River Island North
Preliminary Design Report

SUBMITTED TO
Metro

AUGUST 2015

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SUBMITTED TO
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Portland, OR

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Introduction

BACKGROUND

River Island Natural Area is located near Barton County Park near river mile (RM) 14 on the Clackamas River, a tributary to the Willamette River. The Clackamas River supplies drinking water to over 200,000 people and supports significant runs of federal and state listed fish species, including Chinook salmon, Coho salmon, steelhead, cutthroat trout, bull trout and Pacific lamprey. River Island's abundant native habitats – which include oak savannah, riparian forests and upland forests – support diverse wildlife populations including anadromous salmonids, migrating birds, and native turtles.

This report describes instream and floodplain designs proposed for the River Island North Area. The River Island North Area is defined by Metro as an umbrella work area that includes the River Island North and Goose Creek areas identified as part of the conceptual design process. While Metro's restoration efforts at River Island will focus on the entire ecosystem, this report and these efforts are primarily focused on instream and floodplain work. The River Island Conceptual Design Report (Inter-Fluve 2014) should be reviewed for additional watershed- and site-specific background information. This report covers designs proposed for the River Island North Area.

This report is being submitted as part of a preliminary design package that includes a preliminary design planset and an opinion of probable cost. Included in this report are descriptions of the more focused technical analyses that were conducted in order to support project design at the River Island North site. These analyses include site survey, additional hydrologic analysis, and hydraulic modeling. Project design criteria and descriptions of the individual project components are also provided.

SUMMARY OF PROJECT COMPONENTS

This memorandum focuses on preliminary analysis and design of the following project elements:

- Reconnect and enhance habitat of Goose Creek using excavation and wood placement
- Increase floodplain connectivity and habitat complexity along the Clackamas River by removing levees, re-grading the floodplain, and installing floodplain roughness features
- Preserve and enhance important turtle habitat and protect sensitive wetland areas

PROJECT GOALS & OBJECTIVES

The following project goals were developed throughout a one-year long stakeholder and technical outreach process.

Overall Goals:

- ***Hydrologic Connectivity***: Strategically implement restoration actions in areas where existing hydrologic connectivity is impaired. Perform actions that will enhance both floodplain and tributary connectivity in a way that will be geomorphically sustainable given the current and reasonably foreseeable sediment, landuse, and large wood regimes. Restoring these connections will support native fish use of these habitats, improve riparian forest health and increase flood storage. Increasing floodplain roughness will increase channel stability and decrease the probability of a future avulsion.

- ***Native Fish Habitat*****:** Increase off-channel habitat quantity, diversity, and complexity for native salmonids over a range of flows by enhancing and reconnecting floodplain and tributary habitats. These areas will provide velocity refuge during high flow periods and provide access to spawning and rearing habitat during critical low flow periods.
- ***Native Wetlands and Turtle Habitat*****:** Preserve and enhance selected areas where native turtle use has been identified, including foraging, nesting and basking areas. Create and expand suitable nesting areas and upland overwintering habitats where feasible. Preserve and enhance existing turtle habitats by providing isolated slow-water areas for foraging, south-facing basking logs, and bare ground nesting areas.

Site Analysis

SITE SURVEY & DATA COLLECTION

Site visits were conducted on multiple dates in 2013, 2014, and 2015 for site reconnaissance, collection of topographic data, and installation of gaging stations.

Site Reconnaissance

Initial site reconnaissance occurred in November 2013, and continued intermittently until February 2015. This included repeat site walks utilizing aerial photography and LiDAR. General notes on existing form and process were taken and compared to observations and data collected by Inter-Fluve from 2002 through 2006 as part of previous restoration opportunities analyses. Desktop-level analyses included evaluation of historical riparian condition, vegetation communities, soil types, and meander migration events.

Topographic Survey

Topographic surveys were conducted in December 2013 and continued intermittently until February 2015. The surveys collected bathymetry data of the mainstem Clackamas and backwater areas, as well as detailed topographic data of the floodplain. The bathymetry was collected using a HydroLite singlebeam echosounder (Seafloor) mounted on a jet boat. The floodplain topography was collected with survey-grade GPS and total station equipment. Data from the surveys was used for: 1) ground-truthing existing LiDAR data, 2) channel and floodplain cross-sections for hydraulic modeling of current and proposed restoration alternatives, and 3) creation of a grading plan and calculation of excavation quantities for floodplain and tributary restoration alternatives.

Water Level & Temperature Monitoring

Water surface elevation monitors were deployed at the project site in summer of 2014. Where possible, monitoring stations utilizing HOBO U20 water level data loggers were placed in similar locations as the deployments in 2005. These loggers were used to monitor water levels via a pressure transducer. An additional station was deployed to collect atmospheric pressure, which is necessary for data processing in order to obtain accurate water level readings. These stations are intended to provide accurate water surface data for the reach. The U20 loggers also record water temperature, which is useful for assessing temperature conditions as it relates to aquatic habitat quality.

Turtle Habitat
Turtle presence and use surveys in the lower Clackamas River were performed in summer and fall of 2014 by the Oregon Wildlife Institute to identify critical turtle habitat areas.

Fish Habitat
Evaluation of fish habitat was conducted in December 2013 and continued intermittently until February 2015. Field surveys evaluated the diversity and accessibility of different habitat types within the project area. These habitat types were compared against habitat types required by the various species historically found throughout this reach of the Clackamas (e.g. Chinook salmon, coho salmon, winter steelhead, cutthroat trout and Pacific lamprey). Information on fish use, populations, and habitat use timing was obtained from previous surveys and reports (see Inter-Fluve 2014).

Recreational Use & Safety Considerations
Instream recreational use and safety of the area was evaluated and considered throughout the design process. Evaluation included review of existing recreational use surveys (e.g. OPB 2013), area whitewater guide books, and informal interviews with river users.

This river is commonly used for recreation, and is frequently used by those with little to no knowledge of whitewater safety or swiftwater rescue. A number of potential safety concerns have been considered as part of project design. These considerations primarily apply to the use of large wood, which can pose a potential risk to recreational river users.

Though no mainstem large wood structures will be constructed at River Island North, recreationalist safety considerations were still a factor in concept design. A number of safety guidelines are available, primarily from the State of Washington, and were reviewed and considered during design, including:

- Washington State Department of Transportation. August 9, 2010. Project Delivery Memo #10-01, Geomorphic/Safety Guidance for the use of Large Woody Materials for Mitigation Applications in Bridge Scour Projects.
- Skellenger & Bender Attorneys. 2007. Understanding the Legal Risks Associated with Design and Construction of Engineered Logjams. Written by Beth Andrus & James Gessford, P.E.
- River Safety Council. Proposed Safety Guidelines for the Construction and Placement of Large Woody Debris (LWD) Affecting Streams used for Recreation in Washington State.
- American Whitewater. Integrating Recreational Boating Considerations into Stream Channel Modification & Design Projects.

In general, these guidelines are aligned with the standard approach taken by Inter-Fluve in design and placement of large wood. A number of considerations were included in the design to minimize risk consistent with the guidelines:

- This portion of the Clackamas is heavily utilized by casual recreational river users such as those people inner-tube floating, fishing, rafting, and swimming. Children are common user-group members and personal floatation devices (PFDs) are commonly not worn.
- Given the traffic and skill level of many river users, safety signage is recommended to warn river users of the presence of log structures. This is consistent with recommendations by Andrus & Gessford (Skellenger & Bender, 2007); the River Safety Council; and the Washington State Department of Transportation.

HYDROLOGY

Overview

The Clackamas River is a large tributary of the Willamette River. The River Island Natural Area is located near RM 14 on the Clackamas. The contributing watershed area is approximately 785 square miles and originates in the high cascades, and meanders north and westward until its confluence with the Willamette River.

The watershed receives precipitation as rain and snow primarily between fall and spring. The headwaters of the Clackamas, between Mt. Hood and Mt. Jefferson, receive approximately 130 inches of precipitation and the lower basin receives approximately 61 inches of precipitation. Winter precipitation in the upper watershed infiltrates into groundwater aquifers at high rates. Groundwater upwelling during dry summer months leads to high baseflows and cool water temperatures in the Clackamas River (Taylor 1999). High flows occur as a result of storms, spring snowmelt and occasional rain-on-snow events. Major tributaries to the Clackamas River include Eagle Creek, Clear Creek, Deep Creek, North Fork Clackamas, South Fork Clackamas, Fish Creek, Roaring River, Oak Grove Fork and Collawash River.

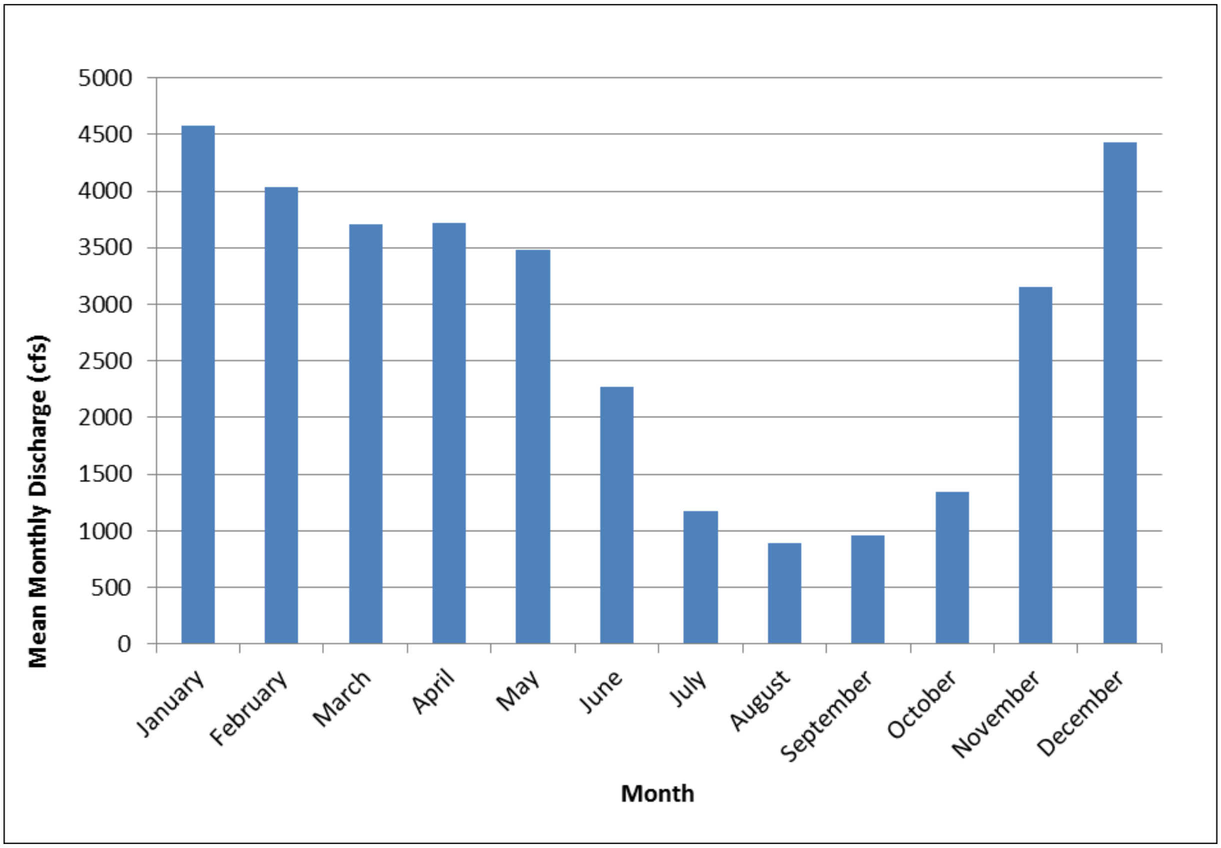

Figure 1. Mean monthly from 1959-2013 at the USGS gage at Estacada, OR (USGS gage #14210000).

Peak Flow Hydrology

The nearest operating USGS real-time stream gauge is on the Clackamas River RM 23.1 at Estacada (USGS #14210000), with a period of record from 1908 to present. Eagle Creek is a major tributary of the Clackamas, and enters downstream of the gage but upstream of the project area. A bulletin 17b flood frequency analysis was performed on Estacada gage, for valid data following construction of the River Mill Dam. *StreamStats* (USGS 2014) was used to calculate the Eagle Creek recurrence interval flood events because there is no gauge on Eagle Creek. These two values were then summed to calculate flows at the project site. When compared with *Streamstats* results generated at the downstream end of the model (near the SE Bakers Ferry Road bridge), this is a slightly conservative estimate. This is due to Eagle Creek's smaller basin size, and its hydrograph likely peaks prior to the Clackamas. Given that the magnitude and intensity of flooding is expected to increase due to climate change (e.g. Tohver and Hamlet 2010), the more conservative estimate was selected. Flood frequency values are presented in Table 1.

Table 1 Flood frequency data used in the hydraulic models.

Flood Recurrence Interval (years)	Flow (cfs)
1.01	8,417
2	32,281
5	47,675
10	57,279
25	66,357
50	76,534
100	83,944

Low-flow Hydrology

In order to support components of design, a low flow hydrologic analysis was conducted. Low flow conditions often have an important influence on fish use of off-channel habitats, stream temperatures, persistence of riparian vegetation, and beaver dynamics. Due to the off-channel habitat features that are intended to convey surface flow throughout the year in this project, the low-flow conditions are particularly important to design the appropriate elevation of these features. For this analysis, the minimum seven-day moving average flow that occurs once every 2 years (7Q2) and once every 10 years (7Q10) was calculated. This was performed by conducting a low-flow frequency analysis using data from the Clackamas River near Estacada, OR gage (USGS gage #14210000). Only gage data from 1959 to current was used for this analysis, though the record begins in 1908, due to the dam becoming operational in 1958. A noteworthy tributary, Eagle Creek, enters the Clackamas River between this gage and the study area. Eagle Creek contributes an estimated 12% of flow at the study area, therefore the 7-day moving average flows based on the USGS gage data were adjusted to account for this 12% increase. All further calculations are based on these adjusted, estimated values for flow at the study area.

