

Technical Memo

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Date: October 28, 2013
From: Thomas Grindeland, P.E.
Subject: CM-10 Monitoring Report – Ridgefield Pits Bathymetric Survey



Introduction

WEST Consultants Inc. (WEST) conducted a bathymetric survey and developed an estimate of sediment infill rates for the Ridgefield Gravel Pits located along the East Fork Lewis River. The periodic survey and infill rate estimate are required under Conservation Measure 10 (CM-10) of the Habitat Conservation Plan (HCP). The location of the Ridgefield Pits is shown on Figure 1 (Appendix A).

The East Fork Lewis River avulsed into the abandoned Ridgefield Pits in 1996. Figure 2 shows the path of the avulsion from aerial photography taken in November 1996. Because the river has the potential to avulse into the off-channel Daybreak Pits, the HCP requires an estimate of the amount of time that would be required for geomorphic recovery. Geomorphic recovery of the East Fork Lewis River channel within the Ridgefield Pits will occur when the geometry and hydraulics of the channel return to conditions similar to those that existed prior to the 1996 avulsion. This is assumed to occur when the channel has returned to an elevation similar to the pre-avulsion channel. The avulsion into the Ridgefield Pits that occurred in 1996 provides an opportunity to estimate recovery time.

The geomorphic recovery of the Ridgefield Pits is also important in the discussion of the potential for avulsion into the Daybreak Pits. It was determined that the potential for the river to avulse into the downstream end of the existing Daybreak Pits is greatly reduced due to the river's current location within the Ridgefield Pits (WEST, 2001). Once geomorphic recovery occurs within the reach of the Ridgefield Pits, the river may have an increased potential for migration in the lateral direction. Lateral migration could allow the channel to move back to a location near the Existing Daybreak Pits.

Methodology

WEST conducted a bathymetric survey of the Ridgefield Gravel Pits 1 – 7 along the East Fork Lewis River. The survey was completed on August 27, 2013. The survey included the active channel, back channel areas, gravel/sand bars, and the overbank areas below ordinary high water within the boundaries of Ridgefield Pits 1 through 7. Pit 8, Pit 9, and an isolated portion of Pit 3 located along the eastern boundary were not included in the survey. The vertical datum for the survey is NGVD 29.

Survey control was established using a Trimble RTK GPS system. To establish control, a Washington State Department of Transportation benchmark (monument ID: 4880) was used. Control was verified using other benchmarks in the vicinity of the project site (National Geodetic Survey benchmark RD4104 and Clark County benchmark 1267). Control was established along the entire project reach in order to complete shallow water and ground portions of the survey. For the areas which were too deep for conventional survey equipment, a survey grade SONAR instrument, integrated with the RTK GPS system, was used to collect bathymetric data.

In order to estimate the sediment infill rates from the survey results, a digital terrain model (DTM) of the project area was developed using Arc-GIS. Overbank areas not included in the survey were supplemented with available LiDAR (USACE, 2010). The resulting DTM of the 2013 survey is shown in Figure 3.

A contour map of the bathymetric survey performed in September 1999 (Chase Jones, 1999) of Ridgefield Pits 1 through 7 was also available for this analysis. The map provided only below water surface contours of 1999 pit conditions. Unfortunately, the contour map of the 1999 survey contained only a few overbank elevation points. The 1999 contours were recreated in Arc-GIS and a DTM was created from the 1999 bathymetry. The DTM of the 1999 bathymetry was supplemented with overbank contour data developed from LiDAR flown in 2004 (USACE, 2004). The DTM of the 1999 survey is shown in Figure 4.

A boundary for each pit was developed to conduct sediment infill calculations. The boundary extends beyond both the historic and current pit area in order to capture potential channel migration. The boundaries for each pit are shown in Figure 5. The volume of the Ridgefield Pits for 1999 and 2013 surveys were estimated using Arc-GIS. The same top elevations were used in the calculation of remaining pit volumes.

Sediment Infill Rate

The average depths of the Ridgefield Pits before the avulsion occurred were estimated by a former gravel mine operator at the Ridgefield Pits. The pre-avulsion pit volumes are shown in Table 1 (WEST, 2001). The estimated pit volumes from the 1999 and 2013 bathymetric surveys are also shown Table 1.

Table 1: Estimated Changes in Volume of the Ridgefield Pits since the 1996 avulsion.

