish of all species**
6e	**Predation by birds as a result of favorable habitat conditions for birds created by past and/or present land use activities**
9a	**Elevated water temperatures from past and/or present land use practices resulting increased survival and/or growth**
9h	Toxicity due to agricultural practices
9i	Toxicity due to urban and industrial practices
9j	**Elevated water temperatures due to reservoir heating**
10d	**Reduced peak flows leading to decreased channel complexity and diversity of fish habitat by reducing channel movement that is important for recruitment of gravel and large wood, and maintaining varying seral stages of riparian vegetation.**

Section 5 Restoration Project Concepts includes restoration concepts to address the limiting factors that are impacting habitats that potentially support juvenile UWR spring Chinook salmon and steelhead in the BRSP portion of the Willamette River. In addition to benefitting listed species, addressing limiting factors would include restoring river corridor process and functions that have been impaired by river regulation, river isolation from the adjacent floodplain, and floodplain

development. Actions benefiting ecosystem functions would benefit native species beyond ESA-listed fish.

4 Bowers Rock State Park Existing Conditions

The following section reviews the existing conditions at BRSP. Information is provided for both the BRSP gravel pond area as well as the stream crossings in the eastern portion of BRSP. The stream crossings currently provide access to leased agricultural fields centrally located on BRSP. Figure 4-1 includes an overview of the project area with highlighted features of interest.

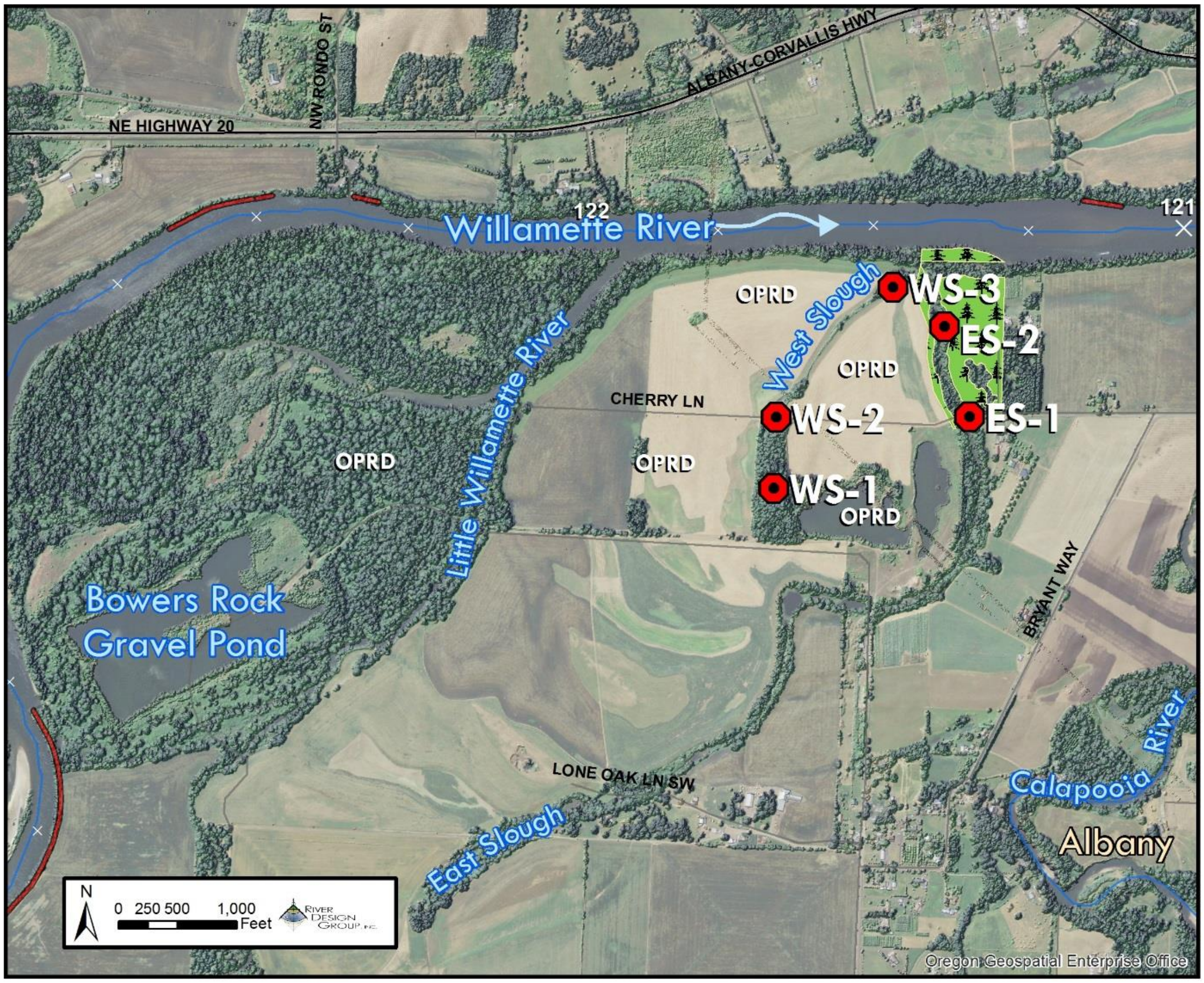


Figure 4-1. The BRSP project area with the BRSP gravel pond, West Slough and East Slough, and slough crossings highlighted.

4.1 BRSP Gravel Pond

RDG completed a remote sensing analysis and site visit to BRSP to better understand the recent and current conditions of the Willamette River, floodplain, and BRSP gravel pond. The following section provides a summary of the remote sensing and site visit.

Remote Sensing Summary

Prior to gravel pit development, the Willamette River floodplain in the vicinity of the future gravel pit was characterized by dispersed trees, likely cottonwoods, ash, and conifers. The broader floodplain appeared to be mainly low-lying vegetation including grasses and shrubs. Trail patterns in the vicinity of the gravel pit suggest the floodplain was grazed, influencing the vegetation community. Compared to current conditions, the floodplain in the vicinity of the gravel pond supported a more dispersed riparian canopy in 1967.

In 1962, the U.S. Army Corps of Engineers completed the Coon Creek revetment (see Attachment B) on the river-right bank of the Willamette River adjacent to the future gravel pit. The revetment is a low elevation, 3,276 foot-long revetment that provides scour protection, but not flood protection. The revetment terminates west of the gravel pond's midpoint and is currently functioning as intended (Figure 4-2). Typical elevations for the revetment surface adjacent to the gravel pond range from 188.0 ft to 189.0 ft. A scoured pond located to the east of the revetment was present in the 1967 air photo and may be maintained by flows that overtop the revetment (see Figure 4-2).

Figure 4-2. An upstream view of the Coon Creek revetment located on the river-right bank of the Willamette River to the west of BRSP (left). A pond located between the revetment and gravel pit pond (right).

The 1967 air photo captured the site 3 years after the 1964 flood (186,000 cfs), the largest flood event in the last 50 years. Based on the historical flood record (1862-1942) prior to the completion of the Willamette Valley flood control projects, the 1964 event was between a 5-year and 10-year flood event. Based on the modern, regulated period (1969-2013) flood record, the 1964 event would exceed a 500 year event at the Albany gage. The 1967 air photo shows broad sediment deposits on the Willamette River floodplain north and west of the future gravel pond site, and are also visible in the Western Arm of the Little Willamette River.

Gravel development planning documents, inspection summaries, air photos and survey data were used to determine the historical elevation of the gravel pit site. The floodplain elevation at the gravel pit location was ±202 ft, substantially higher than surrounding floodplain surfaces. The disturbance footprint extended beyond the gravel pit pond and included a dozer-cleared line and access roads. These disturbed areas are now largely covered by dense blackberry thickets. Road markers and through-cuts for the access road are still apparent adjacent to the gravel pit pond.

RDG reviewed DOGAMI files covering the BRSP gravel pit. The files included six air photos with known acquisition dates spanning from 1967 to 2008 and captured the Willamette River at discharges ranging from 5,050 cfs to 45,100 cfs. RDG also has two additional high flow air photos taken at 67,000 cfs and 69,500 cfs. Table 4-1 includes a summary of air photos that were used to estimate when the floodplain in the vicinity of BRSP is inundated by the Willamette River.

Table 4-1. Mean discharge recorded at USGS Albany gage on the Willamette River associated with air photos covering Bowers Rock State Park. The 1964 and 1996 events are included for comparison.

Air Photo Date	Albany Gage Mean Discharge (cfs)	Albany Gage April 2014 Rating Table Stage (ft)	Albany Gage Elevation (NAVD88, ft)	Approximate Elevation at BRSP Gravel Pit Pond (NAVD88, ft)
6/30/1967	5,050	2.96	173.45	173.45
7/4/1997	6,600	3.79	174.28	174.28
1/19/1998	45,100	16.49	186.98	186.98
2/3/2000	23,500	10.38	180.87	180.87
2/15/2002	13,100	6.7	177.19	185.19
6/15/2008	12,400	6.42	176.91	184.91
2/28/2012	69,500[1]	22.07	192.56	198.06
2/17/2014	67,000[1]	21.54	192.03	197.53
2/9/1996	125,000[1]	30.08	200.57	-
12/24/1964	186,000[1]	34.08	204.57	-

[1]: Instantaneous discharge.

A review of the 2000 air photo suggests the Willamette River begins to inundate low elevation floodplain areas to the northwest of the gravel pit around 23,500 cfs, a discharge that is exceeded on average 70 days/year. The 2000 air photo also shows a surface water connection on the west side of the Coon Creek revetment (Figure 4-3). The estimated Willamette River water surface elevation associated with the 23,500 flow is 188.5 ft at the upstream end of the BRSP gravel pit pond. The Western arm of the Little Willamette River channel has a high point elevation of 186.6 ft, suggesting a surface water connection occurs between the Willamette River and the Little Willamette River via a scoured channel that runs parallel between the Coon Creek revetment and the gravel pit pond. Similarly, a scoured channel that runs east and parallels the north side of the gravel pit pond has a high point elevation of 187.7 ft, again, a lower elevation than the 23,500 cfs discharge captured in the 2000 air photo. For restoration alternatives development, 23,500 cfs could be a conservative target discharge for increasing river connectivity with the BRSP gravel pit pond since floodplain inundation currently initiates at this flow.

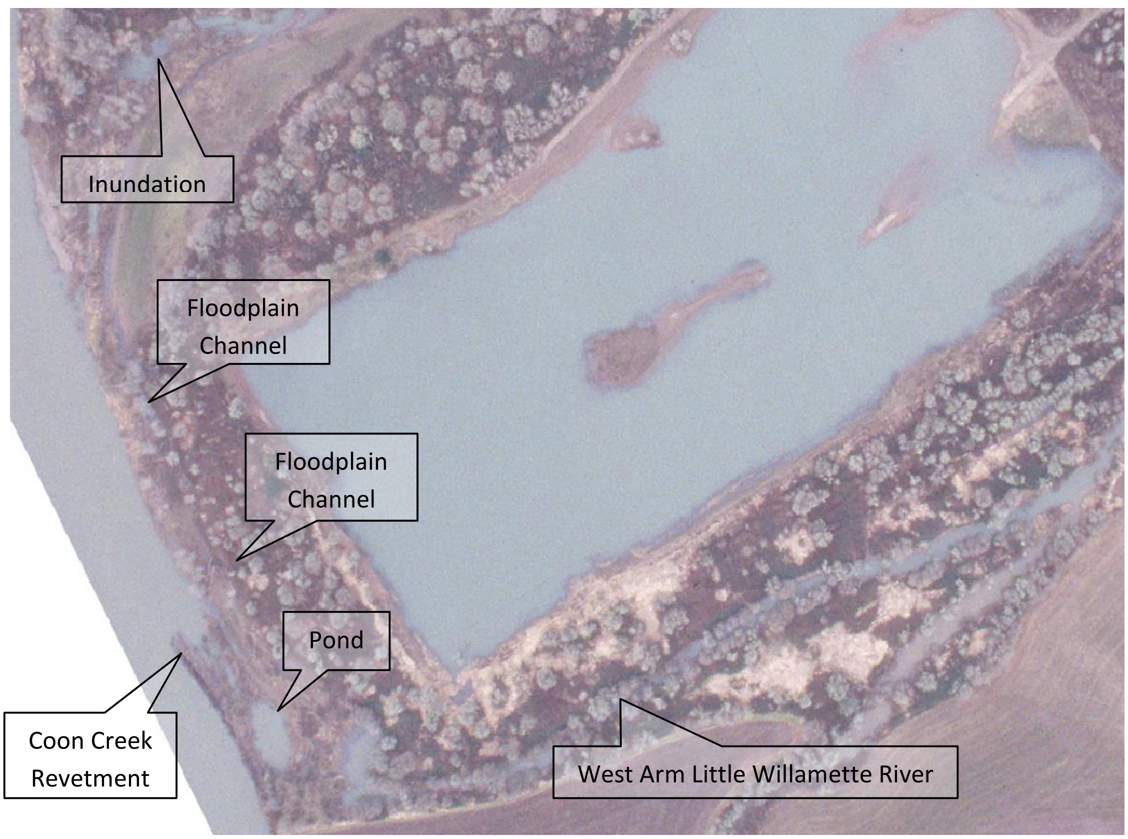


Figure 4-3. The 2000 air photo of the BRSP gravel pit pond at a Willamette River flow of 23,500 cfs. The air photo shows a surface water connection at a flow that is exceeded 70 days/year on average.