The 7-day low flow was then calculated for each climatic year, defined as April 1 to March 31. This was only performed where there was a complete record of flows for the climatic year, or it was clear that the available data captured the lowest flow period during the year. There were 58 years of available low flow data. The data were then subjected to a log-normal, low flow frequency analysis. The ranked data are included in

Table 2 and the results of the frequency analysis, including the 7Q2 and 7Q10 statistics, are included in Table 3.

Table 2. Ranked list of low flows over the 58-year period of available data.

Rank	Climatic Year (Apr 1 - Mar 31)	Minimum 7-day moving average flow (cfs)
1	1965	638
`2	1979	657
3	1992	665
4	1994	672
5	1964	679
6	1987	684
7	2001	696
8	1962	713
9	1977	720
10	1980	729
11	1967	735
12	1978	736
13	1991	748
14	1988	755
15	1988	755
16	1988	755
17	1966	768
18	1990	772
19	1963	782
20	1989	784
21	1993	785
22	1981	785
23	2005	787
24	1986	791
25	1970	812
26	1973	814
27	2003	817
28	2004	822
29	2007	823
30	1968	837
31	1998	845
32	1959	848
33	1985	850
34	1995	863
35	2006	864
36	1982	890
37	1983	893
38	2002	893
39	1961	901
40	2013	904
41	1976	915
42	2009	926
43	1960	939
44	1960	939
45	2000	942
46	2010	942
47	1996	942
48	2012	960
49	1969	975
50	1971	991
51	1972	1003
52	1975	1026
53	2011	1051
54	1997	1060
55	2008	1063
56	1974	1077
57	1984	1079
58	1999	1098

Table 3. Results of the low-flow frequency analysis. Flows are expressed as 'non-exceedence' flows, which means that the lowest flow in a given year (7-day average), on average, would be expected to drop below the non-exceedence value once during the given recurrence interval. For example, on average, once every 10 years, the lowest 7-day moving average flow would be expected to drop below 699 cfs.

Low Flow Recurrence Interval (years)	Non-exceedence flow (cfs)	Statistic
1.01	1171	
2	840	7Q2
5	745	
10	699	7Q10
25	654	
50	626	
100	602	

HYDRAULICS

One-Dimensional Modeling

Existing channel and floodplain hydraulics were simulated using the U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS 4.1.0; USACE 2010). HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. The program is one-dimensional, meaning that there is no direct modeling of the hydraulic effect of lateral cross section shape changes, bends, and other two- and three-dimensional aspects of flow. The hydraulic model calculates channel and floodplain water surface elevations, velocities, depths, and shear stresses (among other metrics) for various input flows. Due to the extremely dynamic and complex nature of the River Island site, the primary modeling objective here was to understand relative water surface elevations at flood flows, as well as velocities, depths, and shear stresses for ballasting calculations during high-flow conditions.

The model geometry was developed using topographic and bathymetry data obtained through surveys completed in December 2013 and February 2014. Survey data was supplemented with LiDAR data (Watershed Sciences 2007) in select locations, including those locations that span private (non-Metro) property. The existing conditions model geometry includes twenty-five cross sections spaced over the project reach on the mainstem Clackamas River (Figure 2). Cross sections extend through the right bank floodplain to the right valley wall terrace toe. The 1-, 5-, 10-, 25-, 50-, and 100-year recurrence interval floods were modeled.

The downstream-most cross-section was tied into the FEMA floodway for Clackamas County, allowing for use of the boundary conditions from the FEMA model. Mannings values were based on field observation of median size of channel substrate, and calibrated according to photographic comparisons in Barnes 1967, with reference to values provided in Acrement and Schneider (1989). Modeled values are displayed in Table 4.

Table 4 Manning values for preliminary HEC-RAS modeling

Modeled feature	Mannings Value
Left Bank Floodplain	0.06
In-channel	0.028
Right bank floodplain	0.06

The model was calibrated to surveyed water surface elevations and high water marks. It is expected that calibration and model geometry in this location will have to be re-visited after larger flow events due to the changing bed and bank topography at the flow split location. As an example, the somewhat large flow event of December 2014 (~2 year recurrence year interval) appears to have caused changes to the bed topography that are not reflected in the current model geometry.

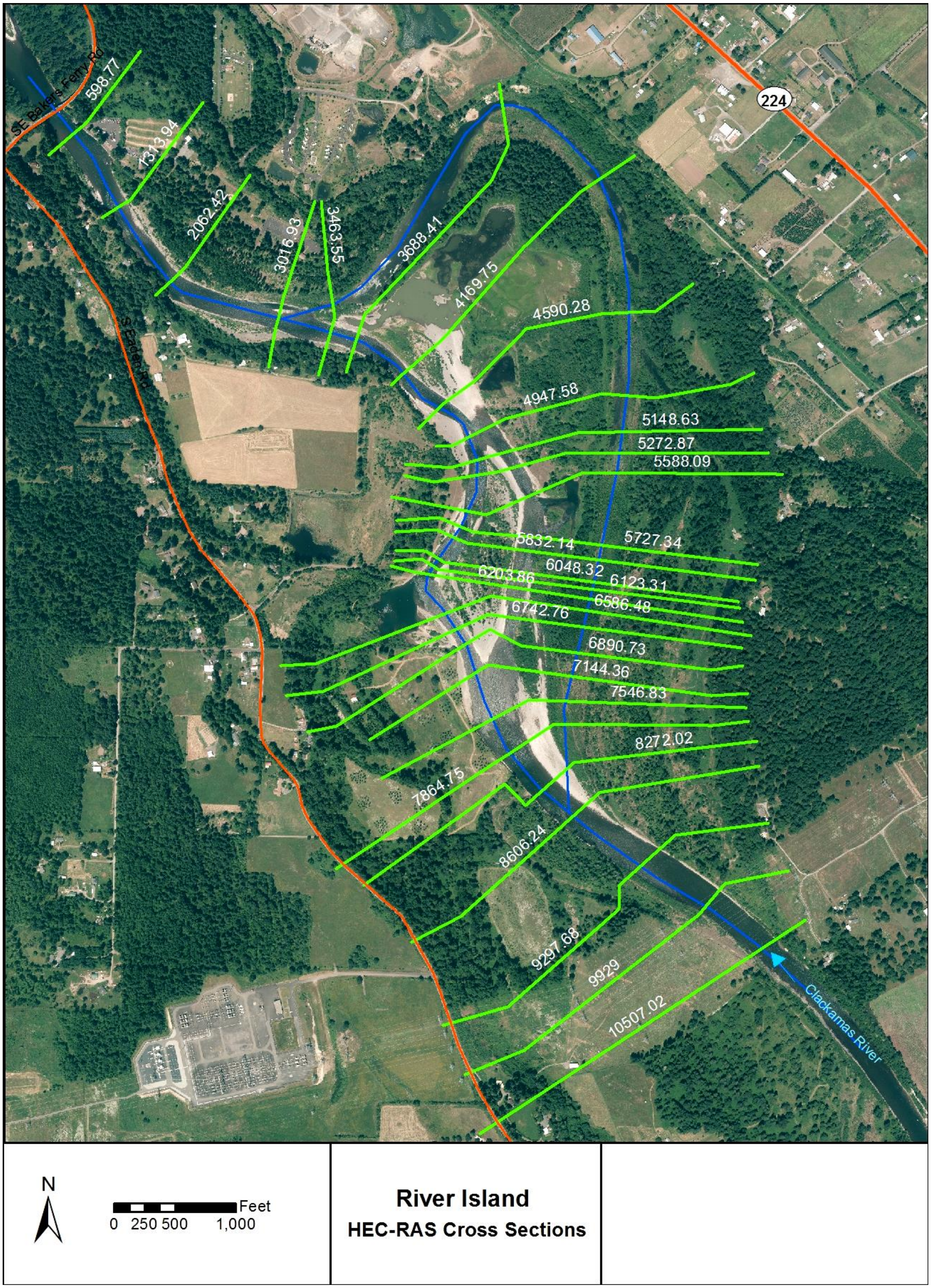

Figure 2. HEC-RAS Cross-sections for River Island North.

WATER TEMPERATURE

HOBO U20 water level data loggers placed in Upper and Lower Goose Creek were intended to provide comparative analysis of water temperatures in the two locations. However, shortly after installing the HOBO U20s, results indicate the lower extent of Goose Creek went completely dry, rendering water temperature readings at this location inaccurate. Data suggest that, prior to going dry, lower Goose Creek had temperatures in the upper 70s (◦F) and low 80s. Comparatively, upper Goose Creek exhibited temperatures in the low 60s. Figure 3 displays the context for the two data loggers, with the Lower Goose Creek logger (A) in the wide, shallow, ponded portion of Goose Creek while the Upper Goose Creek logger (B) is in the shaded, narrower portion of the channel. A map of the two HOBO locations is presented in Figure 4. The Lower Goose Creek HOBO was moved further upstream to a deeper pool area to provide a longer comparison during the warmer summer months.

Figure 3 Comparative locations of Lower Goose Creek HOBO U20 highlighted in yellow outline (A) and Upper Goose Creek HOBO U20 (B)

Figure 4 Locations of the HOBO loggers placed in Goose Creek.

Two-Dimensional Modeling

Methods

The SRH hydraulic model was built in Aquaveo's Surface-water Modeling System (SMS) (version 11.2). Proposed contours were merged with existing LiDAR, ground survey and bathymetry data for boundary extents and elevation. The mesh was constructed with higher resolution (triangle lengths < 5 feet) in and near the areas of particular interest such as the reconstructed bank on river right, and coarser cell resolutions near the outer boundaries (up to 150 feet triangle edge lengths) to produce a final cell count of 59,827. This variation in resolution ensured that river channel features and grade breaks were well defined while the outer ineffective extents were limited, thus improving model efficiency. Roughness values for the model were delineated in ArcGIS using the available aerial images and exported to SMS. One roughness value was specified throughout the main channel based on the calibrated values from the HEC model. The value was reduced from 0.028 to 0.025 upon initial calibration in SMS. This value is consistent with the values predicted with the empirical approach described by Arcement and Schneider (1989). Other roughness values were estimated using the Arcement and Schneider (1989) method and look-up tables (Chow 1959).

The downstream boundary condition for the model was the estimated water surface elevation obtained from the one-dimensional HEC-RAS model. Since the model's downstream boundary was located so that the model had sufficient channel length to establish a stable and accurate level below the area of interest. All models were simulated with a time step of 0.5 seconds, which was consistent with the Courant condition (see Wu 2007). Each flood simulation was routed through the model for at least four hours to allow sufficient time for steady-state hydraulic conditions to occur.

Discussion

The hydraulic analysis provides insight into flood inundation and stream energy conditions in the Clackamas River under proposed project conditions. Modeled velocities under proposed conditions are as high as 11 ft/s along the proposed right bank at Q2. This magnitude of velocity is comparable to other nearby locations, including the right bank of the mid-channel bar immediately to the southwest. At Q50, velocities along the constructed right bank are similar, with higher velocities concentrated in the center of the main channel. Zones of high shear at Q2 occur in anticipated locations (such as the head of mid channel bars). Shear stress values along the constructed right bank are similar to other locations in the mainstrem Clackamas River at Q50.

While velocity and shear values at the location of constructed features are significant, they are not unexpected given the depth, slope and volume of the Clackamas River during large flood events. Preliminary model results will be used to fine tune the locations and scale of wood structures as well as inundation depths at low flows. Modeled results for proposed conditions are presented in Figure 5 through Figure 9.

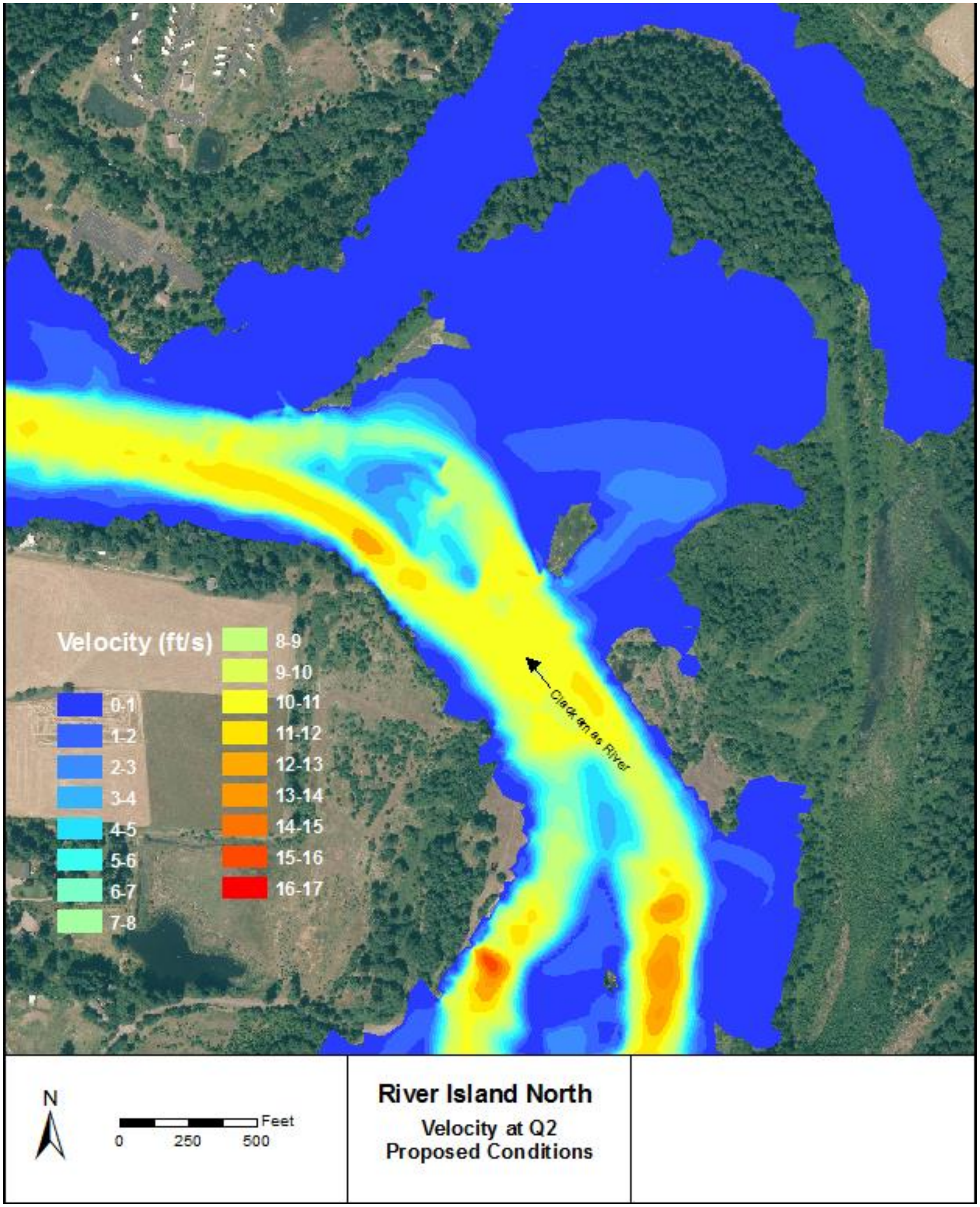

Figure 5 Modeled velocity at Q2 under proposed conditions for River Island North.