Pit	Pre-1996 Pit Volume (2001 study)	Pre-1996 Pit Depth (2001 study)	Pit Top Elevation (2001 study)	1999		2013	
				Volume	Volume Change	Volume	Volume Change
	(yd ³)	(ft)	(ft)	(yd ³)	%	(yd ³)	%
1	157,700	12	35	118,583	-25%	21,958	-86%
2	102,900	12	34	130,131	26%	54,185	-47%
3	108,500	20	33	124,203	14%	76,290	-30%
4	143,500	20	32	105,176	-27%	51,000	-64%
5	164,800	20	31	160,661	-3%	88,955	-46%
6	204,900	30	31	128,119	-37%	66,211	-68%
7	186,900	20	30	178,981	-4%	96,299	-48%
total	1,069,200			945,854	-12%	454,897	-57%

According to the results listed in Table 1, the reduction in total volume for Pits 1 – 7 averaged approximately 3-percent per year for the period of 1996 – 1999. For the period of 1999 – 2013, the reduction in total pit volume averaged approximately 3.2-percent per year. For the period of 1996 -1999, the volume of Pit 2 and Pit 3 increased 26-percent and 14-percent, respectively. The noted volume increase in these pits is attributed to several factors: 1) Localized erosion from lateral channel migration may have increased the pit volumes and transported the material downstream; 2) The geomorphic boundaries (Figure 5) established for this study may have increased the pit volume because it includes areas which were excluded in the previous study; 3) The pre-1996 pit volumes may have been under-estimated.

The predicted recovery period developed from the recent survey is approximately 30 years from time of the initial avulsion (1996). This suggests that the Ridgefield Pits will fill by 2026. Figure 6 summarizes the observed and predicted infill rate for the Ridgefield Pits. This information corresponds very favorably to the prediction of 25 – 30 years originally published in the Habitat Conservation Plan (WEST, 2001).

Geomorphic Observations

A site reconnaissance of the Ridgefield Pits site was conducted by Thomas R. Grindeland P.E. and Rick Shimota P.E. on August 30, 2013. Observations of the channel and overbank areas were made to determine the extent and characteristics of sediment infilling. A photographic log of site reconnaissance observations is provided in Appendix B.

The material deposited in Pits 1 and 2 was observed to be sands, gravels and, cobbles with a median diameter (D_{50}) of approximately 2.5 inches. The general characteristic of Pit 1 was riverine in nature and characteristics of a former gravel pit were not evident. The eastern portion of Pit 2 has a geomorphic character similar to Pit 1. The western portion of Pit 2 is more similar

to a back channel environment, with fine sands being the predominant sediment. Historic aerial photography shows the channel was located in this area in 2007 and coarser material may have been deposited under the current sand deposits. Portions of the channel in Pit 3 were observed to have a gravel and cobble substrate, with a D_{50} of approximately 2.5 inches. Again, the sediment deposits observed in the backwater areas of Pit 3 are primarily sand. Predominantly, sediment deposits in Pits 4 through 7 were observed to be sand.

Native material or “leave strips” were noted to have separated each of the gravel pits. The 1996 avulsion and subsequent floods have eroded away transportable material in the area of where leave strips had been breached, leaving behind gravels and cobbles, which have formed short riffles connecting Pit 3 to Pit 4, Pit 4 to Pit 5, and Pit 5 to Pit 7.

A review of historic aerial photography for the Ridgefield Pits was performed to evaluate lateral channel migration conditions. Aerial photography of the site was available for years 1990, 2000, 2002, 2004, 2007, 2011 and 2012. A channel centerline for each available year was developed and overlain as shown in Figure 7.

The most significant migration of the channel centerline was observed to have occurred in Pit 2. The channel centerline in the vicinity of Pit 2 moved laterally approximately 350 feet between years the 2007 and 2011. The centerline switched from the western edge of Pit 2 to the eastern edge of Pit 1. The channel migrated eastward a further 80 feet from 2011 to 2012. If the lateral channel migration continues eastward, the channel could move into the eastern portion of Ridgefield Pit 3 or into Ridgefield Pit 9. Potential migration paths are shown in Figure 7.

If the channel migrates into Pit 3, portions of Pit 2 and Pit 3 may be bypassed, lengthening the recovery time of those pits. If the channel migrates into Pit 9, then Pits 2, 3, 4, and 5 will be bypassed, which may lengthen the recovery time of the bypassed pits. However, it is likely that the channel will still be contained within the Ridgefield Site even if the channel shifts to Pit 3 or Pit 9.

Conclusion

The recent bathymetric survey conducted in 2013 suggests that the pits are on a trajectory to fill by 2026, with a predicted recovery period of 30 years from the time of the initial avulsion. Figure 6 summarizes the observed and predicted infill rate of the Ridgefield Pits. The observed rate corresponds well with the prediction of 25 – 30 years originally published in the Habitat Conservation Plan (WEST, 2001). It is recognized that if lateral channel migration bypasses the pits, recover times may be significantly longer. However, it is likely that the East Fork Lewis River channel will remain in the Ridgefield Pits Site for an extended period into the future.