Site Visit Summary

RDG completed a BRSP site visit on April 16, 2014. RDG personnel began the site visit on the east side of the pond and walked around either side of the pond to the Willamette River. The pond and adjacent floodplain are characterized by a dense riparian zone. The vegetation on the pond perimeter is dominated by mature willows and aquatic and upland grasses. Blackberry is common with increasing elevation to the top of the gravel pit excavation where it forms a monoculture. Other disturbed areas adjacent to the pond, such as the old road network, are also dominated by dense blackberry.

Mature maple, ash, and cottonwood trees are located on surfaces outside of the historical disturbance footprint and indicate the extent of the gravel mining operation. Figure 4-4 includes representative ground photos of the gravel pit pond and adjacent disturbed ground surfaces.

Figure 4-4. A view of the gravel pit pond from the northeast pond margin looking to the west (left). The photo shows the transition from blackberry at the excavated slope to willows at the pond edge. The right photo shows the typical dense blackberry cover on historical haul roads located adjacent to the pond.

The upstream extent of Coon Creek is a broad floodplain channel north of the BRSP gravel pond. Coon Creek was historically active at relatively low flows. Based on RDG's remote sensing analysis, the Willamette River inundates this surface at approximately 23,500 cfs. This channel continues to provide high quality floodplain habitat although it no longer functions as frequently as it did historically due to river regulation and reduced flood magnitudes. The fine sediment that has filled the channel could be a fill material source for modifying the BRSP pond. Removing sediment from the channel would improve function, habitat condition, and provide a nearby fill material source for the BRSP pond. Figure 4-5 includes representative photos of the upstream Coon Creek channel.

Figure 4-5. An upstream view of the upstream extent of the Coon Creek channel showing the broad floodplain channel morphology (left). A debris raft collected on a riparian shrub in the Coon Creek channel suggests the height of recent floodwater (right).

The eastern bank of the Willamette River between the river and the BRSP gravel pit pond is a dynamic area with large wood accumulations, scoured channels, and dense riparian vegetation. The Coon Creek revetment maintains the eastern bank line of the Willamette River, but allows overtopping flows that access the narrow floodplain between the revetment and the BRSP gravel pit pond perimeter. Scoured channels trend to both the north and south leading to the broad northern floodplain channel and the West Arm of the Little Willamette River, respectively. These channels could be used to route flow into the BRSP gravel pit pond as part of a restoration strategy. Figure 4-6 includes ground photos of the floodplain between the Willamette River and the BRSP gravel pit pond.

Figure 4-6. The low elevation floodplain between the Willamette River and the BRSP gravel pit pond is characterized by scour ponds and channels that route water throughout the area, and dense riparian vegetation. Extensive sand deposits suggest the relatively frequent inundation of the near-bank floodplain.

BRSP Gravel Pit Pond Summary

The BRSP gravel pit pond is a substantial feature on the Willamette River floodplain. Mined from 1975 to the early1990s, the pond is disconnected from the Willamette River until approximately the 2-year flow due to the naturally higher elevation of the landform relative to the adjacent floodplain. The Coon Creek revetment located on the east bank of the Willamette River was installed by the U.S. Army Corps of Engineers in 1962 to halt lateral channel migration. The revetment has effectively maintained the Willamette River channel alignment in the vicinity of BRSP. Without natural floodplain erosion, vegetation communities located inland from the revetment have matured and create a diverse riparian community. The revetment has also likely ensured the persistence of the BRSP pond by eliminating lateral channel migration.

Higher elevation areas that were formerly disturbed by the gravel mining operation are dominated by dense blackberry. Haul roads and the upper elevations of the excavated area support a blackberry monoculture. Addressing invasive plant species like blackberry and enhancing the hydrologic function of the BRSP gravel pit pond are goals for future restoration.

4.2 BRSP Crossings

The East Slough and West Slough flow from south to north through the BRSP property. The East Slough is a historical feature on the landscape, the West Slough includes both natural and excavated segments. The West Slough was historically a floodplain swale connected to the East Slough. Prior to the 1970s, Albany Sand and Gravel (ASG) mined a gravel deposit at the former connection between the West Slough and the East Slough, disconnecting the sloughs at low water. The remnant forest located west-northwest of the ASG pond is a relict forest stand remaining from the historical riparian area that existed up until at least the mid-1930s. The West Slough north of the forest stand was excavated to drain the adjacent land for farming. The northern portion of the West Slough continues to function as a drain.

The following section provides an existing condition review of the crossings. Recommended crossing treatments are presented in Section 5 Restoration Project Concepts.

ES-1 – Primary Access Crossing at East Slough

The ES-1 crossing is the primary road access into BRSP from Bryant Way. Access to the crossing is by way of a dead end road that terminates at the OPRD gate in front of the Huber residence. The crossing is an earthen fill with an unimproved surface. An existing 6 ft culvert provides conveyance through the earthen fill (Figure 4-7). Although the culvert provides a channel connection through the road crossing, the culvert is periodically affected by beaver dams, debris, and sediment deposition. Due to current stagnant conditions, poor water quality (e.g., depressed oxygen concentrations due to decaying vegetation) may affect fish inhabiting the East Slough).

Figure 4-7. An upstream view of the culvert (white box) at ES-1. The mature cottonwood is located to the right of the culvert.

ES-2 – Secondary Access Crossing at East Slough

ES-2 is a secondary crossing on the East Slough. The crossing is an earthen fill with an unimproved surface (Figure 4-8). The crossing is mainly used to access the northeastern field adjacent to the East Slough. The narrow crossing primarily supports 4-wheel all-terrain vehicles (ATVs) and is too narrow for larger farm equipment to safely pass. Similar to ES-1, slough conditions upstream of the crossing may be affected by stagnant water related to the insufficient conveyance capacity and the elevation of the existing concrete box culvert.

Figure 4-8. A view to the east across the ES-2 crosing (left) and upstream of the ES-2 crossing (right).

WS – 1 Secondary Access Crossing at OPRD Pond Outlet

WS-1 is a primary crossing at the outlet of the OPRD pond. The OPRD pond is a relict gravel pit formerly developed by Albany Sand and Gravel. The ford includes a low flow channel and low gradient approach slopes (Figure 4-9). During the time of the April 2014 survey, outflow from the pond connected the pond with the downstream flooded forest. The north-south oriented ford allows access to the east-west running road on OPRD property adjacent to the Scheler property and provides access to the Little Willamette River shared crossing. The road is suitable for passenger vehicles, farming machinery, and off-road construction equipment.


Figure 4-9. A view to the north of the WS-1 crossing (left), and a view of the low flow channel outlet from the OPRD pond (right).

WS-2 – Secondary Access Crossing at West Slough

WS-2 is located on the West Slough in the downstream portion of the flooded forest stand. The crossing is a shallow earthen fill with an unimproved surface (Figure 4-10). Historically, this crossing was part of an east-west road that linked the primary site access (ES-1) with the west side of the property. The main portion of the road is believed to have been removed in the middle to late 2000s in order to farm the area occupied by the former road. Based on the crossing size and poor condition, the crossing looks to be mainly used by ATVs. The existing 18 inch corrugated plastic pipe is covered by minimal fill and the water surface elevation was close to the road surface at the time of survey. Similar to the East Slough, the West Slough is influenced by back water conditions created by downstream channel roughness. The crossing likely regularly overtops during winter high flows.

Figure 4-10. A view to the north across WS-2 (left). The right photo is a view downstream from the crossing showing the flooded forest stand conditions and the transition to the confined West Slough.

WS-3 – Secondary Access Crossing at West Slough

WS-3 is a secondary crossing on the West Slough immediately upstream of the East Slough-West Slough confluence. The crossing is an earthen fill with an unimproved surface (Figure 4-11). Based on the crossing size and poor condition, the crossing looks to be mainly used by ATVs. The existing pipe includes a damaged corrugated metal pipe on the upstream end and a clay pipe on the downstream end of the crossing. The pipe looks to be frequently overtopped but the damaged upstream side of the pipe likely limits fish passage.

Figure 4-11. A downstream view of WS-3 (left) showing the minimal road fill over the culvert (white box), and a downstream view in the West Slough towards the East Slough-East Slough confluence (right).

BRSP Crossing Summary

RDG suggests OPRD consider how OPRD and the lessee plan to use the crossings in the future to access the property. The existing crossings appear to mainly be for ATV access with the exception of ES-1 and WS-1 which also support passenger vehicle and farm equipment access. For secondary crossings that provide non-essential vehicular access, OPRD may consider either removing the crossings or upgrading existing conveyance pipes with larger diameter pipes that will improve crossing stability, hydrologic connectivity, fish passage, and water quality. Installing a larger diameter culvert at ES-1 is advisable although the culvert installation should consider the preservation of a large diameter cottonwood growing in the road embankment.

5 Restoration Project Concepts

The following section reviews the project goals for BRSP with specific emphasis on features that currently limit hydraulic and ecological connectivity between the Willamette River and floodplain habitats. The following recommended treatments are made based on ground observations and remote sensing efforts. Reported topographic locations or elevations are derived from LiDAR and are referenced to NAVD88. Additional detailed topographic site survey and analysis will be necessary for designing selected treatments.

5.1 Project Goals

RDG and CWC established several project goals to guide the restoration concept development for BRSP. Project goals are tied to the limiting factors highlighted in *Section 3 Willamette River Fish Community* and include the following.

- Improve connectivity between the Willamette River and project areas to enhance inundation frequency and duration of off-channel habitat features to restore high flow refugia and exchange of flow, sediment, nutrients, and organisms.
- Increase the frequency and duration of stream-like conditions that favor native fish species, and decrease the amount of deep water lentic-type habitat that favors non-native predatory fish species.
- Restore hydrology that supports desired vegetation types and restore riparian buffers to drainages on agricultural lands.
- Maintain necessary levels of landowner access.
- Minimize the potential for adverse effects to adjacent and downstream neighboring properties.

The following sections provide explanation on how restoration actions would achieve the project goals and address the limiting factors.

Goal 1: Improve connectivity between the Willamette River and project areas to enhance inundation frequency and duration off-channel habitat features and restore high flow refugia.

Provide connectivity for exchange of water, nutrients, sediments, and biomass between the Willamette River and the adjacent riparian forest by modifying infrastructure that currently limits inundation frequency and duration. Modifying infrastructure, such as removing channel fill plugs and upgrading low water crossings, will improve fish access to overbank areas, sloughs, and off-channel habitat areas that are not currently accessible, or not frequently accessible with clear egress. Removing or modifying current obstructions will increase the length of the channel network available for fish use.

Limiting factors addressed: 5a, 8a, 9a, 9j, 10d, 10f

Goal 2: Increase the frequency and duration of stream-like conditions that favor native fish species, and decrease the amount of deep water pond-like habitat that favors non-native predatory fish species.

Predatory non-native fish species dominate pond-like water bodies on the Willamette River floodplain. Fish sampling at BRSP and other relict gravel pit ponds in the Willamette Valley shows that non-native species prosper in ponds that are characterized by low velocities, warm summer water temperatures, and stable water levels. Periodic connections between the Willamette River and floodplain ponds annually replenish the prey base that allows non-native fish to persist. Replacing these habitat types with flow-through, stream-like conditions is expected to reduce non-native fish populations and potentially increase native fish populations. Techniques to improve flow conditions include berm removals and side channel reconstruction, approaches that increase the connectivity between the Willamette River and floodplain habitats.