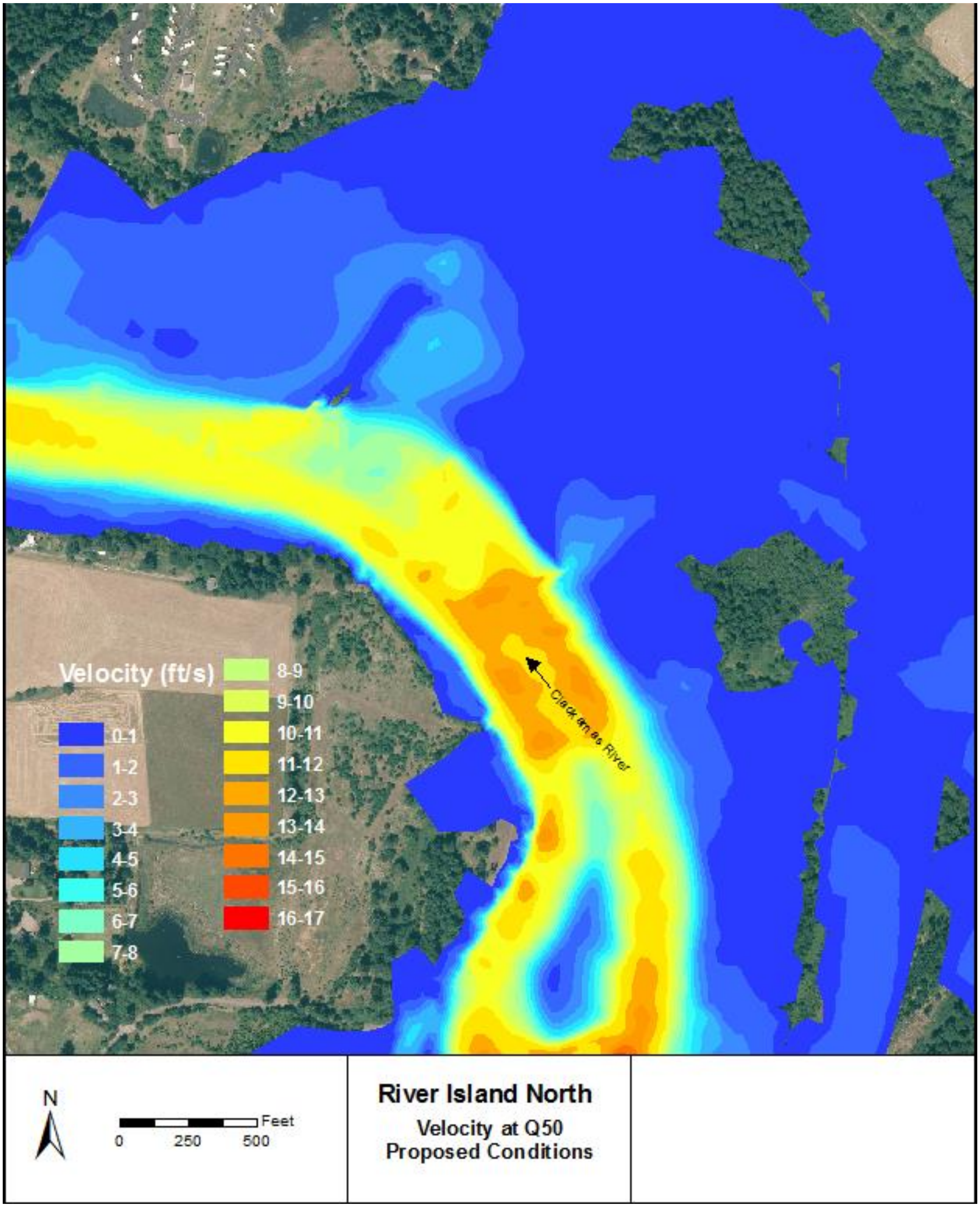

Figure 6 Modeled Velocity at Q50 under proposed conditions at River Island.

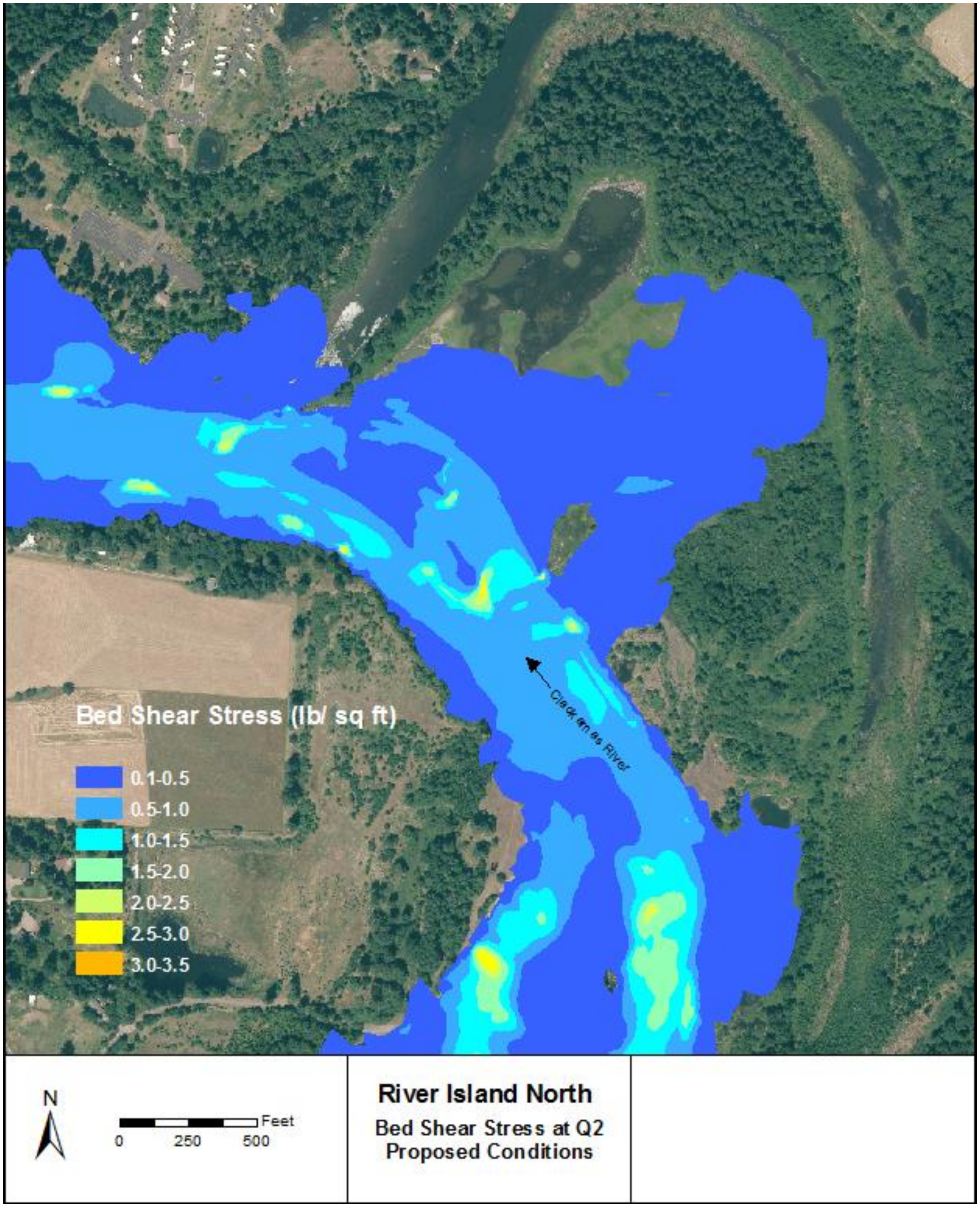

Figure 7 Modeled Q2 Bed Shear Stress under proposed Conditions for River Island North.

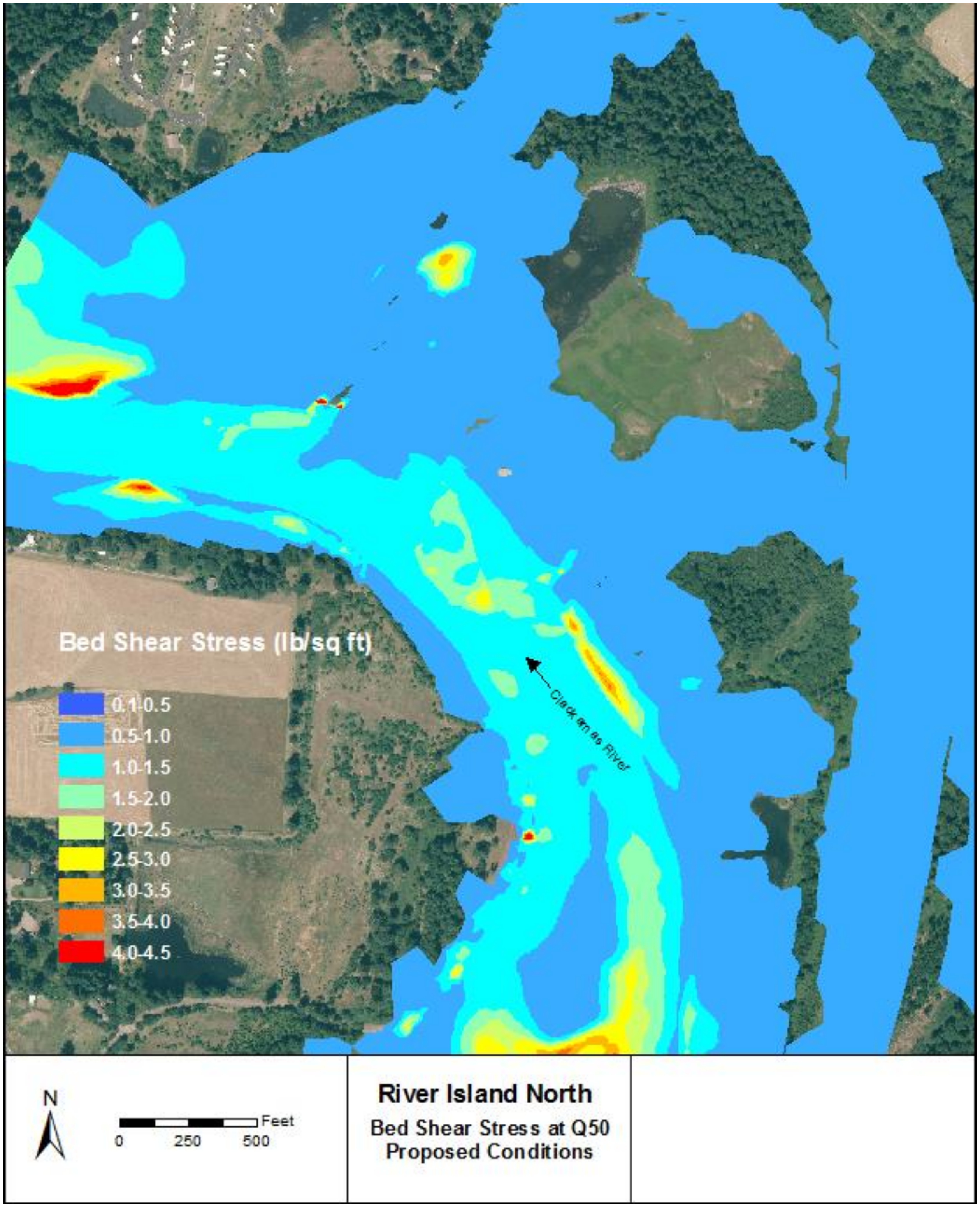

Figure 8 Modeled bed shear stress under proposed conditions at Q50 for River Island North.