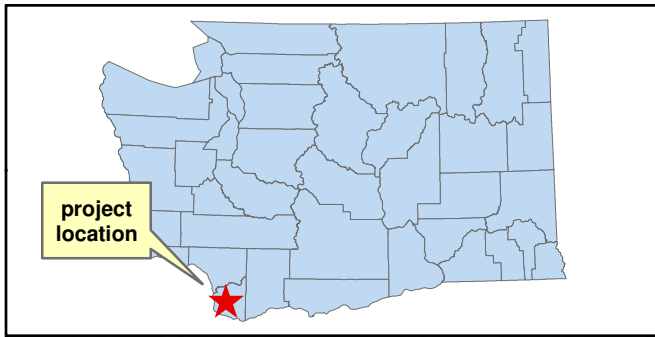
Since the observed infill rates are approximately the same as the original 2001 prediction, and the risk of the channel shifting out of the Ridgefield site has not changed significantly, no change to the Avulsion Contingency Plan (CM-09) associated with the HCP is recommended.

References

U.S. Army Corps of Engineers, LiDAR data, 2010.

WEST Consultants, Geomorphic Analysis of the East Fork Lewis River in the Vicinity of the Daybreak Mine Expansion and Habitat Enhancement Project, May 18, 2001.

Appendix A: Figures



0 250 500 1,000 Feet

Ortho Imagery - 2011

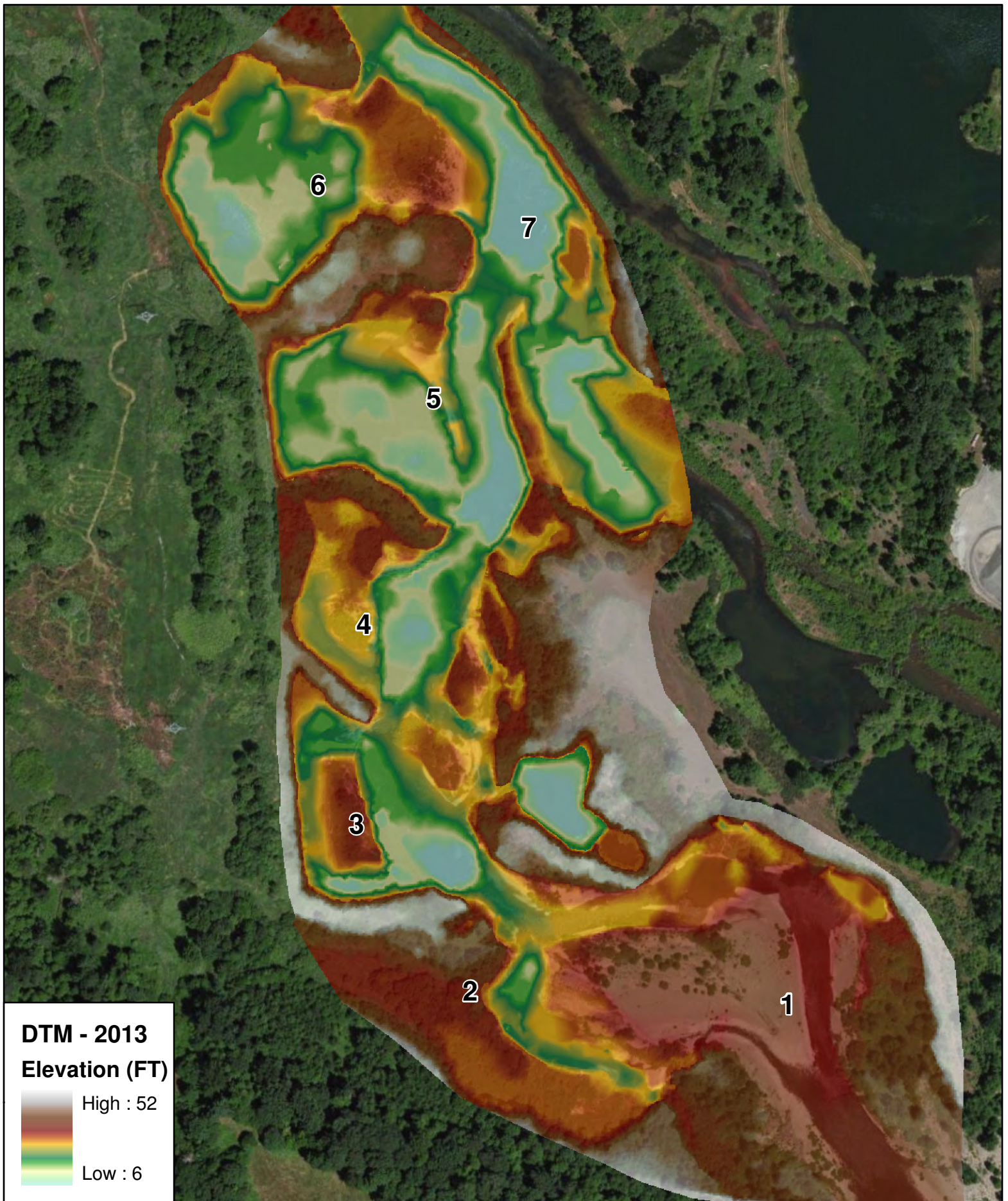
Figure 1
Project Location
Ridgefield Pits - EF Lewis River