Limiting factors addressed: 5a, 8a, 9a, 9j, 10d, 10f

Goal 3: Restore hydrology that supports desired vegetation types, convert agricultural lands to riparian forest

Working in concert with riparian planting efforts at the project sites, actions would be taken to restore wet soil hydrology and increase overbank flooding, including a cycle of wetting and drying supported by flood pulses on the Willamette River. Floodplain connection efforts will help to make the floodplain work with the Willamette River flow regime to make these moisture cycles possible in areas where this function is lacking. Increased overland connections will create areas for river-deposited fines that support germination, and create areas for seed and plant propagules propagation. These actions would be intended to create, enhance, and maintain land surfaces that support desired types of vegetation. Better manage invasive non-native plant species like blackberry and promote native riparian vegetation.

Limiting factors addressed: 5a, 8a, 10d

Goal 4: Maintain necessary levels of landowner access.

Existing crossings at BRSP provide lessee, OPRD, and utility company access throughout the property. Although several of the crossings are necessary to travel throughout the property, a number of crossings provide convenient access but are not essential for site access. Removing unnecessary crossings would improve floodplain channel connectivity, debris transport, and fish passage

Goal 5: Minimize the potential for adverse effects to adjacent and downstream neighboring properties.

Proposed project alternatives for the BRSP gravel pit pond are intended to minimize disturbance to adjacent private landowners. Proposed pond reconnection locations are located on the north and west sides of the gravel pit pond. The reconnection channel would join Coon Creek and the Little Willamette River downstream from private properties. Increased flows to Coon Creek, the Little Willamette River, and ultimately the Willamette River are not expected to affect private properties.

5.2 BRSP Gravel Pit Pond Alternatives Analysis

Four alternatives were developed for the BRSP gravel pit pond. The alternatives vary by implementation cost and degree of connectivity between the gravel pit pond and the Willamette River. The alternatives include the following.

- Alternative 1 – Channel Outlet
- Alternative 2 – Flow-through Connection
- Alternative 3 – Floodplain Channel
- Alternative 4 – No Action

The following sections provide a preliminary overview of the four project alternatives. In addition to the ecological restoration goals, the alternatives also seek to minimize hydrologic and scour effects to neighboring private landowners. To minimize private land impacts, the alternatives include the following elements.

- Outlet channel connections are located on the north and east sides of the pond and receiving waters join the Little Willamette River downstream from the primary Scheler/OPRD crossing.

- No grading would occur on the west side of the pond between the pond and the Little Willamette River.

- Connector channel elevations would be set so that floodplain areas are inundated in a pattern similar to existing conditions.

- Fill material would be generated from the OPRD property or would be imported. Minimizing the imported material volume is recommended for cost savings and to minimize disturbance to neighbors.

Each alternative could also include modifying the gravel pit pond by creating a more diverse shoreline and partially filling the pond to create shallow areas for wetland development. The extent of the pond modification will be dependent on the availability of fill that is generated on-site and/or imported to the gravel pit pond. Concept-level drawings are included in Attachment C.

Alternative 1 – Channel Outlet

Alternative 1 includes excavating a channel to connect the gravel pit pond with the existing floodplain channel that connects with Coon Creek to the northeast of the gravel pond (Figure 5-1). The dimensions and elevation of the connector channel would be set to ensure frequent connection with the existing floodplain channel. Preliminary concepts include setting the connector channel bed at an elevation of 185 ft so that the gravel pond is connected with Coon Creek at a Willamette River discharge of 14,000 cfs. Based on the flow duration analysis, the pond would be connected with Coon Creek for approximately 110 days/year. Currently, the pond does not connect with Coon Creek until approximately the 2-year flow which occurs less than one day per year on average.

The alternative would include constructing 1,550 ft of channel to connect the pond to the perennial portion of Coon Creek. The approximately 12,000 cy of excavated floodplain soils would be placed in the gravel pond margins to modify the pond shape. Of the three action alternatives, Alternative 1 has the lowest project cost, stability risk, and ecological benefit. The estimated project implementation cost is $315,000.

Figure 5-1. An aerial image of the BRSP gravel pond with the Alternative 1 – Channel Outlet highlighted. Alternative 1 includes excavating a connector channel between the gravel pond and Coon Creek.

Table 5-1 includes a comparative analysis of the advantages and disadvantages of Alternative 1.

Table 5-1. Alternative 1 advantages and disadvantages.

Advantages	Disadvantages
• Minimal excavation and disturbance • Connects pond to channel network • Improved fish access to off-channel habitat • Excavated material used for pond modifications • Lowest cost	• Least change relative to existing condition • Minimal change to pond • Potential fish stranding in pond • Similar project formerly denied SIP funding

Alternative 2 – Flow-through Connection

Alternative 2 includes excavating both inlet and outlet channel segments to create a flow-through pond condition (Figure 5-2). Two sub-alternatives, Alternative 2A and Alternative 2B, were developed based on the inlet channel and partition berm locations. Under both alternatives, the pond inlet channel would be located on the west-southwest side of the gravel pit pond and set at an elevation of 190 ft, similar to the low elevation floodplain channel that exists between the Coon Creek revetment and the gravel pond. The inlet channel would likely be set to convey flow when the Willamette River discharge is approximately 25,000 cfs. The inlet channel would allow flow-through conditions for approximately 70 days/year based on the flow duration analysis. Currently, the pond does have a minor connection with the Willamette River through the southwest corner of the pond at the 2-year flow which occurs less than one day per year on average. More substantial river-pond connection occurs at infrequent, substantial floods.

Similar to Alternative 1, the outlet channel would connect the gravel pond with the perennial portion of Coon Creek located northeast of the gravel pond. The channel would be located in the northeastern corner of the pond where an existing excavated area (former access road) is located. The dimensions and elevation of the connector channel would be the same as described for Alternative 1. The outlet channel would connect the gravel pond with Coon Creek for an additional 40 days/year on average (connection for a total of 110 day/year).

Alternative 2A would include constructing 2,010 ft of connector channel. The approximately 25,000 cy of excavated floodplain soils would be placed in the pond to create a partition berm. The partition berm would extend from the western pond bank to the existing island. The berm would reduce the pond's effective cross sectional area to promote higher velocities and improved habitat for native fish when the upstream pond connection to the Willamette River is activated. An additional 7,000 cy of fill material would have to be imported or generated on-site to complete the partition berm.

Alternative 2B would include constructing 1,830 ft of connector channel. The approximately 26,000 cy of excavated floodplain soils would be placed in the pond to create a partition berm. The berm would extend from the southern pond bank to the existing island. The partition berm would reduce the pond's effective cross sectional area, but would likely have less beneficial effect on velocities due to the orientation of the berm relative to the flow path. However, additional fill could be generated and placed on the northwest side of the pond to further narrow the effective channel. Alternative 2B would require less fill material than Alternative 2A, but would likely be less effective at creating flow-through conditions to the benefit of native fish.

The southeastern side of the pond that is enclosed by the pond perimeter and the partition berm-island, would function as a low velocity habitat, similar to the current gravel pond environment. In addition to non-native fish, this area would likely be inhabited by turtles, amphibians, and waterfowl.

Of the three action alternatives, Alternative 2 has a moderate project cost, stability risk, and ecological benefit. The estimated project implementation cost for Alternative 2A and Alternative 2B is $592,000 and $545,000, respectively.

Figure 5-2. An aerial image of the BRSP gravel pond with Alternative 2A (top) and Alternative 2B (bottom) highlighted. Alternative 2 includes excavating inlet and outlet connector channels and an interior partition berm to reduce the effective flow-through area to promote native fish habitat. The sub-alternatives vary according to the inlet channel and partition berm locations.

Table 5-2 includes a comparative analysis of the advantages and disadvantages of Alternative 2.

Table 5-2. Alternative 2 advantages and disadvantages.

Advantages	Disadvantages
• Moderate excavation and disturbance • Active pond connection with channel network • Improved fish access to off-channel habitat • Excavated material used for pond modifications • Moderate cost	• Erosion potential at inlet channel • Potential fish stranding in pond • Alt 2B not as effective flow-through condition • Minimal change to pond, greater potential for natural pond filling from sediment deposition

Alternative 3 – Floodplain Channel

Alternative 3 includes constructing a channel and floodplain through the pond (Figure 5-3). Similar to Alternative 2, an inlet channel would be located on the west side of the pond. The constructed outlet channel would begin north of the gravel pit pond and tie into the perennial portion of Coon Creek. Because Alternative 3 would include building a narrow floodplain surface within the pond to form the river-right bank of the floodplain channel, substantially more fill material would be required to complete the project compared to the other two action alternatives. The river-left bank of the channel through the pond would tie to the existing vegetated slope forming the northeast pond margin.

The constructed channel inlet would be located on the west side of the gravel pit pond and set at an elevation of 190 ft, similar to the floodplain channel that exists between the Coon Creek revetment and the gravel pit pond. Similar to Alternative 2, the floodplain channel would be activated at approximately 25,000 cfs and maintain a flow-through condition for approximately 70 days/year on average. The downstream outlet channel would also connect with the gravel pond for an additional 40 days/year (connection for a total of 110 days/year).

Alternative 3 would include constructing 3,740 ft of channel. Connector channel excavation would generate 25,000 cy of floodplain soil for filling the pond. An additional 345,000 cy of material would have to be generated on-site or imported to create the floodplain surface through the pond. The floodplain would extend to the pond centerline. The flow-through channel conditions would create more natural hydrology and preferential habitat for native fish.

The southeastern side of the pond that is enclosed by the pond perimeter and the interior floodplain, would function as a low velocity habitat, similar to the current gravel pond environment. In addition to non-native fish, this area would likely be inhabited by turtles, amphibians, and waterfowl.

Of the three action alternatives, Alternative 3 has the greatest project cost, risk, and ecological benefit. The estimated project implementation cost for Alternative 3 is $4.6 million.

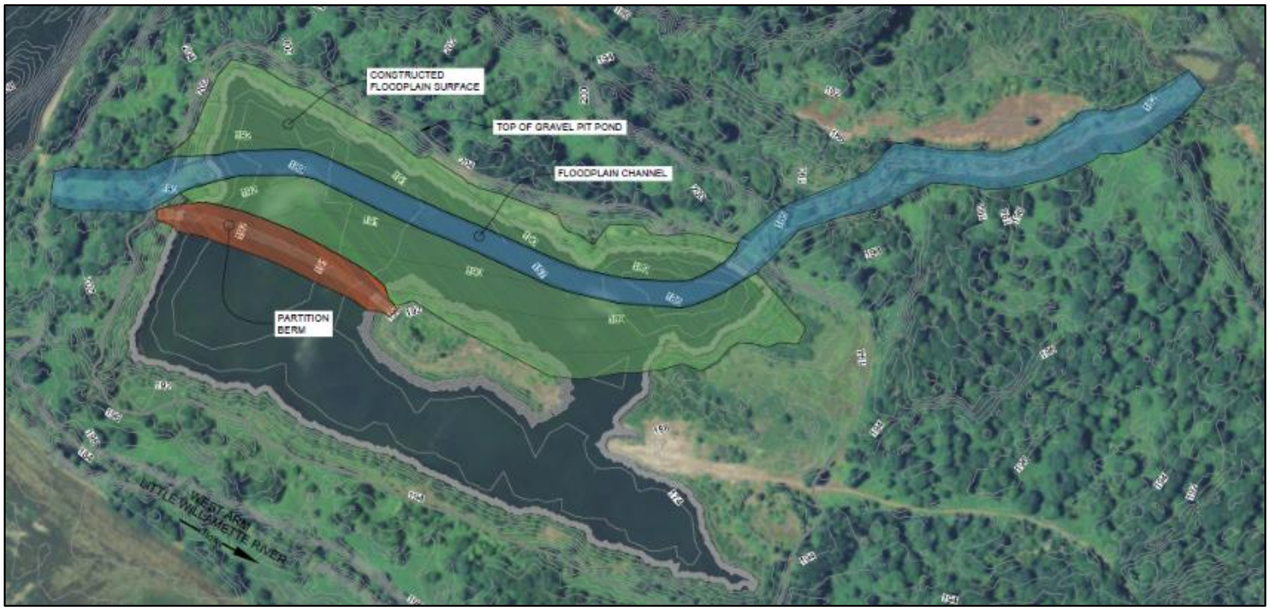


Figure 5-3. An aerial image of the BRSP gravel pond with Alternative 3 highlighted.

Table 5-3 includes a comparative analysis of the advantages and disadvantages of Alternative 3.