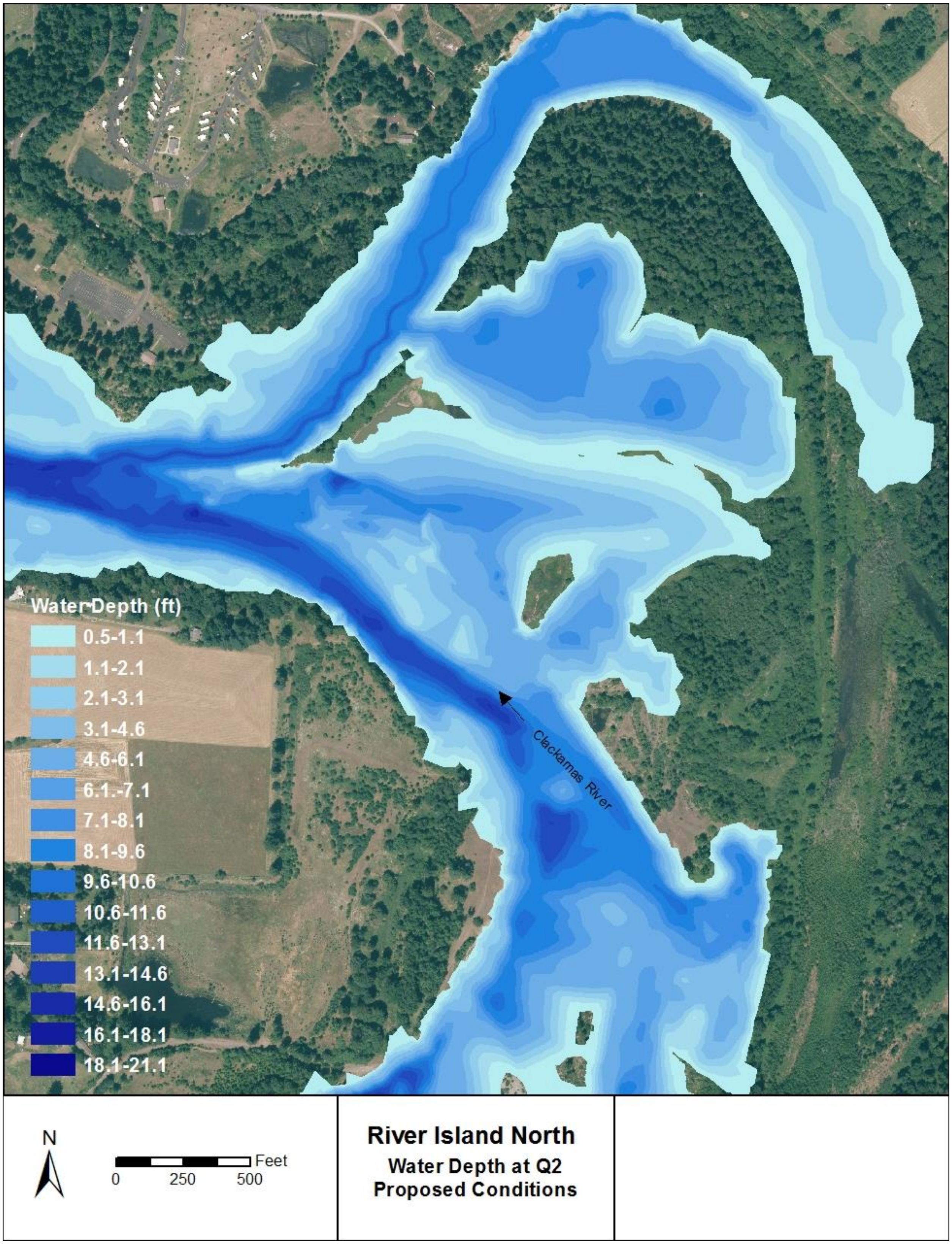

Figure 9 Modeled depth under proposed conditions at Q2 for River Island North.

Design

SELECTION OF PREFERRED ALTERNATIVES

As part of the River Island Conceptual Design Report (Inter-Fluve 2014), a total of four restoration planning areas were identified and evaluated. Planning areas were divided based on geomorphic feature classification and proximity for construction feasibility. Development of restoration opportunities was driven by design criteria outlined in the Conceptual Design Report, outreach to the public, and input from a technical review team, as well as regional and local restoration objectives. The opportunity areas are as follows:

Alternative A – Shoe Island Opportunity Area

Alternative B – Goose Creek Opportunity Area

Alternative C – River Island North Opportunity Area (including Right Bank and Borrow subareas)

Alternative D – River Island South Opportunity Area

Following review of existing alternatives, Alternatives A and D were approved by Metro as the first phase of work, and were constructed in 2015 (collectively called "River Island South"). Alternatives B and C (now collectively called "River Island North") were chosen as the preferred restoration opportunity areas for the second phase of construction, to occur in 2016.

DESIGN CRITERIA

Designs were developed with consideration given to the restoration objectives, constraints, regulations, safety, and feasibility. Design criteria have been developed to guide the design process, including providing measurable design objectives and ensure project constraints understood and explicitly addressed. Design criteria were developed with reference to the site analysis and project objectives identified in the Conceptual Design Report (Inter-Fluve 2014).

Design criteria are presented below for both opportunity areas: Goose Creek and River Island North. The following design criteria may continue to be revised throughout the design process.

General Criteria

- Large wood placements are to be stable up to the Q100 event.
- Existing turtle habitat and sensitive vegetation areas are not to be disturbed to the extent practicable.

Goose Creek Criteria

Goal: Increase off-channel habitat availability by improving connectivity between the Clackamas River and Goose Creek. Increase the diversity and complexity of available habitats that will support multiple salmonid life stages. Below are objectives that will be addressed to achieve this restoration goal.

- Re-grade Goose Creek to allow connectivity with the Clackamas River during baseflow.
- Re-size Goose Creek's geometry to correlate with Goose Creek flows.
- Use large wood placements to add complexity and cover at multiple river stages
- Preserve and protect existing vegetation to the extent practicable.

River Island North Criteria

Goal: To improve Clackamas River floodplain connectivity and protect and enhance turtle habitat. Below are objectives that will be addressed to achieve this restoration goal.

- Re-grade approximately one-half of the floodplain to correlate with the river's contemporary hydrologic regime to increase the depth and frequency of inundation.
- Increase floodplain complexity and floodplain roughness with buried log jams and floodplain roughness elements.
- Reconstruct the river's right bank with native coarse material (gravel, cobble, small boulders) and slash to create a naturally deformable river bank.
- Preserve and enhance existing turtle nesting habitat by protecting open water areas (see Turtle Habitat Preservation Area in accompanying planset) and placing brush and nesting substrate along south facing slopes (see Turtle Nesting Enhancement Area).
- Place large wood in the floodplain to provide high flow refuge as well as nesting and foraging habitat for birds and other wildlife.

DESIGN COMPONENTS

Based upon the above project goals and objectives, site analyses and design components of the River Island North restoration effort have been developed. The individual design components including a description, anticipated benefits and hydraulic, engineering and construction considerations are discussed in detail below. These components will continue to be refined throughout subsequent design phases.

Goose Creek

Description

Prior to the 1996 avulsion, Goose Creek entered the mainstem Clackamas River approximately 4,000 feet upstream of Barton Park. Following the avulsion, Goose Creek now runs within the abandoned pre-1996 mainstem Clackamas River channel (Figure 10). This has created a channel geometry that is substantially "over-fit" for the volume of water running through the channel (i.e. the channel size and substrate is much too large for Goose Creek's hydrologic and sediment regimes). This, combined with mainstem incision and deposition by the Clackamas at the post-avulsion confluence, has led to ponding and elevated summer water temperatures in lower Goose Creek (Inter-Fluve, 2014). Though Goose Creek flows year-round, it does not produce enough flows to maintain a surface water connection to the Clackamas during low to moderate flows. Therefore, the outlet of Goose Creek is disconnected at low to moderate annual river flows.

The Goose Creek proposed work includes the reconnection of Goose Creek to the Clackamas River at all but extreme low flows. A 3,000 foot-long channel will be constructed with a more appropriately sized 12-foot channel bottom width for Goose Creek. The work will require select excavation and bedform manipulation to regrade areas that were previously pools on the Clackamas River. The new channel alignment will have a designed slope of 0.12%, which here is the slope required to move fine sediments through the channel. Because the new Goose Creek will be constructed in material appropriate to the Clackamas River's hydrologic regime, the majority of coarse Goose Creek substrate is unlikely to transport except during the largest flood events. With 2:1 sloped banks the Goose Creek channel will require fill along a total of approximately 1800 (discontinuous) feet of channel, or a total fill volume of 23,116 c.y. (22,215 c.y. below OHW). Fill in this area will consist of native fill material sourced from removal areas along the Goose Creek alignment. Removal of native fill material in the Goose Creek Area will be along approximately 2.400 (discontinuous) feet of channel, for a total volume of 65,315 c.y. (61,383 c.y. below OHW). The upstream extent of the work area was selected in an effort to preserve areas of existing beaver activity (see accompanying plansets for further detail)

The new channel alignment will be constructed using the existing Clackamas River alluvial substrates at the site. Consequently, limited lateral movement is expected to occur along this new Goose Creek channel alignment. The channel has been sized to encourage frequent overtopping during high water events. The Clackamas River is expected to backwater into the new Goose Creek channel and floodplain, which may encourage the build-up of sediments and gravels/fines along the new floodplain. Beaver are expected to move back into the channel after construction has been completed.

Large wood will be installed along the reconnected Goose Creek to increase habitat diversity and provide cover for fish. Proposed large wood enhancements are designed to provide features consistent with natural processes of large wood recruitment within the both the floodplain and Goose Creek channel. Large wood enhancements will follow the typical configurations presented on the plansets and will be oriented in the field to optimize habitat. To achieve ballast to the Q100, logs will be partially-buried and/or attached to vertical logs using fully threaded rod. Pile pullout tests will be performed on vertical logs to determine burial depth required to achieve stability at the Q100. Salvaged trees and slash generated onsite will be incorporated and reused in the habitat structures. Localized scour pools will be excavated around the large wood enhancements on the outsides of channel bends.

Figure 10. Goose Creek ponding in the oversized pre-1996 Clackamas River channel.

Anticipated Benefits

Adjusting Goose Creek's geometry is expected to support riparian, wetland, and instream process and function. Specifically, the reconnection, large wood habitat enhancements and revegetation work in Goose Creek will provide velocity refuge and create spawning and juvenile rearing areas for ESA-listed Chinook salmon, steelhead trout, and Coho salmon along 3,000 feet of channel. The more gradual drop in grade will re-open fish passage at all but extreme low flows. Additionally, this work will re-open the upper 4,000+ feet of Goose Creek to target salmonids during low and moderate flows. Large wood additions will provide cover and rearing habitat at a variety of river stages for juvenile salmonids. In the mid to long-term, riparian revegetation is expected to provide temperature reductions during summer months.

Design Considerations

Of particular interest to design is lateral migration within the project reach, particularly the apex of the bend near the right bank gravel pond. As discussed in the Concept Design Report (Inter-Fluve, 2014), the bend near the Goose Creek outlet is migrating in a north, northeasterly direction. As this continues, the outlet of Goose Creek is in the path of the projected migration trend of the Clackamas River. Consequently, it is anticipated that the mainstem of the Clackamas will recapture a portion of its historical planform and the mouth of Goose Creek. The timeline of this migration depends on a number of factors (e.g. future flood events, bank structure, and sediment deposition). However, because the levee near the confluence of the Clackamas and Goose Creek is remaining intact and the proposed slope is very gradual (0.12%), it is expected that recapture would require a flood large enough to remove the levee.

A temporary crossing will be made to provide construction access. Post-construction, this will remain as maintenance access route for Metro for a duration of five years (access provided only during summer and fall). This location, designed as a riffle within the Goose Creek channel, will utilize slightly larger stones in order to provide maintenance access longevity and function as a riffle during its five-year lifespan.

Construction considerations will include coordination with Barton County Park, as well as the utilization of fencing and signage to restrict access. Impact avoidance and minimization measures for this project will consist of following established in-water work periods and adhering to ODFW Turtle Crossing Best Management Practices. In addition, silt fencing will be installed prior to construction in order to prevent the siltation of waterways and wetlands during construction. All heavy equipment will follow specific access ways with trips to and from work areas minimized as much as practicable.

Revegetation activities with native plant species will be undertaken by Metro after construction has been completed.

River Island North

The River Island North area is currently characterized by a large abandoned gravel pit that is connected to the mainstem Clackamas River. The majority of the ponds are habitat for warm-water predatory fish species (e.g. carp, northern pike minnow), though the northern most margin of the ponds provides valuable basking habitat for native turtles. This area also includes a number of levees and compacted soils that are remnant surfaces and substrates from the gravel mining operation.

The River Island North opportunity area identified in the conceptual designs (Inter-Fluve 2014) consists of several distinct project subareas. These include the Right Bank Area, the Goose Creek Connector Channel, the Borrow Area, and the Preservation Areas, described in more detail below.

River Island North (and sub Right Bank Area)

Description

Restoration activities for the Right Bank Area include reclaiming the right bank of the Clackamas River, creating a seasonally-backwatered floodplain refuge, and the construction of a terrace spillway to provide overflow relief during high water events.

The Right Bank Area is designed to be naturally deformable, with future bank shape depending on factors such as future flood events and frequency on the Clackamas River. Meander migration analysis during the concept design phase found the current channel geometry limits sediment transport downstream and prevents the meander from migrating. Currently the Clackamas is rebuilding its floodplain and bank in the River Island North (and Right Bank Area) to fill the void in material created by mining operations. Presumably, following construction, the mainstem will reinitiate its projected north, north-easterly migration trend. As this migration initiates, the river will likely continue as transport conditions will begin to exceed the present depositional conditions. This pattern will likely continue over the course of many years and high flow events, and the channel would then presumably recapture portions of the newly constructed River Island North Area, until the bend fully matures and another avulsion takes place (Inter-Fluve, 2014).

Proposed restoration activities to reclaim the right bank of the Clackamas include reconstructing a 20 feet deep bank along nearly 1,000 feet of channel out of alternating coarse cobble/gravel and slash materials sourced from the site, in order to mimic riparian vegetative roots. This, in addition to log jams buried throughout the Right Bank Area will add complexity and provide roughness as the channel continues to migrate. These design components are intended to provide replantings with a ‘head start’ towards establishment. However, migration is expected to continue around this meander bend and the rate will depend on flows in the Clackamas River and is expected to only slow the rate of migration.

Figure 11. Looking downstream at the Clackamas River and Right Bank Area.

Buried log jams shall follow the typical configuration shown on the planset with four horizontally alternating rows of logs attached to vertical logs by fully threaded rods. Vertical logs will be buried to a minimum of 12 feet deep in native material. Coarse fill will be placed in and around the log jams during construction and native fill will be placed on top of the coarse fill up to the proposed grade. Vertical log ends will be broken or roughened so no sawn ends are visible. Floodplain large wood will also follow typical configurations presented on the plansets, with placements optimized in the field. The floodplain roughness elements will be placed at varying elevations to provide cover and roughness and varying river stages.

The created floodplain behind (to the North of) the log jams in the Right Bank area will be regraded to connect the floodplain to the current Clackamas River hydrologic regime (Figure 12). Select native fill and removal will occur throughout the River Island property, with material being removed from higher abandoned floodplain surfaces and filled along approximately one-half of the remnant mining pits. Inset within this floodplain, a high-flow backwater alcove will be constructed to mimic the geometry of an abandoned oxbow channel. The oxbow will backwater beginning at events as low as the Clackamas River annual high water flow (elevation 160), increasing in elevation in a northeasterly direction (to elevation 170 at the upstream extent of the feature). At the upstream extent of this feature, an existing levee running along the East side of River Island (disconnecting the pre-1996 channel) will be breached in order to provide floodplain access and additional refuge area during a 5 year event or higher. As flood stage increases, water will back up further into this created abandoned oxbow alcove, providing off-channel refuge at varying flood stages. The remainder of the floodplain elevation gradually increases moving away from the Clackamas River to reach a small terrace on the southern border of the Turtle Habitat Preservation Area and the Emergent Vegetation Preservation Area. This terrace is designed to overflow into the Turtle Habitat Preservation Area and the Emergent Vegetation Preservation Area at flows over a 2-year event.

In order to minimize sudden overflows from the terrace into the Turtle Habitat Preservation Area and the Emergent Vegetation Preservation Area, a Terrace Spillway located in the North portion of the Right Bank Area will connect the Right Bank area to the Turtle Habitat Preservation Area at the 2-year event. The spillway will allow for a more gradual increase in water volume to the Preservation Areas during floods and minimize any potential disturbances to aquatic species.

Figure 12 Existing River Island North (Facing North)

Throughout the entire Right Bank Area, approximately 79,847 c.y. (8,257 c.y. below OHW) of native fill material will be removed, while approximately 156,087 c.y. (28,623 c.y. below OHW) will be needed for fill volumes. Native sediment material, slash sourced from the site, and 1059 logs will be used as fill in the Right Bank area. In addition to re-grading, construction will include select removal of remnant quarry materials (e.g. asphalt, compacted road gravel) throughout the entire River Island North site.

Anticipated Benefits

Benefits associated with this opportunity include the re-establishment of floodplain connectivity at more regular return interval flows. Reconnecting the Clackamas with its floodplain will provide space for flood waters to dissipate and infiltrate, habitat for fish and wildlife, retention of nutrients, and filtration of fine sediments within the project area. Specifically, this option will provide velocity refuge during high water events for ESA-listed Chinook salmon, steelhead trout, and Coho salmon. Large wood additions are intended to create cover and holding pockets for fish. Additionally, floodplain large wood is intended to provide wildlife habitat to upland species. Additional benefits may also include the reclamation of soils compacted by the mining operation, which are hindering localized natural erosion processes and preventing re-generation of native floodplain plant species.

Design Considerations

In order for this project to fit within Metro's construction budget, all cut and fill must be balanced onsite. While previous test pits indicate that native material will be suitable for floodplain reconstruction, additional test pits will be conducted in the fall of 2015 to confirm. Construction considerations will include the development of a detailed construction sequencing plan in subsequent design phases as well as careful coordination with ODFW and NOAA to develop a fish salvage/exclusion strategy.

This River Island North area will utilize buried log jams, placed along the right bank margin of the Clackamas River, which will provide bank roughness and complexity as the bank migrates. It should be noted that the bank is expected to continue to migrate and is designed to be naturally deformable.

Construction considerations will include coordination with Barton County Park, as well as the utilization of fencing and signage to restrict access. Impact avoidance and minimization measures for this project will consist of following established in-water work periods and adhering to ODFW Turtle Crossing Best Management Practices. In addition, silt fencing will be installed prior to construction in order to prevent the siltation of waterways and wetlands during construction. All heavy equipment will follow specific access ways with trips to and from work areas minimized as much as practicable.

Revegetation activities with native plant species will be undertaken by Metro after construction has been completed.

River Island North – Goose Creek Connector Channel

Description

The Goose Creek Connector Channel proposed restoration activities include the creation of a 385-foot channel that connects Goose Creek to the Turtle Habitat Preservation Area pond during high flows. As the Turtle Habitat Preservation Area pond fills up during high water events, fed by the spillway and the Right Bank backwater, fish will utilize the pond as velocity refuge. In order to minimize fish stranding, the Goose Creek Connector Channel is designed to maximize the amount of time fish have to retreat back into the Clackamas (via Goose Creek) after high-water events. This has been achieved by setting the connector channel's downstream (the Goose Creek side) grade control (i.e. riffle crest) one foot *higher* than the upstream (the Turtle Habitat Preservation Area side) grade control. Consequently, the connector channel will be active at moderate to high flows (as the Clackamas both backwaters up Goose Creek through the connector channel and also as water flows out of the Connector Channel once water has spilled over the spillway (Q2)), but disconnected at lower flows. This design component is intended to both prevent fish from swimming from Goose Creek into the ponded areas during the warmer summer months and preserve the ponded condition important to turtles in the Turtle Habitat Preservation Area.

To construct this design component, an existing levee that runs along the left bank of Goose Creek will be breached and the Goose Creek Connector Channel will tie into the new Goose Creek alignment (at station 13+00). The Connector Channel will have a 10-foot bottom width, with 2:1 sloped banks extending up to five feet. After five feet, banks will be constructed with a 4:1 slope up to the existing grade. Coarse fill is to be used as the channel substrate and on all 2:1 slopes. An apex jam will be placed in the channel at the downhill inlet to the Turtle Habitat Preservation Area and LW enhancements will be placed throughout the channel. See accompanying plansets for further detail.

Large wood enhancements will be placed along the alignment to provide additional roughness. These components will be with partially-buried or unburied logs attached to vertical logs using fully threaded rod.

Anticipated Benefits
The connection of the floodplain and the Turtle Habitat Preservation Areas to Goose Creek will minimize fish stranding risk during high flows. The connector channel will provide connection to Goose Creek and the Clackamas River for a longer period of time after a high flow event, allowing fish that had found refuge in the off-channel areas time to return back to the Clackamas. Specifically, this option will provide connection for refuge and escape during and after high water events for ESA-listed Chinook salmon, steelhead trout, and Coho salmon. Large wood additions are intended to create cover and holding pockets for fish during these events.

Design Considerations
This area will utilize an apex jam placed at the upstream inlet to the Connector Channel as well as additional large wood placements, which will provide additional bank roughness, floodwater moderation, and complexity.

River Island North – Borrow Area

Description
Prior to the 1996 avulsion, the Borrow Area was a compacted surface being actively utilized by heavy machinery. Following the avulsion, this compacted area has continued to contribute non-native gravels to the system and has acted as a hydraulic constriction (Figure 13).

The Borrow Area proposed restoration activities include select excavation and regrading to remove the compacted gravels (remnants of the mining operations) that are currently acting as a hydraulic constriction to the Clackamas River.

Compacted gravels and non-native material from this area will be taken and appropriately disposed of off-site. The remainder of the Borrow Area will be re-graded and re-sloped to return function as a naturally deformable bank. This will involve the removal of 33,184 c.y. (none below OHW) of material, and the filling of 14,374 c.y. with native fill material. See accompanying plansets for further detail.

Figure 13 Right bank borrow area. Compacted gravel and quarry remnants visible above alluvium.

Anticipated Benefits

Benefits associated with this opportunity include the re-establishment of floodplain connectivity at more regular return interval flows and removal of a hydraulic constriction. Reconnecting the Clackamas with its floodplain will provide space for flood waters to dissipate and infiltrate, habitat for fish and wildlife, retention of nutrients, and filtration of fine sediments within the project area. Additional benefits also include the reclamation of soils compacted by the mining operation, which are hindering localized natural erosion processes and preventing re-generation of native floodplain species.

Design Considerations

Construction considerations will include careful phasing of cut slopes and erosion control measures to effectively regrade the bank without contributing turbidity to the channel.

Similar to other design components, construction will require coordination with Barton County Park, as well as the utilization of fencing and signage to restrict access. Impact avoidance and minimization measures for this project will consist of following established in-water work periods and adhering to ODFW Turtle Crossing Best Management Practices. In addition, silt fencing will be installed prior to construction in order to prevent the siltation of waterways and wetlands during construction. All heavy equipment will follow specific access ways with trips to and from work areas minimized as much as practicable.

Revegetation activities with native plant species will be undertaken by Metro after construction has been completed.

River Island North – Preservation and Enhancement Areas

Description

The Preservation Areas includes four subareas: the Turtle Habitat Preservation Area, the Emergent Vegetation Preservation Area, the North Preservation Area, and the Turtle Nesting Enhancement Area. These subareas will be discussed in detail below:

(1) Turtle Habitat Preservation Area

The Turtle Habitat Preservation Area will preserve locations where native turtle use has been identified post-avulsion, including foraging and basking areas. The preservation and enhancement of the ponded area will provide an isolated slow-water area with appropriate water temperatures and depths, vegetated refugia, and south-facing basking logs that turtles utilize for foraging, overwintering, and rearing.

(2) Emergent Vegetation Preservation Area

The Emergent Vegetation Preservation Area currently supports a wide range of aquatic and terrestrial species.

(3) North Preservation Area

Riparian forests in this Preservation Area contain some of the largest trees found at the River Island North site.

(4) Turtle Nesting Enhancement Area

The Turtle Nesting Enhancement Area restoration activities involve the creation of terrestrial nesting areas that include habitat features compatible with native turtles' needs. Terrestrial habitats are utilized by turtles for nesting, overwintering, dispersal, and basking. Key features in these areas include southern exposure, appropriately-sized ground substrate that are typically dry and well-drained, varying levels of vegetation (minimal tree cover for nest sites) and proximity to aquatic habitats, typically within 100 meters (325 feet).

Anticipated Benefits

Benefits of these restoration activities will be the preservation of natural riparian and floodplain vegetation communities within the Clackamas River floodplain that provide valuable habitat for native aquatic and terrestrial species. Riparian and floodplain vegetation communities along the mainstem and floodplain areas will be protected and be able to return to historical densities, structures, and species compositions. Native riparian forests and emergent vegetation within wetland and water bodies can improve water quality, provide channel margin complexity, support nutrient exchange processes, provide a source for future large wood recruitment and provide essential habitat and refugia for aquatic species, birds and other wildlife.

The Turtle Habitat Preservation Area will protect and enhance known native turtle habitat. Present populations of Oregon's native turtles are substantially lower than historically due to habitat reduction, degradation, fragmentation, road mortality, and the introduction of non-native invasive plants and animal species. Disconnection between aquatic and terrestrial habitats due to urbanization is one of the factors causing habitat loss and turtle population declines. The preservation and enhancement of these Areas provides the appropriate conditions and the wide range of critical habitats for successful reproduction of native turtles in the Portland metro area.

Design Considerations

Preservation and Enhancements Areas are not to be disturbed during construction activities, excepting for the nesting habitat enhancement activities and removal of remnant quarry materials.

NEXT STEPS

Following review and input from Metro Staff, agency personnel, and relevant stakeholders, input from the preliminary design phase will be reviewed and incorporated where appropriate into final designs. Next steps in the design process will include developing a set of stamped construction plans, specifications, a detailed sequencing plan, and a fish salvage/exclusion strategy.

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Appendix A – Historical Aerial Photographs

This appendix presents images of River Island from 1938 to 1999, as well as an 1855 General Land Office (GLO) map.