Table 5-3. Alternative 3 advantages and disadvantages.

Advantages	Disadvantages
• Conversion of pond to flowing channel • Minimizes non-native fish habitat, maximizes native fish habitat • Greatest riparian forest restoration potential • Minimizes fish stranding potential • Excavated material used for pond modifications	• Greatest cost and risk • Greater disturbance footprint but mainly limited to pond • Longer construction period, inconvenience to neighbors

Alternative 4 – No Action

Alternative 4 is the No Action alternative that maintains the existing condition. Conditions in the pond are not expected to change appreciably over time due to the limited connection between the pond and the Willamette River channel network. The pond margin vegetation community will continue to mature and may further encroach into the pond, although water depths will limit riparian expansion. Due to minimal natural deposition in the pond, water depths will likely remain similar over time.

Table 5-4 includes a comparative analysis of the advantages and disadvantages of Alternative 4.

Table 5-4. Alternative 4 advantages and disadvantages.

Advantages	Disadvantages
• No monetary cost. • No construction risk. • No inconvenience to neighbors.	• Maintains current conditions • Habitat remains disconnected from river • Continued non-native fish persistence • Missed opportunity to improve/restore floodplain habitats and function

BRSP Gravel Pond Alternatives Summary

The presented gravel pond alternatives vary based on implementation cost, stability risk, and ecological benefit. Table 5-5 includes a summary comparison of the alternatives.

Table 5-5. Relative comparison of the proposed project alternatives.

Alternative	Predicted Implementation Cost	Relative Stability Risk	Ecological Benefit
Alt 1 – Outlet Channel	$315,000	Low	Low
Alt 2A – Flow-through Connection	$592,000	Moderate	Moderate
Alt 2B – Flow-through Connection	$545,000	Moderate	Moderate
Alt 3 – Floodplain Channel	$4.6 million	Moderate	High
Alt 4 – No Action	$0	Lowest	Lowest

5.3 BRSP Crossings Alternatives Analysis

The following section provides recommendations for addressing the East Slough and West Slough crossings.

ES-1 – Primary Access Crossing at East Slough

The crossing could be improved by installing a larger diameter culvert to improve crossing stability and conveyance capacity. Installing a new culvert towards either end of the crossing would minimize impacts to the mature cottonwood growing out of the crossing embankment. The existing culvert could be left in-place to avoid damaging the mature cottonwood and to provide additional conveyance capacity.

ES-2 – Secondary Access Crossing at East Slough

Depending on the need for the crossing, the crossing could be removed to improve channel conveyance and water quality in the East Slough. If the crossing is to remain, the existing concrete box culvert should be replaced with a larger diameter culvert if access is required prior to the channel going dry. If access is only necessary during the summer, a low water ford could replace the existing road embankment.

WS – 1 Secondary Access Crossing at OPRD Pond Outlet

Due to the broad approach to either side of the crossing, maintaining a low water ford at this site is recommended. The approaches to the topographic low point at the outflow channel could be improved by modifying the outlet channel. Grading the crossing to create a smoother transition at the bottom of the grade would improve drivability.

WS-2 – Secondary Access Crossing at West Slough

Depending on the need for the crossing, the crossing is recommended for removal to improve channel conveyance in the West Slough. If the crossing is to remain, the existing plastic culvert should be replaced with a larger diameter culvert if access is required prior to the channel going dry. If access is only necessary during the summer, a low water ford could replace the existing crossing.

WS-3 – Secondary Access Crossing at West Slough

Depending on the need for the crossing, the crossing should be removed to improve channel conveyance in the West Slough. If the crossing is to remain, the crossing should be replaced with a larger diameter culvert if access is required prior to the channel going dry. If access is only necessary during the summer, a low water ford could replace the existing crossing.

The West Slough between WS-2 and WS-3 should also be considered for filling to improve channel-floodplain connectivity, and to restore the historical hydrology and riparian forest.

BRSP Crossing Alternatives Summary

The presented crossing treatment alternatives vary based on implementation cost, risk, and ecological benefit. Table 5-6 includes a summary comparison of the alternatives.

Table 5-6. BRSP crossing alternatives predicted costs.

Crossing	Improve Crossing	Remove Crossing	No Action
ES-1	$59,000	$37,000	$0
ES-2	$48,000	$30,000	$0
WS-1	$15,000	N/A	$0
WS-2	$22,000	$15,000	$0
WS-3	$19,000	$12,000	$0

6 Summary

RDG completed a historical information review, remote sensing analysis, and site visit to understand the historical and current conditions at BRSP. Proposed project concepts for the BRSP gravel pit pond and crossings address limiting factors identified in the Willamette BiOp. Concepts vary by implementation cost, stability risk, and ecological benefit. OPRD may consider how proposed restoration concepts integrate with both long term and short term planning goals for the BRSP property.

7 References

Bangs, B.L., P.D. Scheerer, B.J. Priz, B.L. Berger, P. Hayden, and R.L. Jacobsen. 2011a. Oregon Chub Investigations. Oregon Department of Fish and Wildlife. Fish Research Project EF-11, Annual Progress Report, Corvallis, Oregon, 80 pp.

Bayley, P.B. 1991. The flood pulse advantage and the restoration of river–floodplain systems. Regulated Rivers: Research and Management 6:75–86.

Colvin, R.W., K.S. Boyer, G.R. Giannico, J.L. Li and S.M. Griffith. 2006. Fish and amphibian use of vegetated and non-vegetated intermittent channels in the Upper Willamette Basin.
Oregon Seed Extension Research Program Seed Production Research Report 2006 - 60 p.

Colvin, R. G.R. Giannico, J. Li, K.L. Boyer, and W.J. Gerth. 2009. Fish use of intermittent watercourses draining agricultural lands in the upper Willamette River Valley, Oregon. Trans. Am. Fish. Soc. 138: 1303-1313.

DOGAMI. 1975a. Pit development plan. 3 pp.

DOGAMI. 1975b. Report of on-site inspection. July 31, 1975. 2 pp.

DOGAMI. 1976a. Correspondence to Mr. Bob Beil, Hub City Concrete, Inc. Estimated gravel pit production at E.M. Edholm property. 2 pp.

DOGAMI. 1976b. Report of on-site inspection. December 2, 1976. 2 pp.

DOGAMI. 1984. Report of on-site inspection. March 5, 1984. 1 pp.

DOGAMI. 1985. Report of on-site inspection. September 10, 1985. 1 pp.

DOGAMI. 1989. Memo to file. Summary of conversation with Mr. Bob Beil concerning lease and gravel royalty payment. 2 pp.

DOGAMI. 1991. Correspondence to Mr. Bob Beil, Hub City Concrete, Inc. Access complaint correspondence. 1 pp.

DOGAMI. 1993. Report of on-site inspection. Open egrees concept for gravel pit pond to Coon Creek. 1 pp.

DOGAMI. 2003. Scheler-Snyder Pit-Bowers Rock Closing File. 2 pp.

Giannico, G.R., and S.G. Hinch. 2007. Juvenile coho salmon responses to salmon carcasses and instream wood manipulations during winter and spring. Canadian Journal of Fisheries and Aquatic Sciences 64:324–335.

Henery, R., T.R. Sommer, and C. Goldman. 2010. Growth and Methylmercury Accumulation in Juvenile Chinook Salmon in the Sacramento River and Its Floodplain, the Yolo Bypass. *Transactions of the American Fisheries Society*, Vol. 139, No. 2. pp. 550-563, doi:10.1577/T08-112.1

Junk, W.J., P.B. Bayley, and R.E. Sparks. 1989. The flood pulse concept in river–floodplain systems. Canadian Special Publication of Fisheries and Aquatic Sciences.

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: Consultation on the Willamette River Basin Flood Control Project. NMFS, Portland, Oregon. July 11, 2008.

Oregon State University (OSU). 2012. Unpublished fish sampling results for Bowers Rock State Park. Excel workbook.

Schroeder, R.K., K.R. Kenaston and L.K. McLaughlin. 2007. Spring Chinook in the Willamette and Sandy Rivers. Annual Progress Report, Fish Research Project Number F-163-R-11/12. Oregon Department of Fish and Wildlife, Salem, OR.

Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer. 2001b. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325–333.

Sommer, T.R., W.C. Harrell, R. Kurth, F. Feyrer, S.C. Zeug, and G. O'Leary. 2004. Ecological patterns of early life stages of fishes in a large river–floodplain of the San Francisco Estuary. Pages 111–123 in F. Feyrer, L. R. Brown, R. L. Brown, and J. J. Orsi, editors. Early life history of fishes in the San Francisco Estuary and watershed. American Fisheries Society, Symposium 39, Bethesda, Maryland.

Attachment A

Historical Air Photos

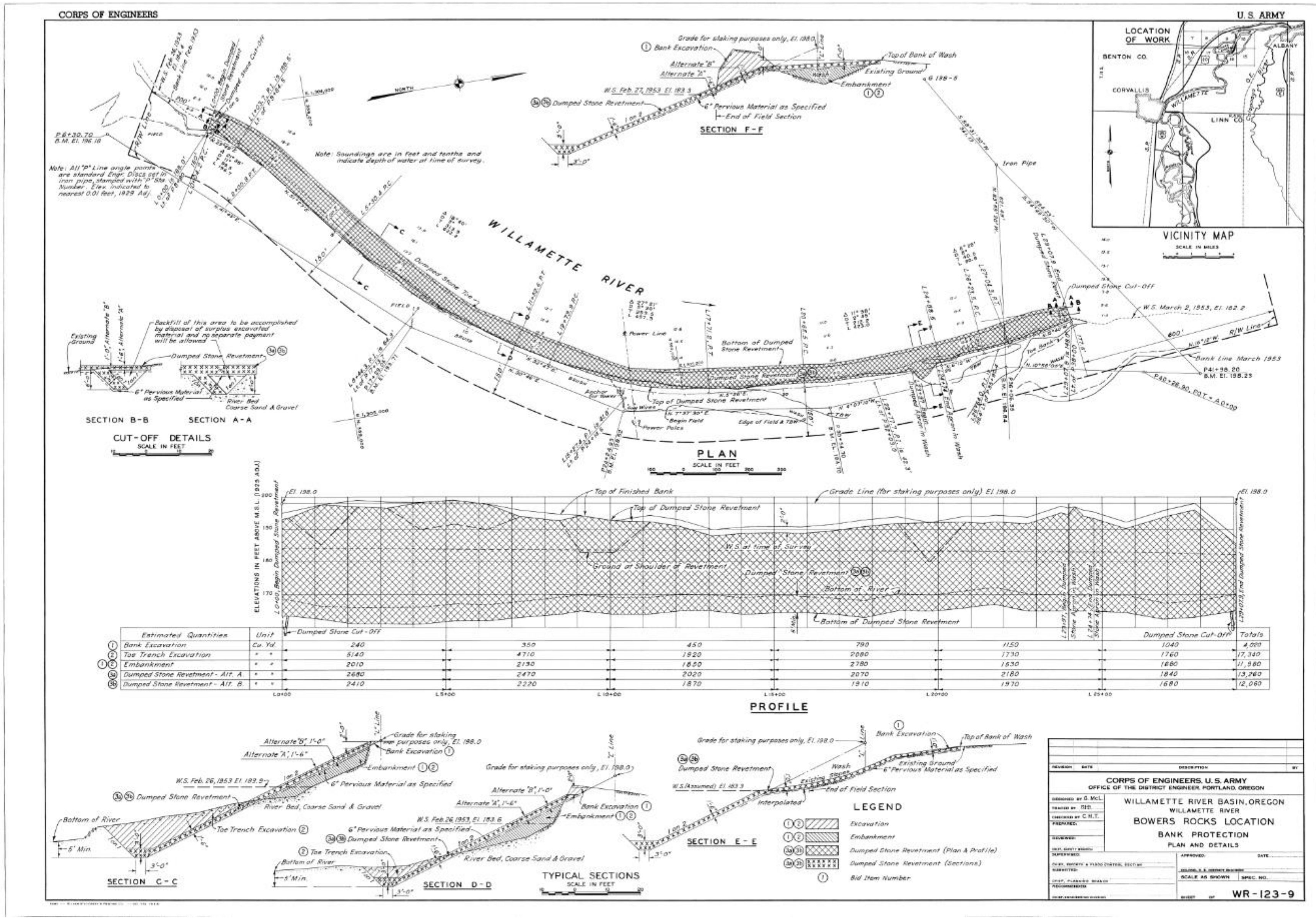

67-138
CE
PP
2 APR
123
CFL 305.22 MM


,123
,122
,121
c.f.l. 208.18


-26-64
HGC-F-4 8-5

Attachment B

Coon Creek Revetment Schematic



	Estimated Quantities	Unit	L0+00 – L5+00	L5+00 – L10+00	L10+00 – L15+00	L15+00 – L20+00	L20+00 – L25+00	Dumped Stone Cut-Off	Totals
①	Bank Excavation	Cu. Yd.	240	350	450	790	1150	1040	4,020
②	Toe Trench Excavation	" "	5140	4710	1920	2080	1730	1760	17,340
①②	Embankment	" "	2010	2130	1650	2780	1630	1860	11,980
③a	Dumped Stone Revetment - Alt. A.	" "	2680	2470	2020	2070	2180	1840	13,260
③b	Dumped Stone Revetment - Alt. B.	" "	2410	2220	1870	1910	1970	1680	12,060

River Design Group, Inc.