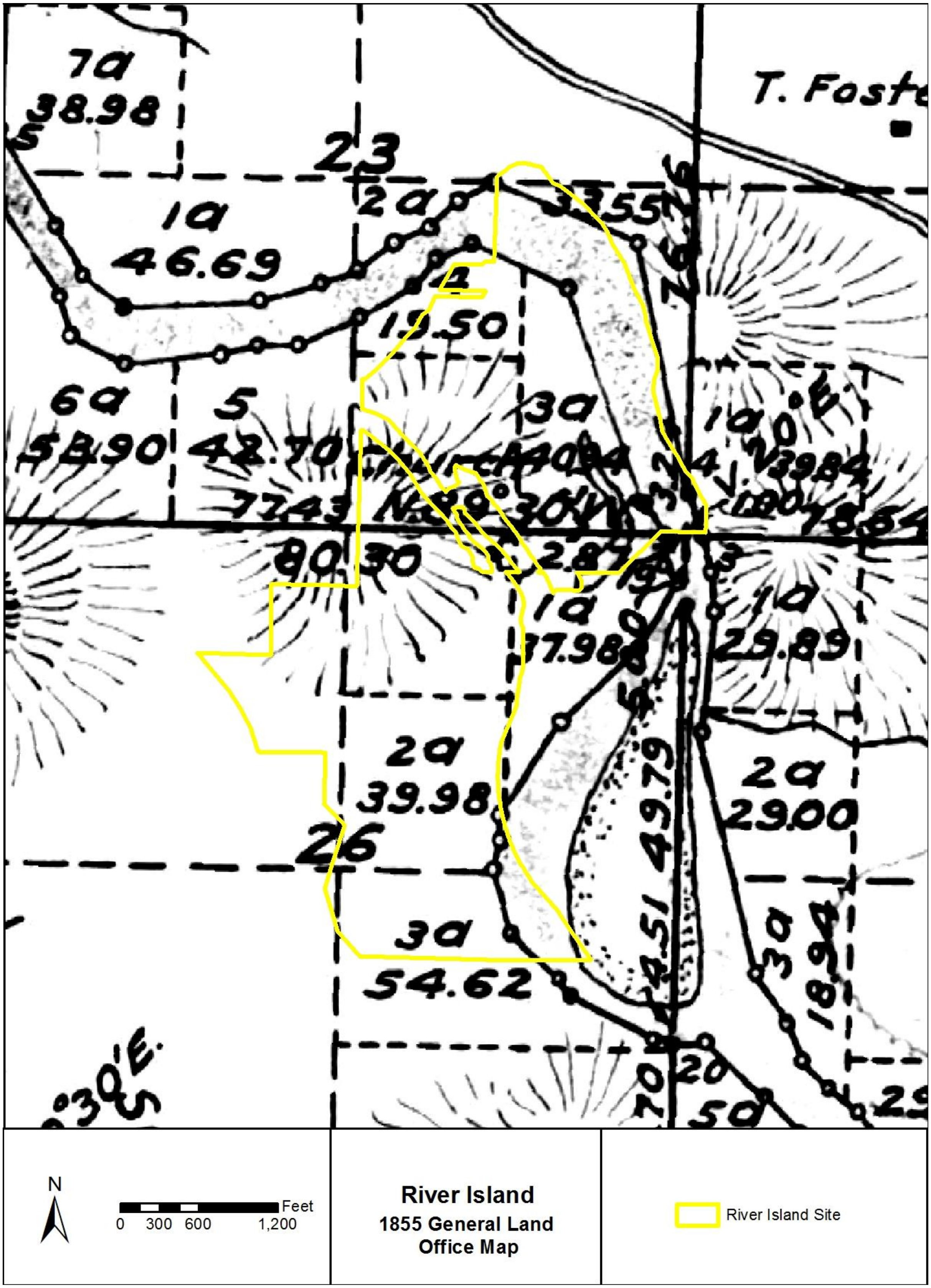

Figure 1. General Land Office map from 1855.

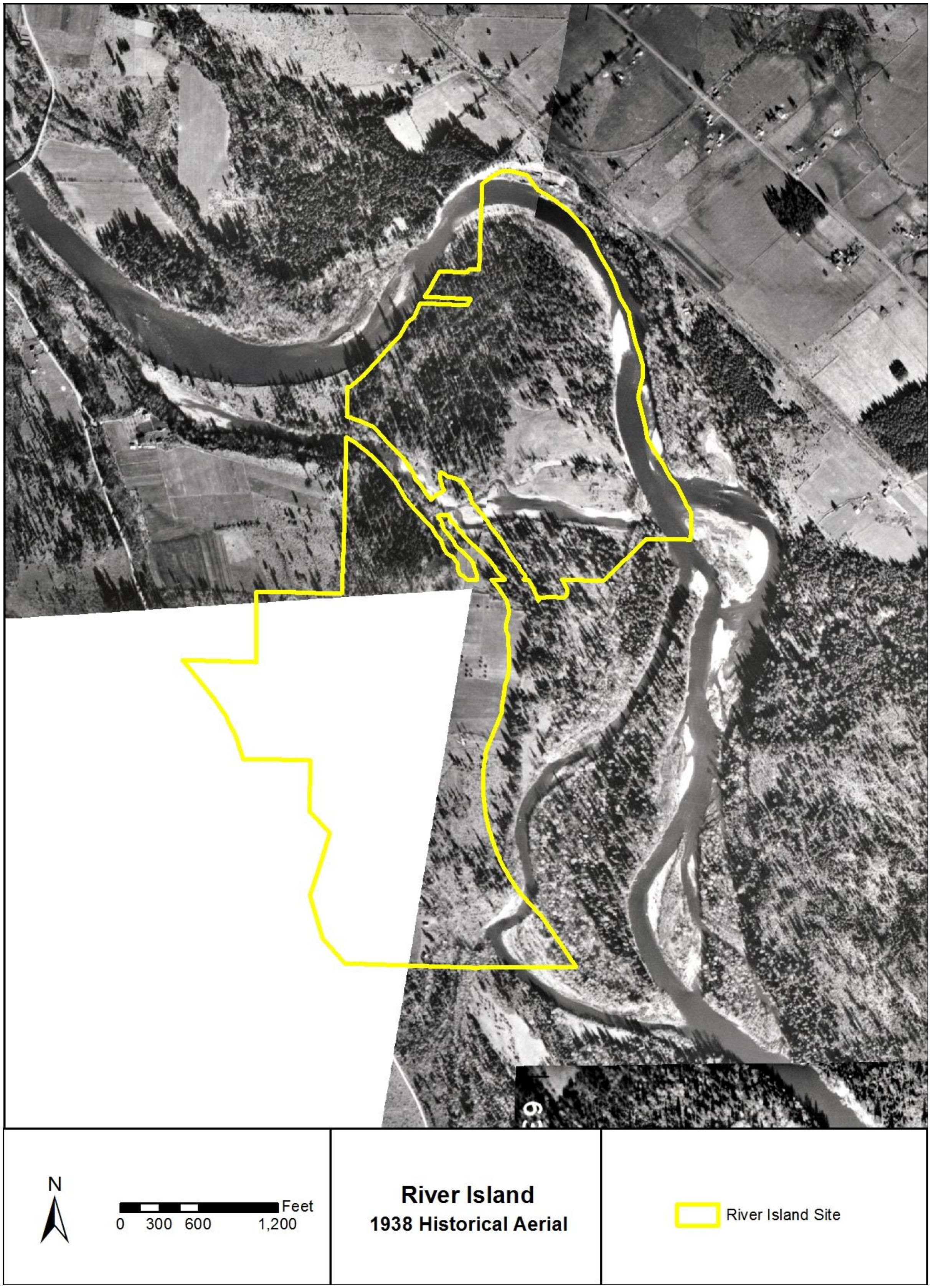

Figure 2. Historical image from 1938.

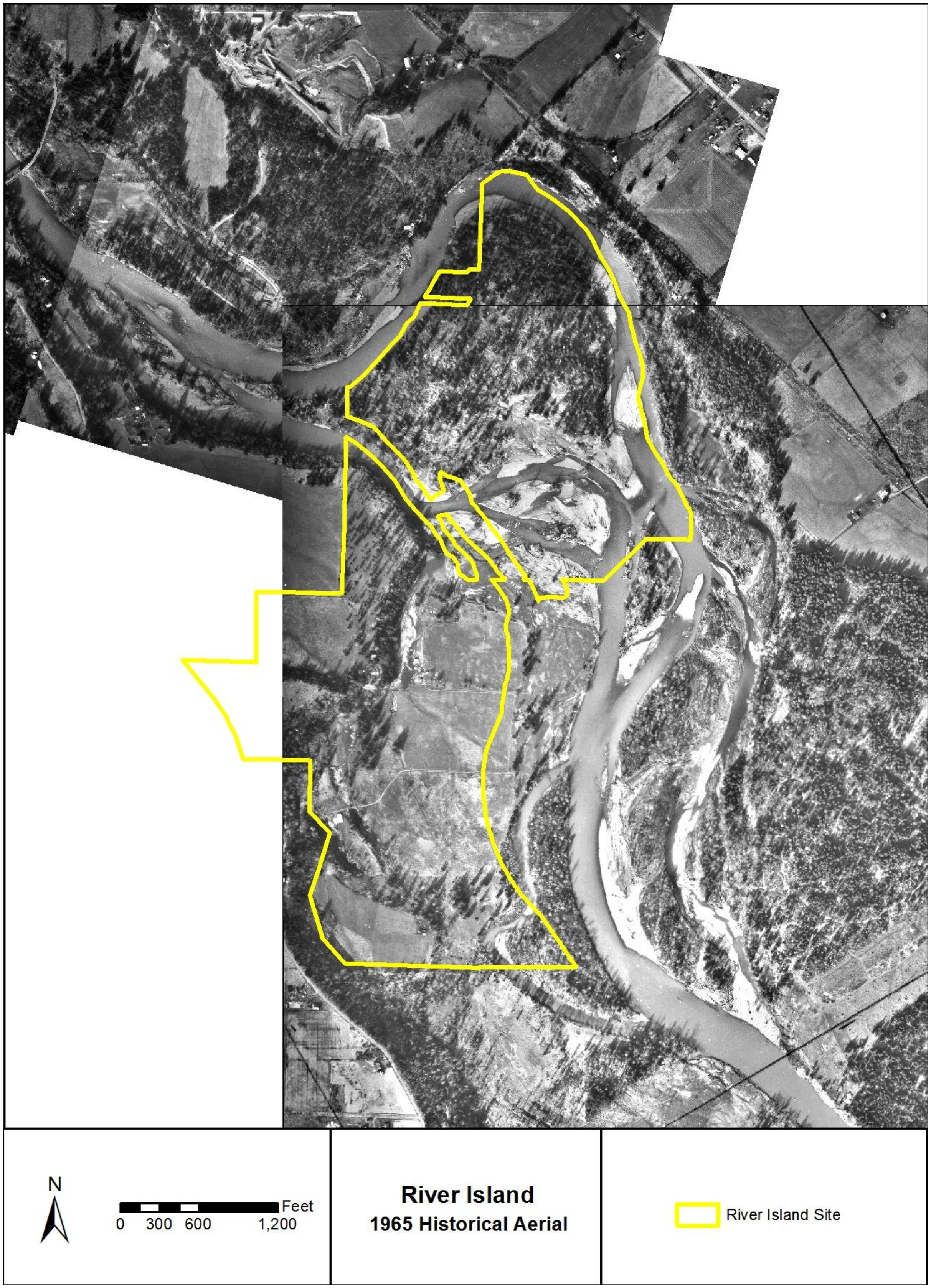

Figure 3. Historical aerial image from 1965.

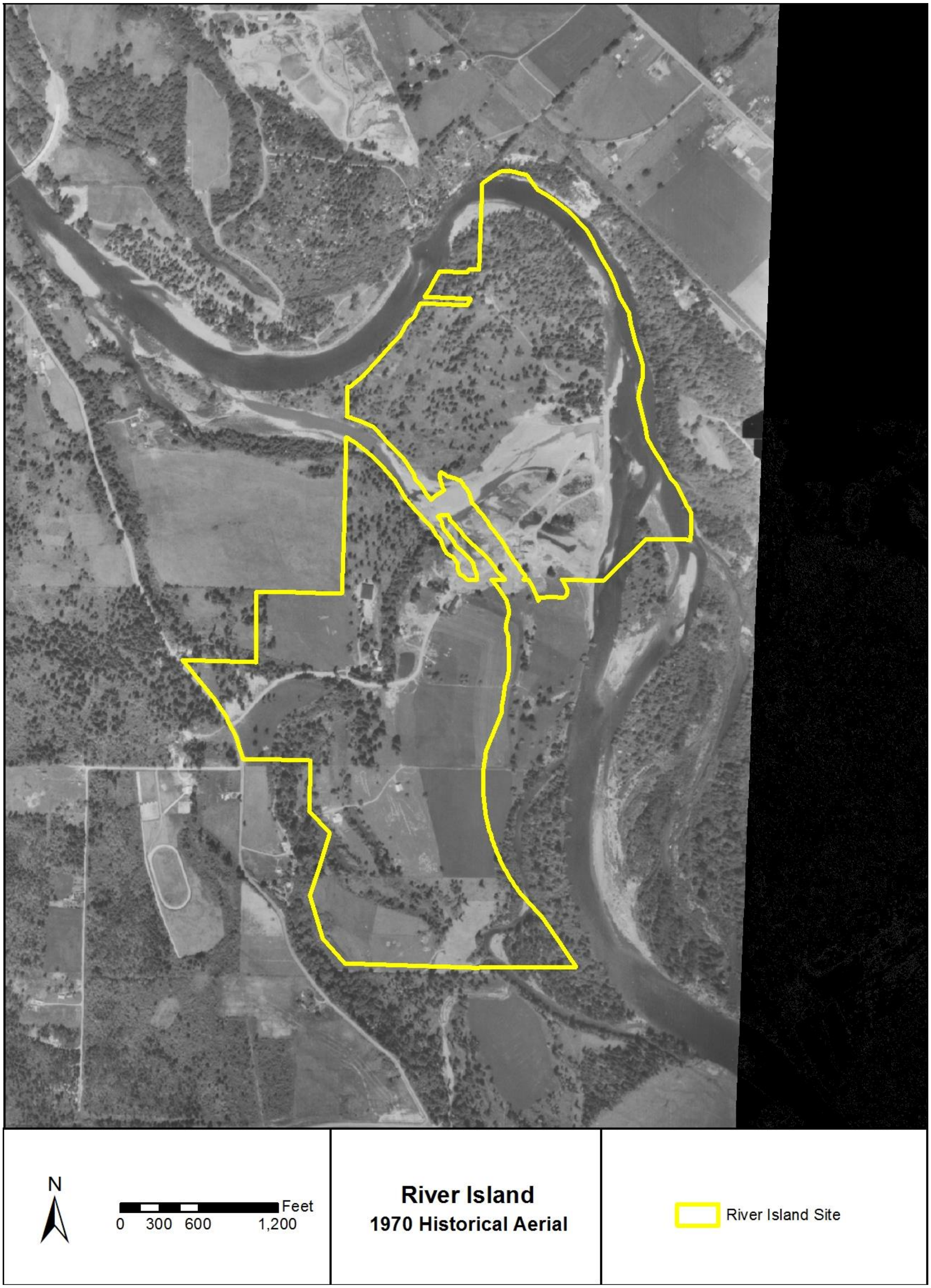

Figure 4. Historical aerial image from 1970.

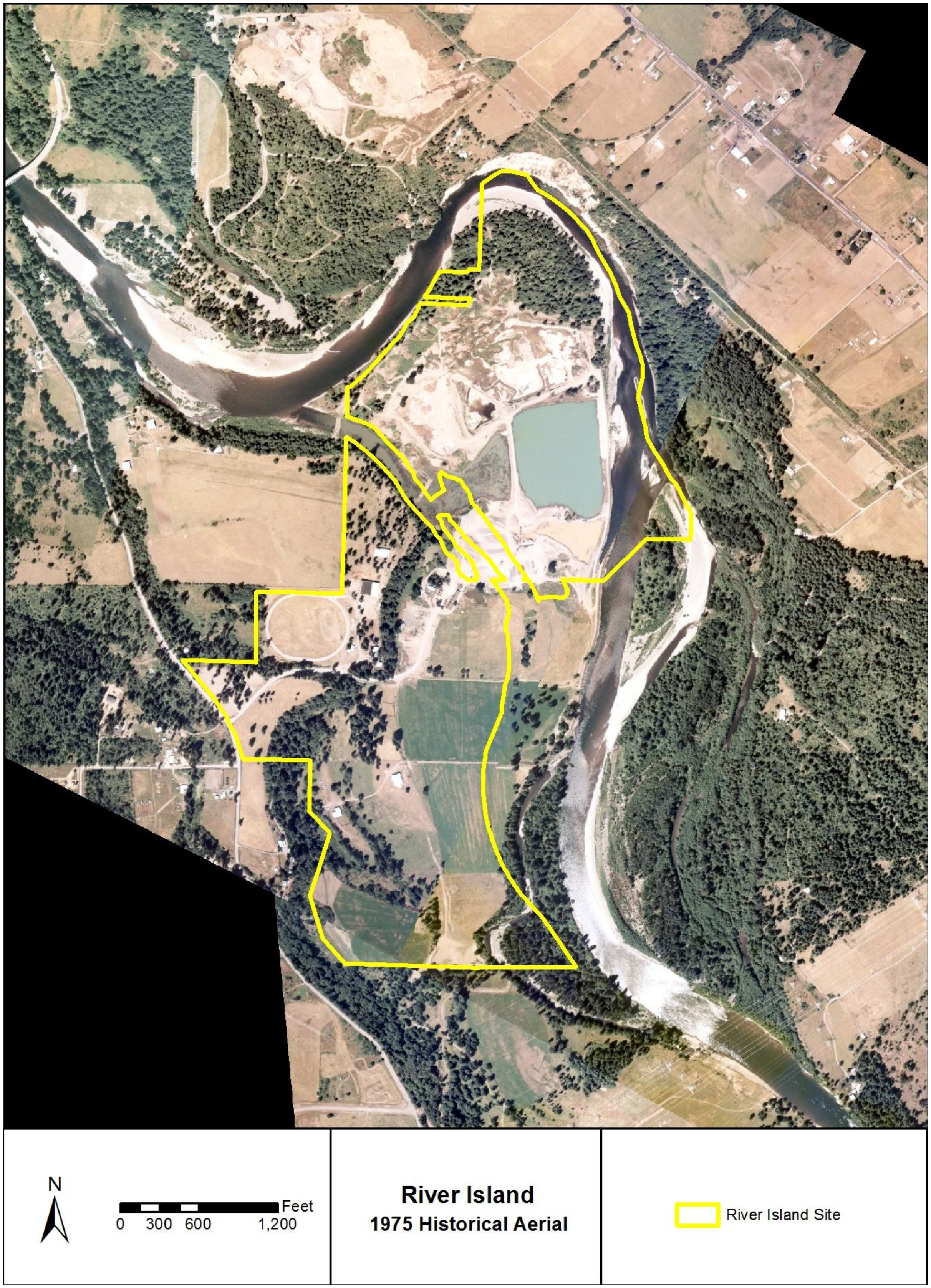

Figure 5. Historical aerial image from 1975.

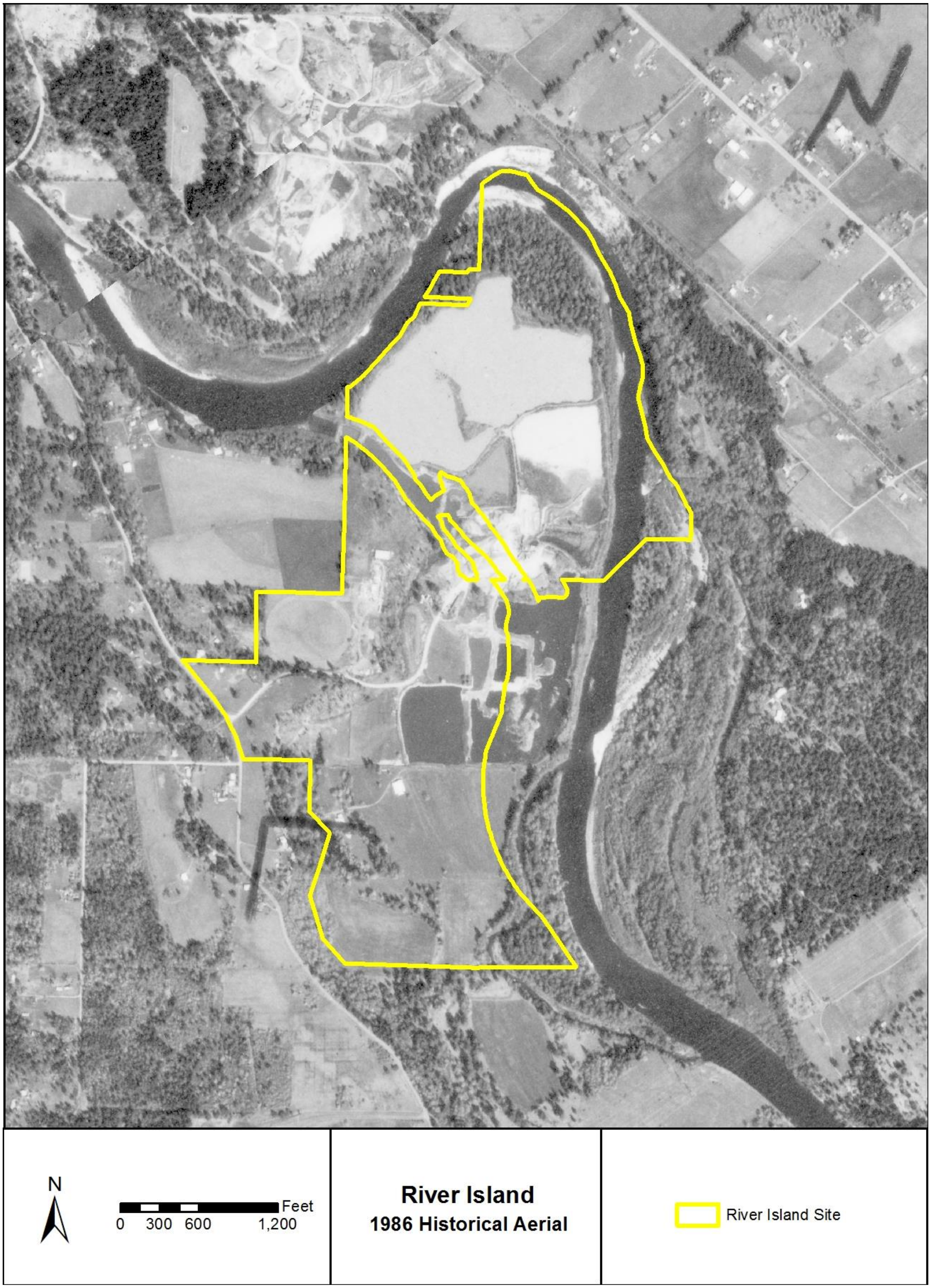

Figure 6. Historical aerial image from 1986.

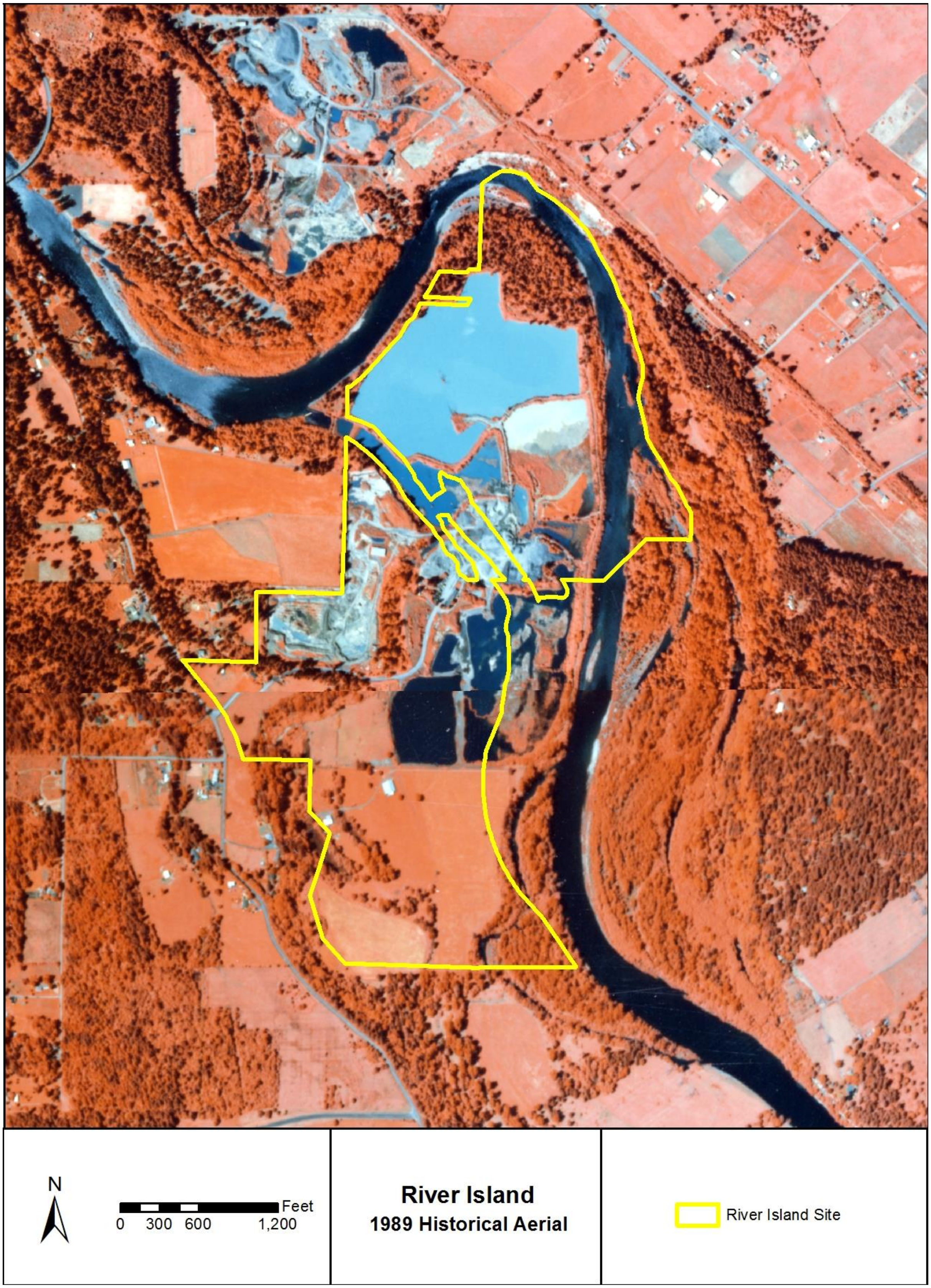

Figure 7. Historical aerial image from 1989.