Attachment C

BRSP Gravel Pit Pond Alternatives Drawing Set

BOWERS ROCK STATE PARK

GRAVEL PIT POND ALTERNATIVES

ALBANY, OREGON

PROJECT PARTNERS

Meyer Memorial Trust

PGE

PROJECT DESCRIPTION

THE PROJECT EVALUATES SEVERAL ALTERNATIVES TO ENHANCE ECOLOGICAL FUNCTION AND ADDRESS LIMITING FACTORS FOR ESA-LISTED FISH AT A RETIRED GRAVEL PIT. THE GRAVEL PIT POND IS LOCATED IN THE WILLAMETTE RIVER FLOODPLAIN AT BOWERS ROCK STATE PARK, NEAR ALBANY, OREGON.

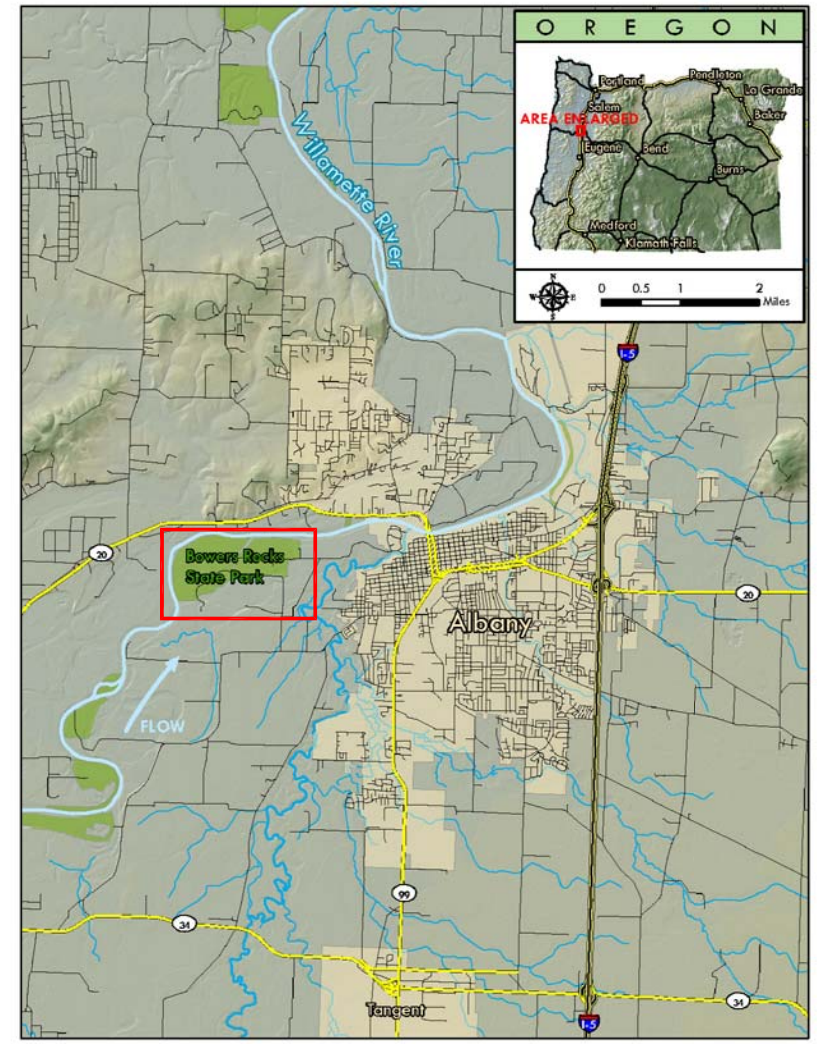
DATUM AND PROJECTION

THE HORIZONTAL DATUM IS NAD 83, STATE PLANE COORDINATES, OREGON NORTH ZONE, AND THE VERTICAL DATUM IS NAVD 88. UNITS ARE IN US SURVEY FEET.

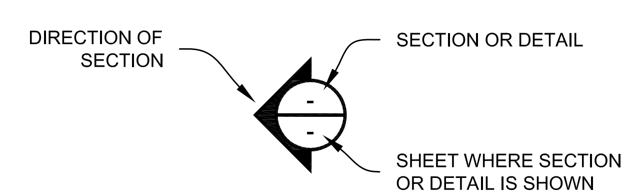
DRAWING INDEX

DRAFT CONCEPT, NOT FOR CONSTRUCTION

PROJECT VICINITY MAP



NW 1/4 OF THE NE 1/4 OF SECTION 011, T.11S., R.04W.,
WILLAMETTE MERIDIAN
LINN COUNTY, OREGON
USGS QUADRANGLE: LEWISBURG, OR



CROSS-SECTION SHEET REFERENCE

RIVER DESIGN GROUP, INC.
5098 Hwy 93 South
Whitefish, MT 59937
406.862.4927
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920

COVER PAGE AND NOTES

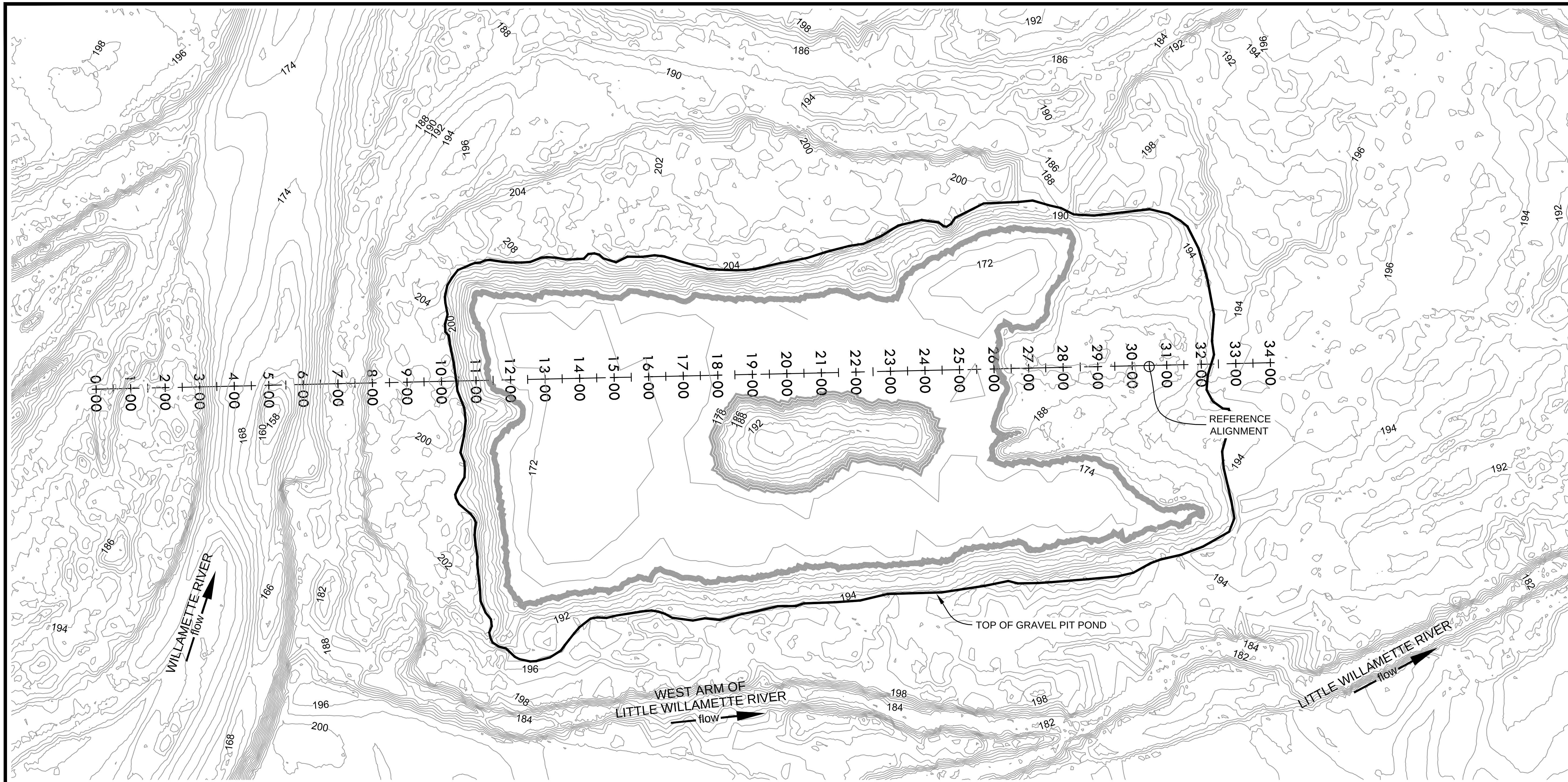
BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

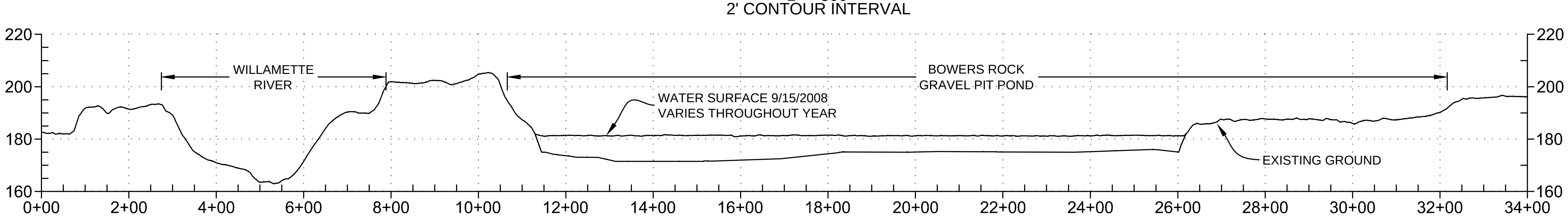
DRAWING NUMBER
1.0

Drawing 1 of 11



1 **BOWERS ROCK GRAVEL PIT POND**

1" = 300'
2' CONTOUR INTERVAL



2 **BOWERS GRAVEL PIT POND PROFILE**

HORIZ 1" = 300'
VERT 1" = 50'

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EXISTING CONDITIONS - GRAVEL PIT POND

BOWERS ROCK STATE PARK
ALBANY, OREGON

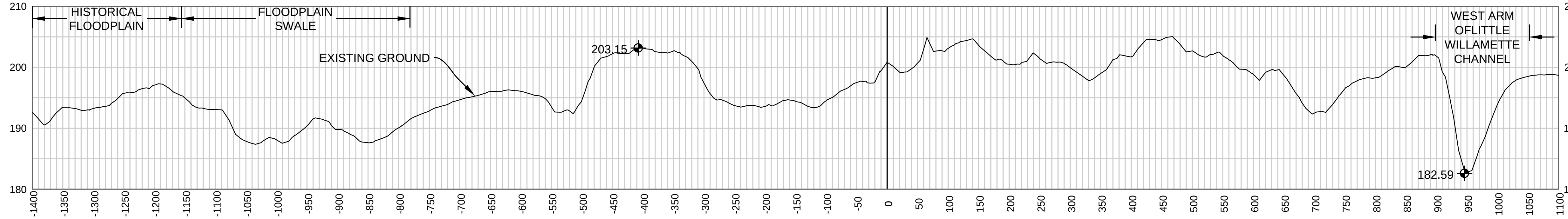
NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
4.0