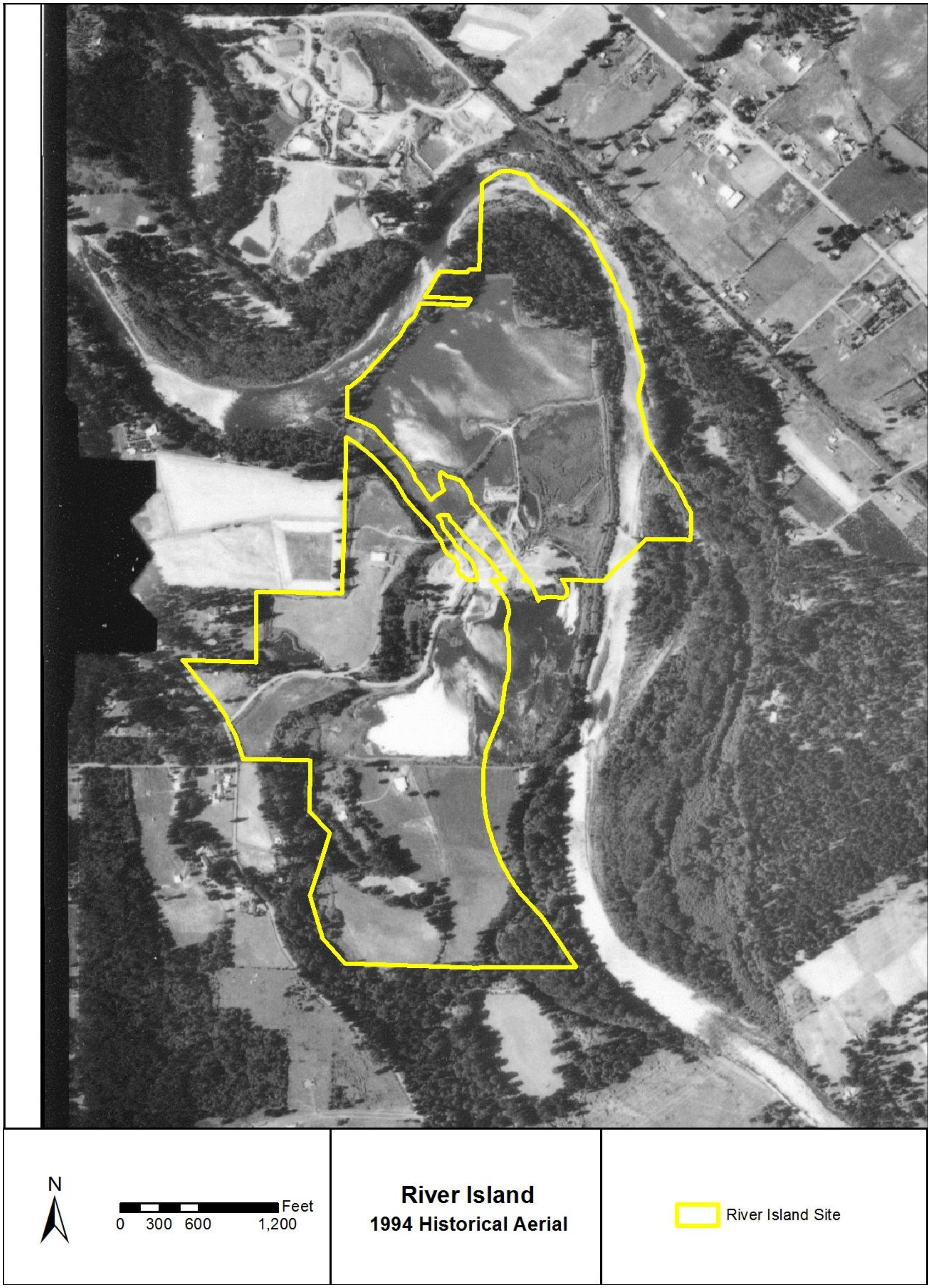

Figure 8. Historical aerial image from 1994 (pre-avulsion).

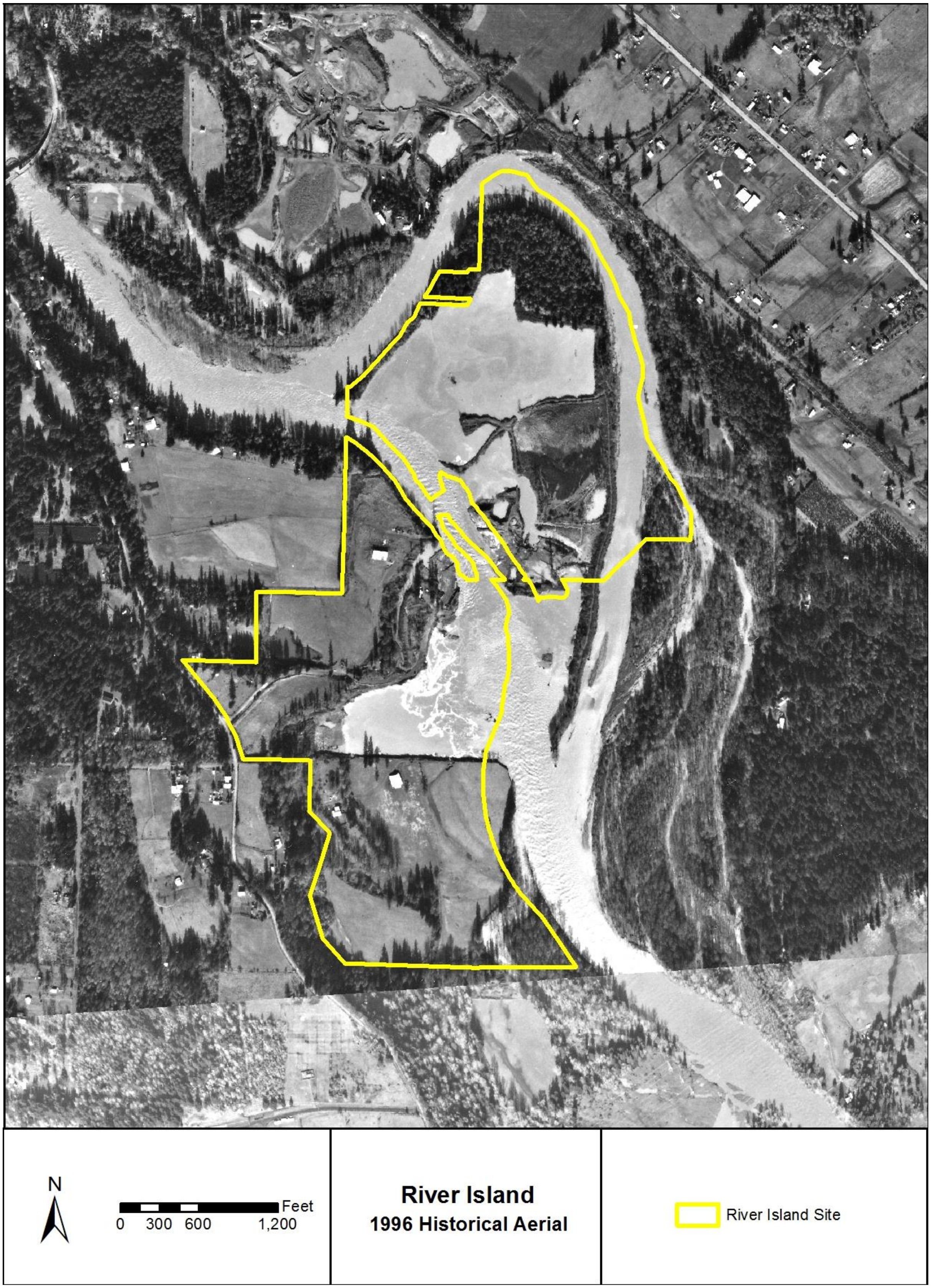

Figure 9. Historical aerial image from 1996 (post-avulsion).

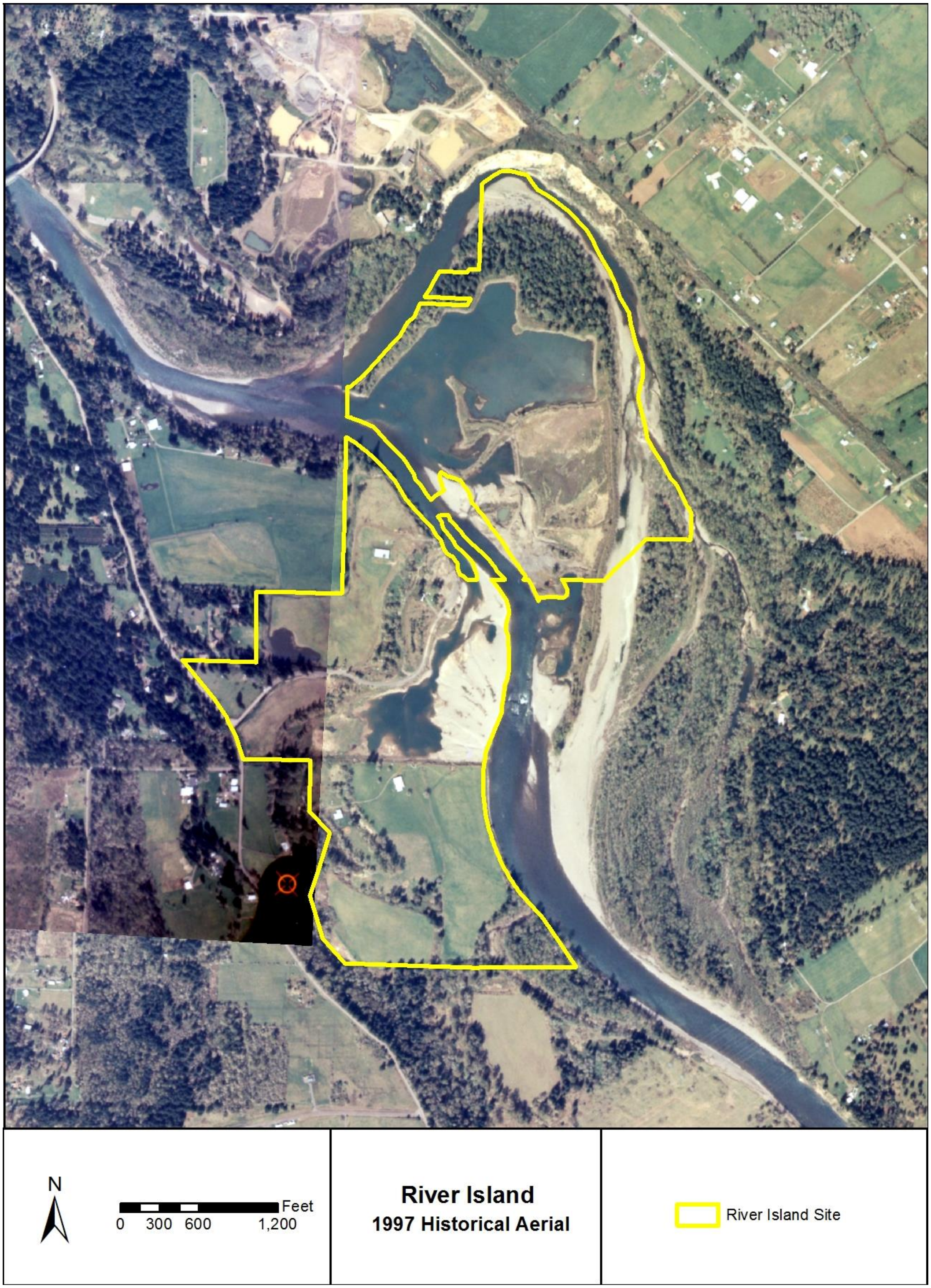

Figure 10. Historical aerial image from 1997.

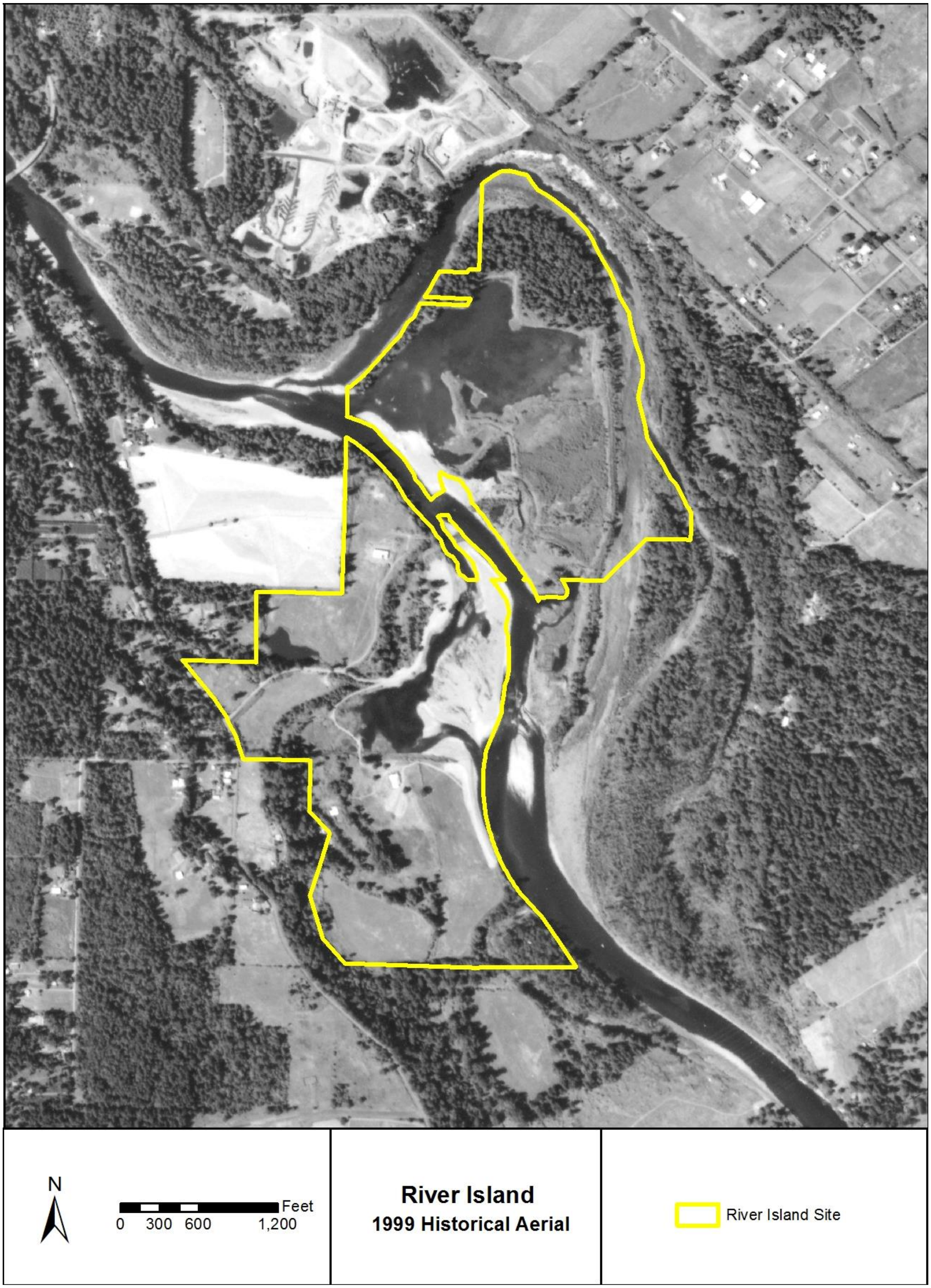

Figure 11. Historical aerial image from 1999.