Drawing 2 of 11

10+50



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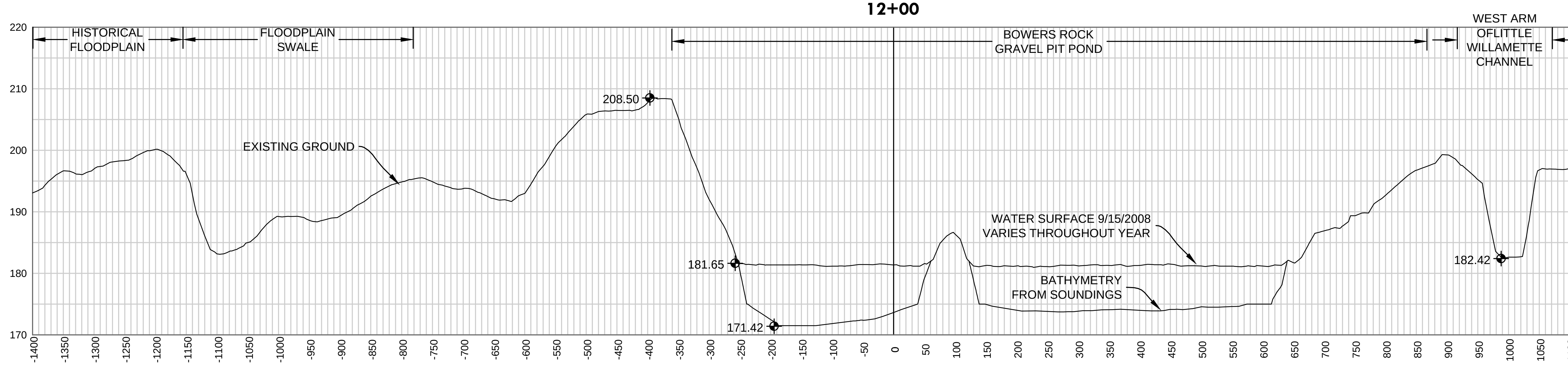

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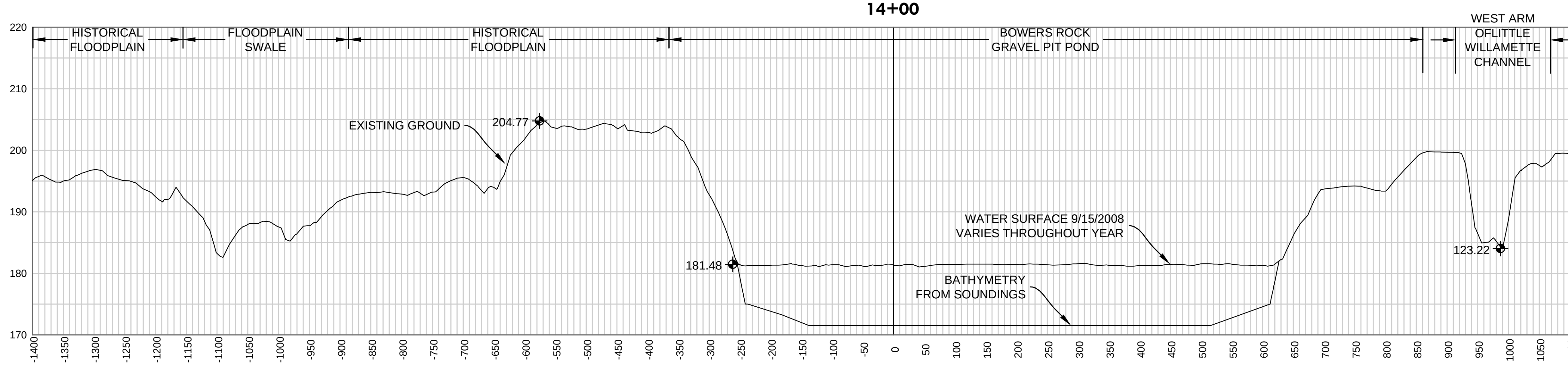

1 FLOODPLAIN CROSS-SECTIONS

HORIZ 1" = 200'
VERT 1" = 20'

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CROSS SECTIONS

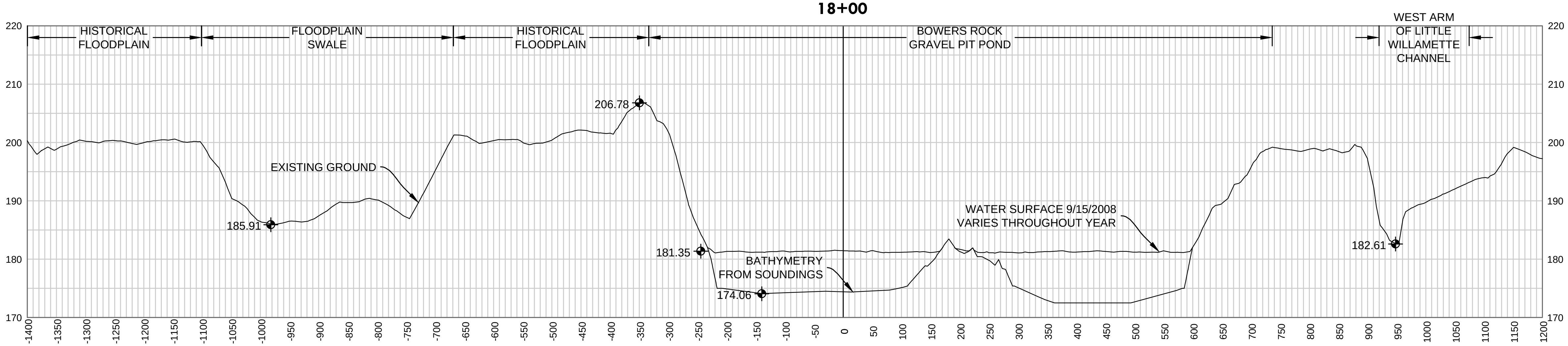
BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
4.1

18+00



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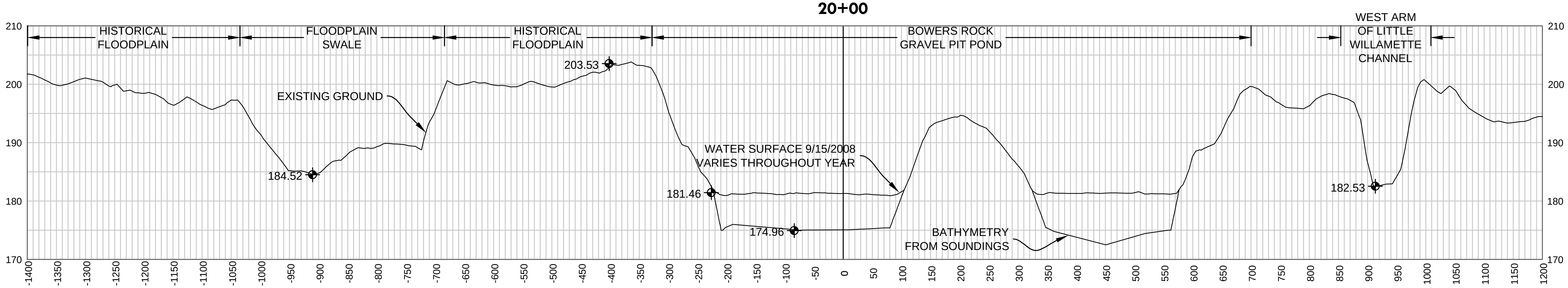

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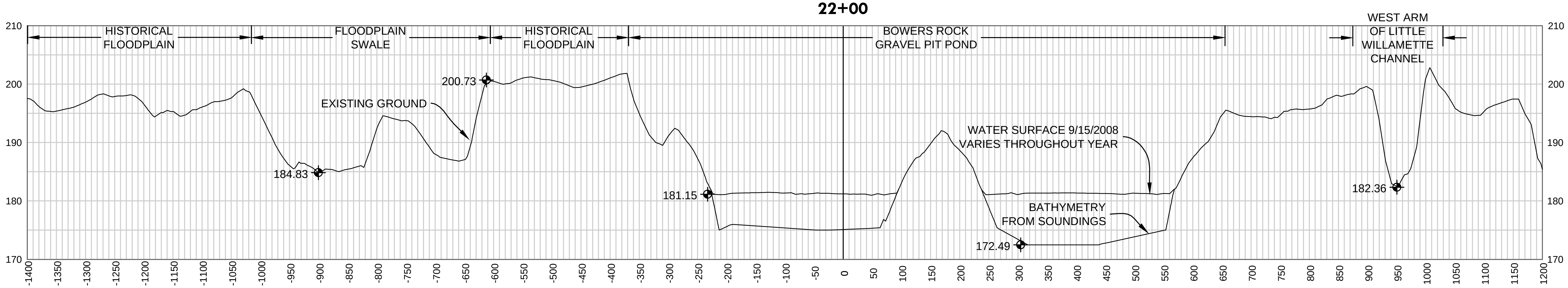

1 FLOODPLAIN CROSS-SECTIONS

HORIZ 1" = 200'
VERT 1" = 20'

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ALBANY, OREGON

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*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
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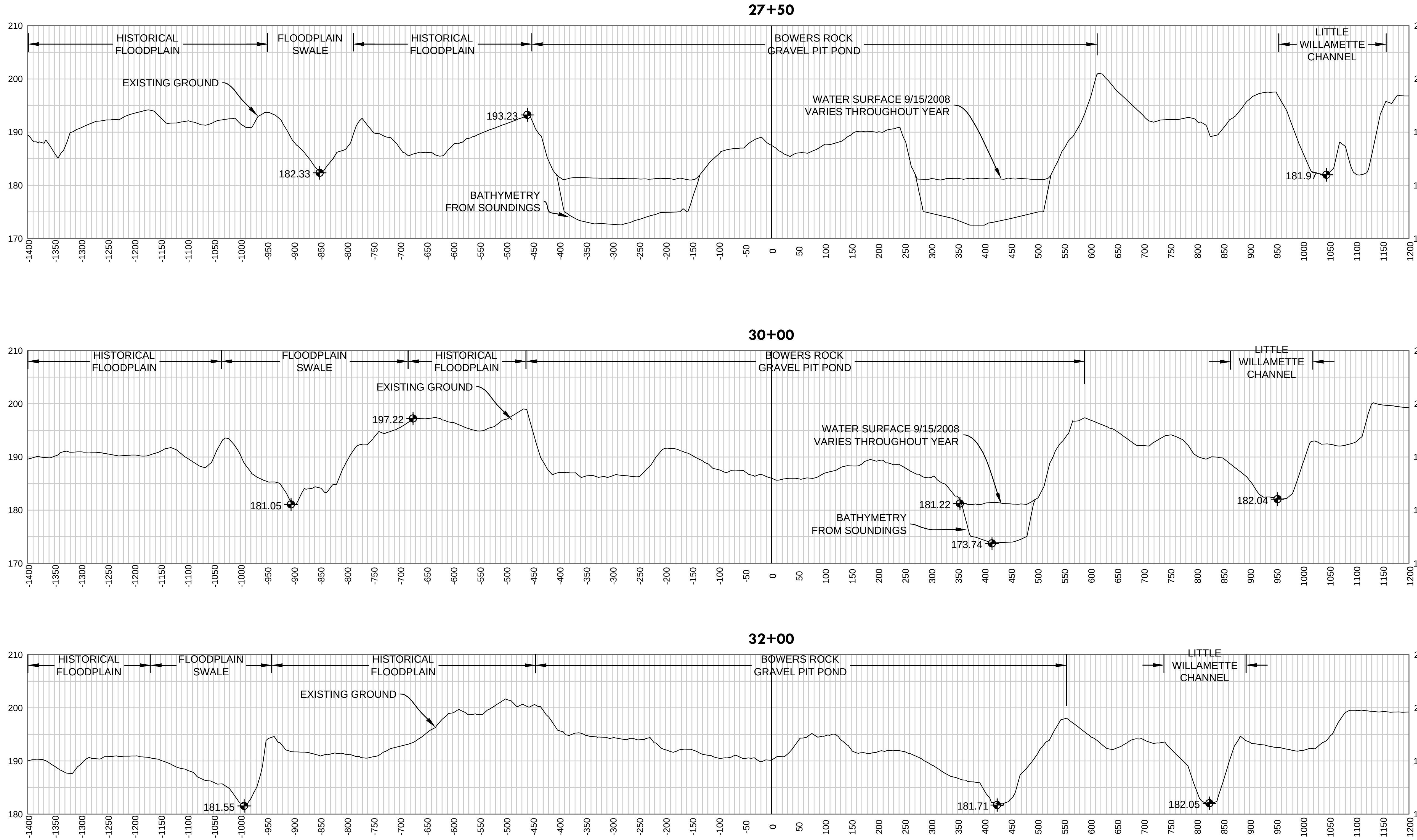

(1) FLOODPLAIN CROSS-SECTIONS

HORIZ 1" = 200'
VERT 1" = 20'

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BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
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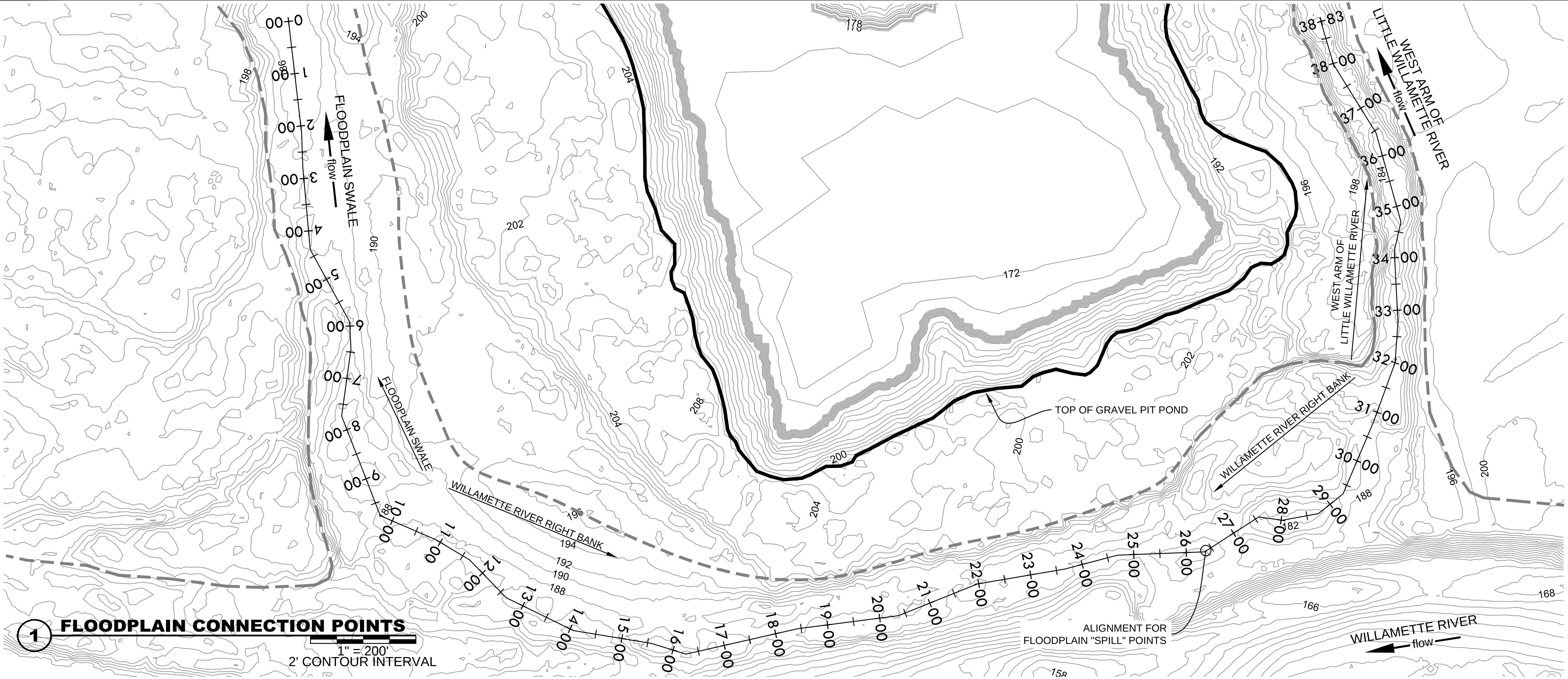
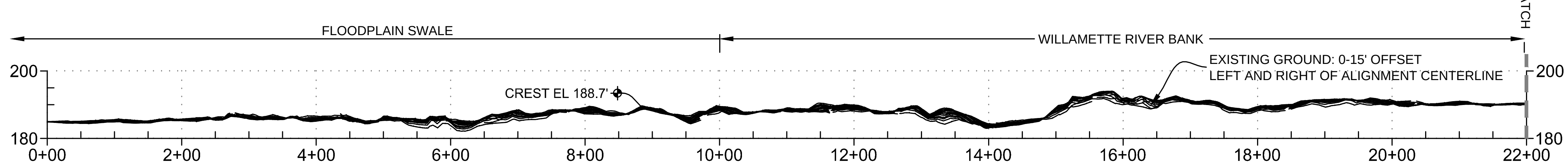
Drawing 5 of 11



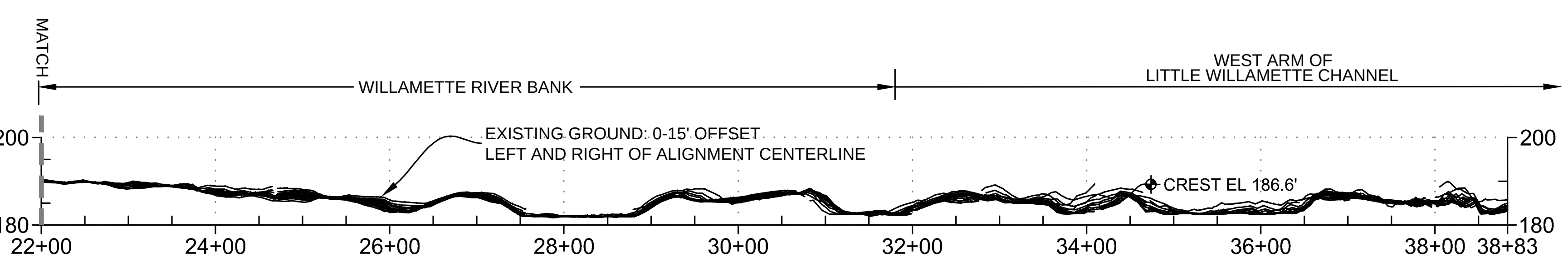
1 **FLOODPLAIN CONNECTION POINTS**

1" = 200'
2' CONTOUR INTERVAL



2 **PROFILE THROUGH FLOODPLAIN CHANNELS**

HORIZ 1" = 200'
VERT 1" = 40'



CREST IDENTIFICATION

CRESTS ARE IDENTIFIED BY EXAMINING CHANNEL BED ELEVATIONS IN THE DIRECTION OF FLOW, BEGINNING AT THE WILLAMETTE RIVER AND EXTENDING DOWN THE FLOODPLAIN SWALE AND WEST ARM OF THE LITTLE WILLAMETTE RIVER. GROUND TOPOGRAPHY IS SAMPLED EITHER SIDE OF THE CENTERLINE TO REPRESENT CHANNEL BATHYMETRY OVER THE WHOLE CHANNEL BOTTOM. CRESTS ARE LOCATIONS WHERE ALL OF THE CHANNEL BATHYMETRY IS HIGH ACROSS A SECTION, AND THE WATER SURFACE ELEVATION WILL NEED TO EXCEED THE CREST ELEVATION TO FLOW DOWN THE RESPECTIVE CHANNEL. BEYOND THE CREST ELEVATIONS, EACH CHANNEL CONTINUES TO FALL IN THE DOWNSTREAM DIRECTION.

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FLOODPLAIN CONNECTION POINTS

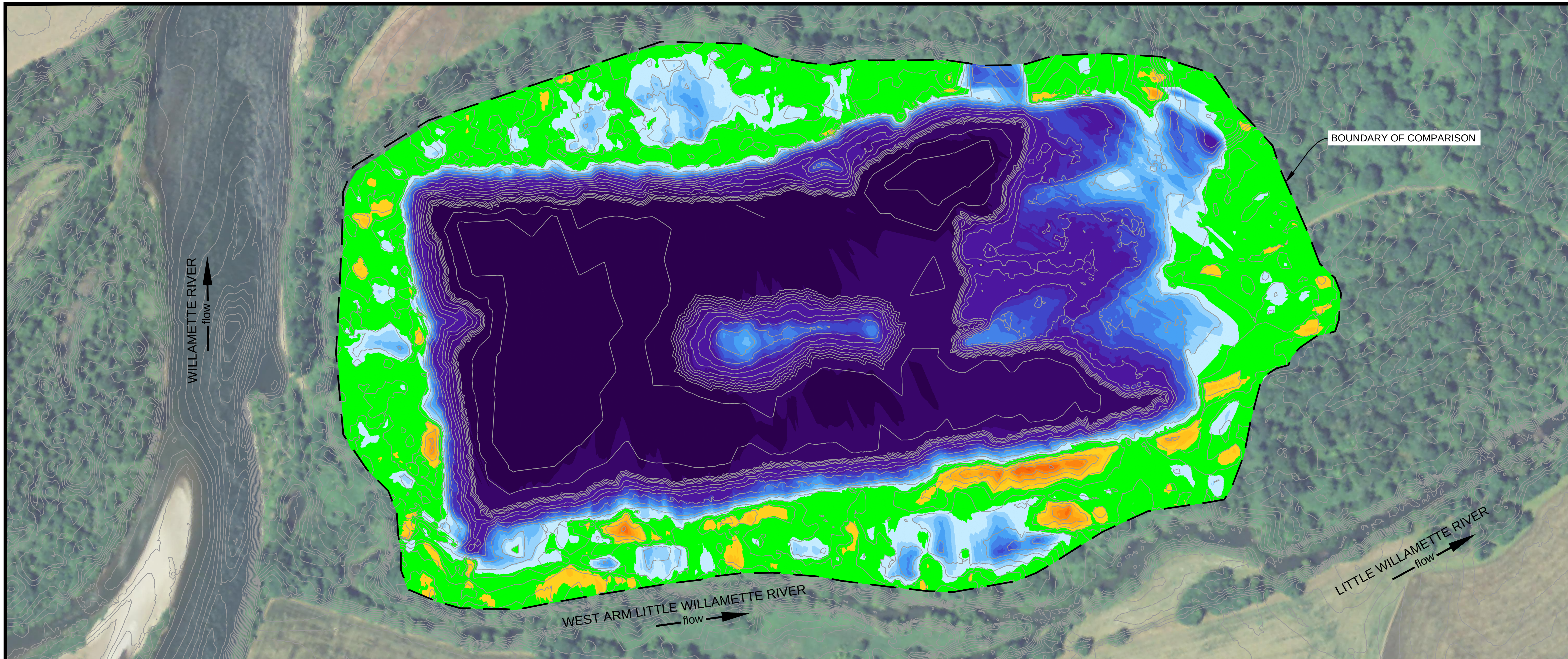
BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
4.4

Drawing 6 of 11



BELOW / ABOVE

<	25.0'	20.0'	15.0'	10.0'	9.0'	8.0'	7.0'	6.0'	5.0'	4.0'	3.0'	-1.5'	1.5'	3.0'	4.0'	5.0'	6.0'	7.0'	8.0'	9.0'	10.0'	15.0'	20.0'	25.0'	>

EXISTING GROUND SURFACE VERSUS PRE-MINE SURFACE

1 PRE/POST GRAVEL MINE COMPARISON

1" = 300'

METHODS

THE FULL EXTENT OF THE GROUND SURFACE PRIOR TO MINING IS UNKNOWN, BUT INDICATORS OF PRE-MINE GROUND SURFACE TOPOGRAPHY EXIST, INCLUDING: REFERENCE TO 205.3' NAVD88 ORIGINAL GROUND ELEVATION IN DOGAMI DOCUMENTS, SIGNATURE OF LINEAR (ALTERED) VERSUS HUMMOCKY (UNALTERED) TERRAIN ON LIDAR, PRESENCE OF MATURE VEGETATION PREDATING THE MINING ACTIVITY, PRE-MINE 1939 AND 1967 AERIAL PHOTOS, AN ACTIVE-MINE 1982 AERIAL PHOTO, AND CONVERSATIONS WITH BOB BEIL (FORMER MINE OPERATOR). ADDITIONALLY, DOGAMI RECORDS ESTIMATE A NET REMOVAL OF 1.95 MILLION CUBIC YARDS OF MATERIAL FROM THE MINE.

THE PRE-MINE SURFACE WAS SYNTHESIZED USING THESE INDICATORS AND WAS CONSTRUCTED BY INTERPOLATING BETWEEN UNALTERED GROUND INDICATORS SURROUNDING THE POND. THE SYNTHESIZED PRE-MINE SURFACE WAS COMPARED WITH THE CURRENT TOPOGRAPHY. A VOLUMETRIC COMPARISON OF THE PRE-MINE SURFACE WITH THE EXISTING GROUND SURFACE SHOWS A NET REMOVAL OF 1.7 MILLION CUBIC YARDS OF MATERIAL, WHICH IS IN-LINE WITH DOGAMI RECORDS OF 1.95 MILLION CUBIC YARDS OF MATERIAL PROJECTED FOR REMOVAL.

DRAFT

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PRE & POST GRAVEL PIT POND COMPARISON

BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	5/6/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
4.5

(1) ALTERNATIVE 1: CHANNEL OUTLET

1" = 300'
2' CONTOUR INTERVAL - EXISTING GROUND
1' CONTOUR INTERVAL - PROPOSED GROUND (SHADED)

ALTERNATIVE 1 PARAMETERS

CONNECTION ELEVATION
UPSTREAM: SAME AS EXISTING
DOWNSTREAM: 185 FT

WILLAMETTE DISCHARGE WHEN CONNECTED
UPSTREAM: SAME AS EXISTING
DOWNSTREAM: ~14,000 CFS

APPROXIMATE INUNDATION DURATION:
110 DAYS/YR

TREATMENT LENGTH: 1550 FT

CUT: 12,000 CY

FILL: 12,000 CY (TO BALANCE)

DRAFT CONCEPT, NOT FOR CONSTRUCTION

RIVER DESIGN GROUP, INC.
5098 Hwy 93 South
Whitefish, MT 59937
406.862.4927
311 SW Jefferson Avenue
Corvallis, OR 97333
541.738.2920

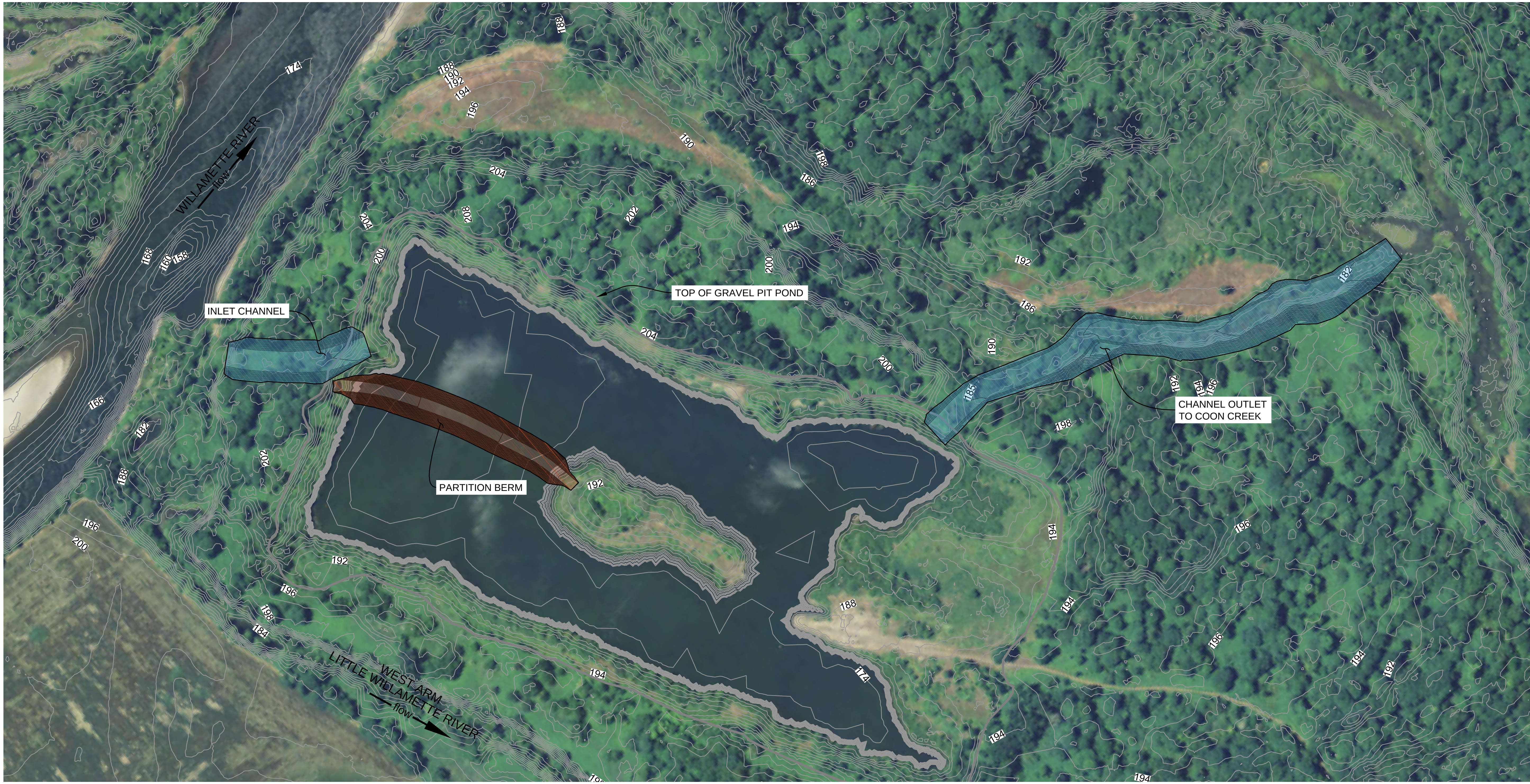
ALT 1 - CHANNEL OUTLET

BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
5.0



1 ALTERNATIVE 2A: FLOW-THROUGH CONNECTION

1" = 300'
2' CONTOUR INTERVAL - EXISTING GROUND
1' CONTOUR INTERVAL - PROPOSED GROUND (SHADED)

ALTERNATIVE 2A PARAMETERS

CONNECTION ELEVATION
UPSTREAM: 190 FT
DOWNSTREAM: 185 FT

WILLAMETTE DISCHARGE WHEN CONNECTED
UPSTREAM: ~25,000 CFS
DOWNSTREAM: ~14,000 CFS

APPROXIMATE INUNDATION DURATION:
UPSTREAM (FLOW-THROUGH): ~70 DAYS/YR
DOWNSTREAM: ~110 DAYS/YR

TREATMENT LENGTH: 2010 FT

CUT: 25,000 CY

FILL: 32,000 CY

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ALT 2A - FLOW-THROUGH

BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
5.1

① ALTERNATIVE 2B: FLOW-THROUGH CONNECTION

1" = 300'
2' CONTOUR INTERVAL - EXISTING GROUND
1' CONTOUR INTERVAL - PROPOSED GROUND (SHADED)

ALTERNATIVE 2B PARAMETERS

CONNECTION ELEVATION
UPSTREAM: 190 FT
DOWNSTREAM: 185 FT

WILLAMETTE DISCHARGE WHEN CONNECTED
UPSTREAM: ~25,000 CFS
DOWNSTREAM: ~14,000 CFS

APPROXIMATE INUNDATION DURATION:
UPSTREAM (FLOW-THROUGH): ~70 DAYS/YR
DOWNSTREAM: ~110 DAYS/YR

TREATMENT LENGTH: 1830 FT

CUT: 18,000 CY

FILL: 14,000 CY

DRAFT CONCEPT, NOT FOR CONSTRUCTION

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Corvallis, OR 97333
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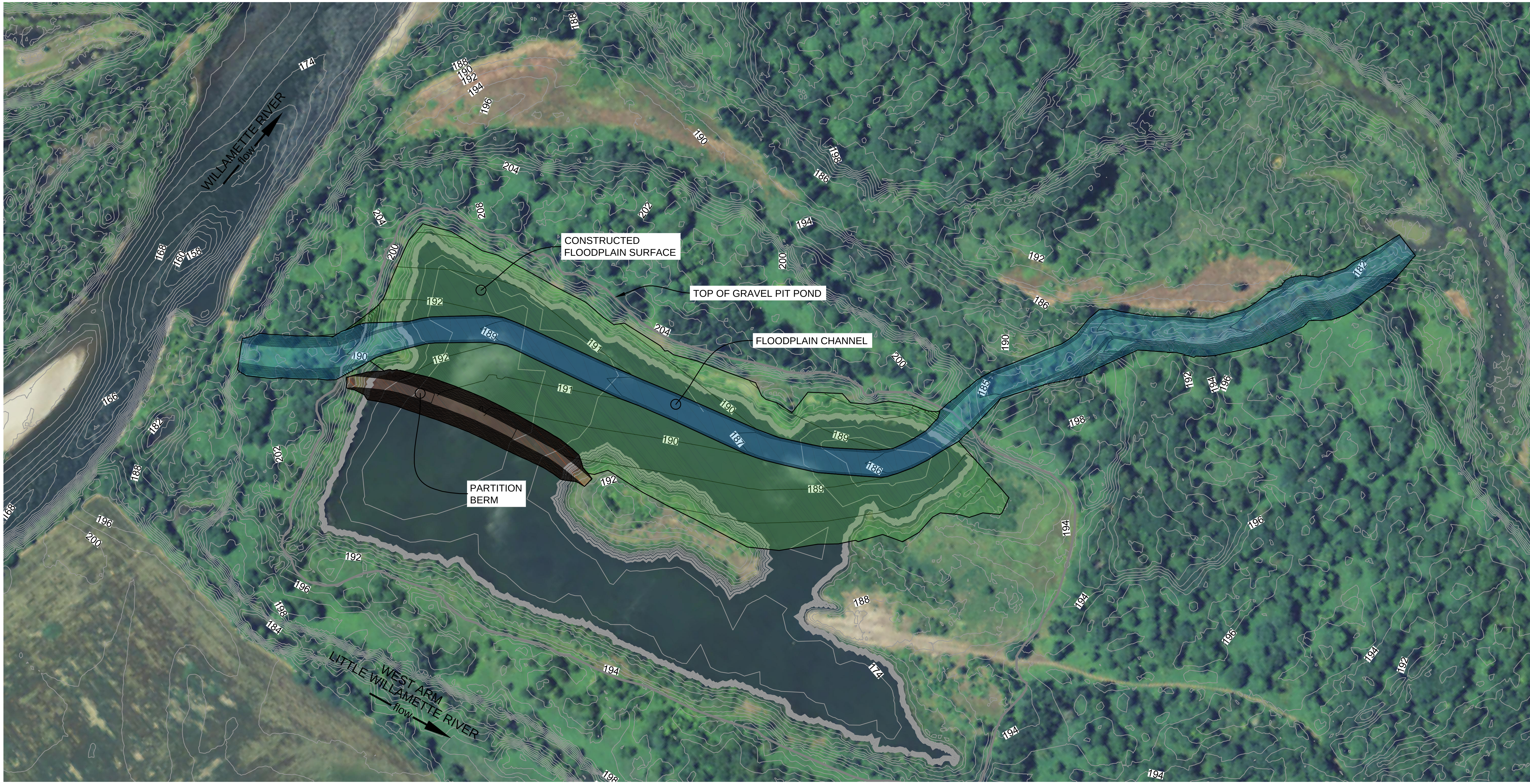
ALT 2B - FLOW-THROUGH

BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
5.2



1 ALTERNATIVE 3: FLOODPLAIN CHANNEL

1" = 300'

2' CONTOUR INTERVAL - EXISTING GROUND

1' CONTOUR INTERVAL - PROPOSED GROUND (SHADED)

ALTERNATIVE 3 PARAMETERS

CONNECTION ELEVATION
UPSTREAM: 190'
DOWNSTREAM: 185'

WILLAMETTE DISCHARGE WHEN CONNECTED :
UPSTREAM: ~25,000 CFS
DOWNSTREAM: ~14,000 CFS

APPROXIMATE INUNDATION DURATION
FLOW-THROUGH: ~70 DAYS/YR
SHALLOW INUNDATION: ~110 DAYS/YR

TREATMENT LENGTH: 3740 FT

CUT: 25,000 CY

FILL: 370,000 CY

DRAFT CONCEPT, NOT FOR CONSTRUCTION

RIVER DESIGN GROUP, INC.
5098 Hwy 93 South
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ALT 3 - FLOODPLAIN CHANNEL

BOWERS ROCK STATE PARK
ALBANY, OREGON

NO.	DATE	BY	DESCRIPTION	CHK
*	06/25/14	CS	EXISTING CONDITIONS	TB

PROJECT NUMBER
RDG-14-020

DRAWING NUMBER
5.3