0 250 500 1,000 Feet

Ortho Imagery - 1996

Figure 2
Ridgefield Pits - EF Lewis River
November 1996



0 100 200 400
Feet

Ortho Imagery - 2011

Figure 3
2013 Survey DTM
Ridgefield Pits - EF Lewis River

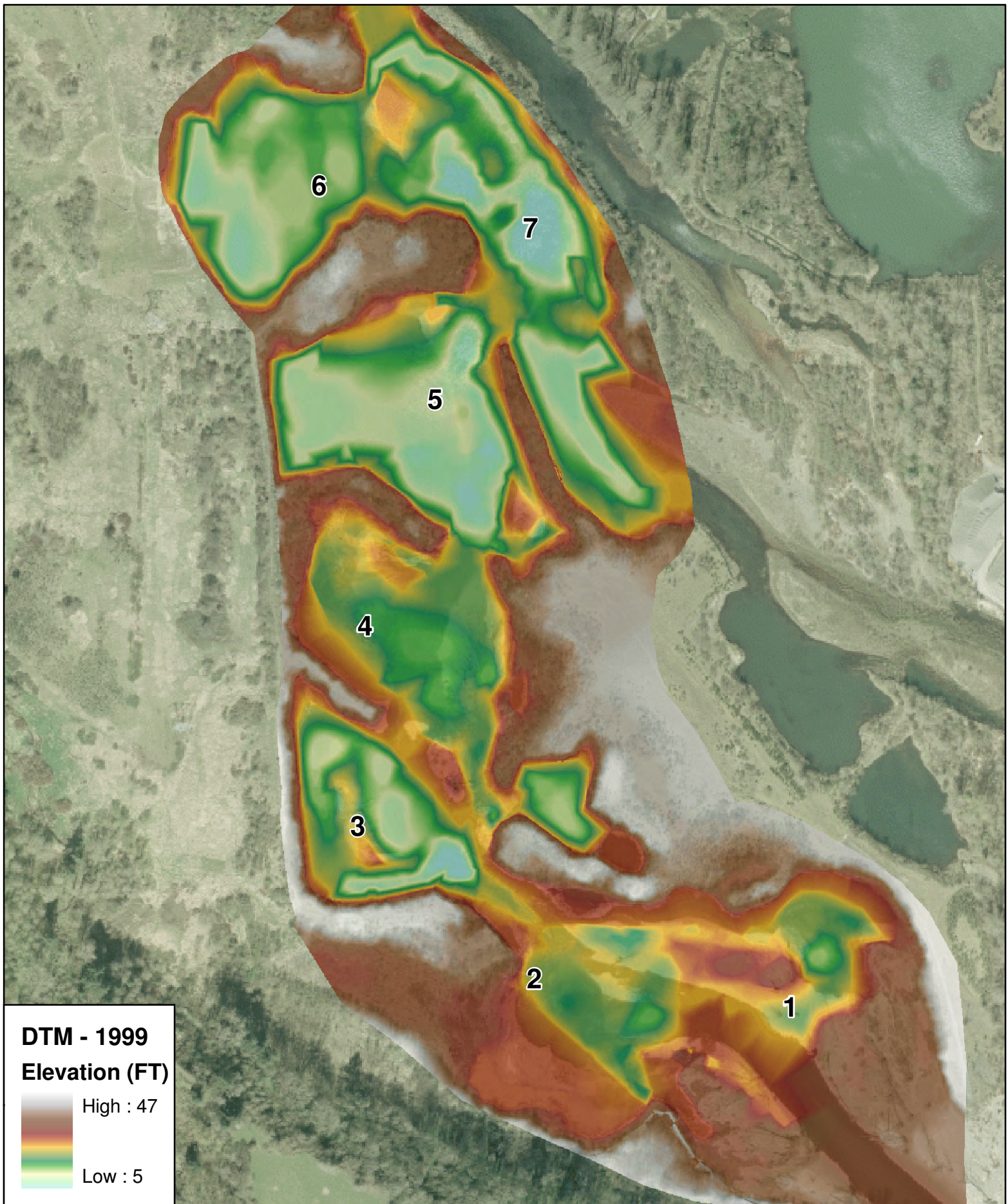


Figure 4
1999 Survey DTM
Ridgefield Pits - EF Lewis River

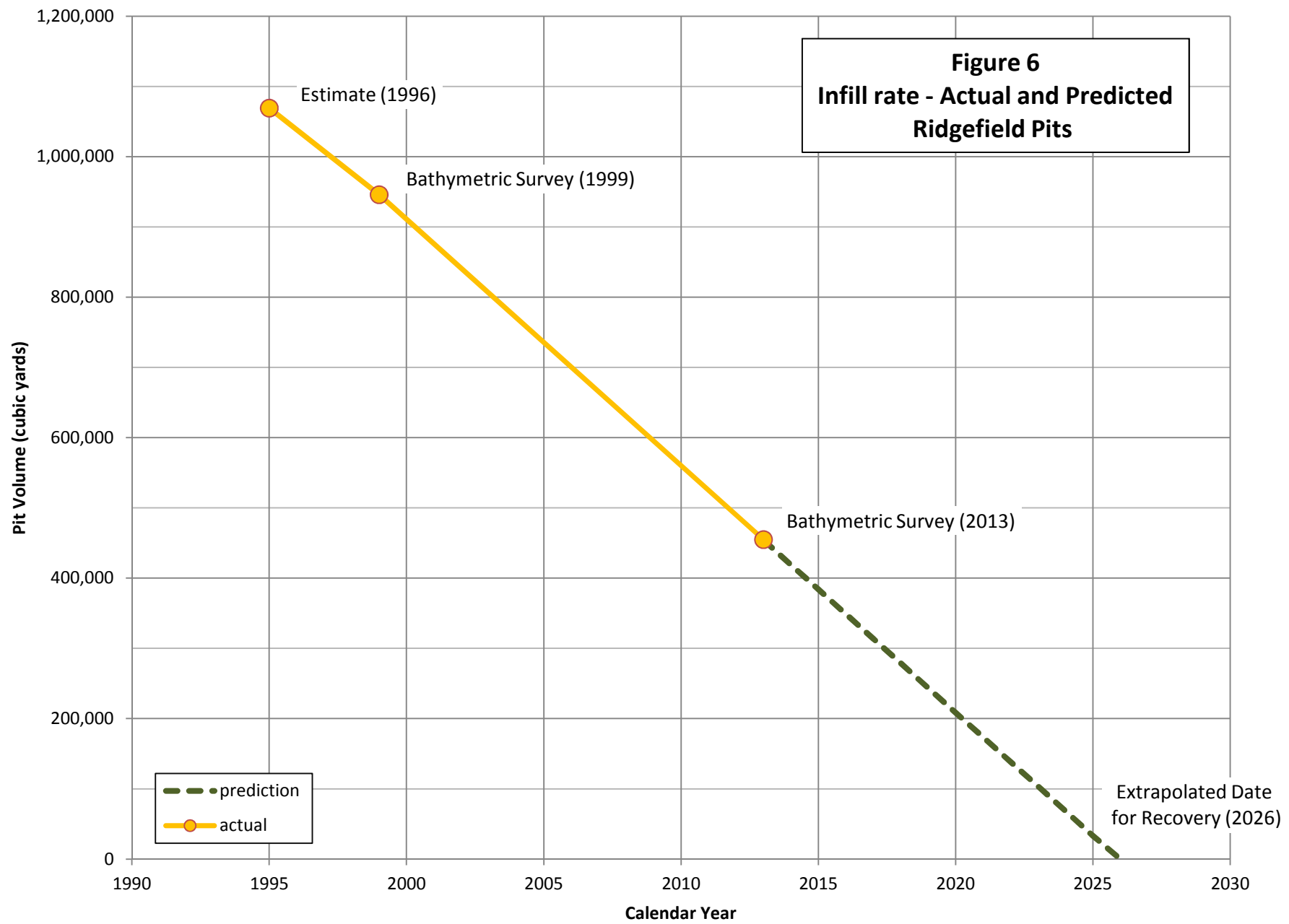


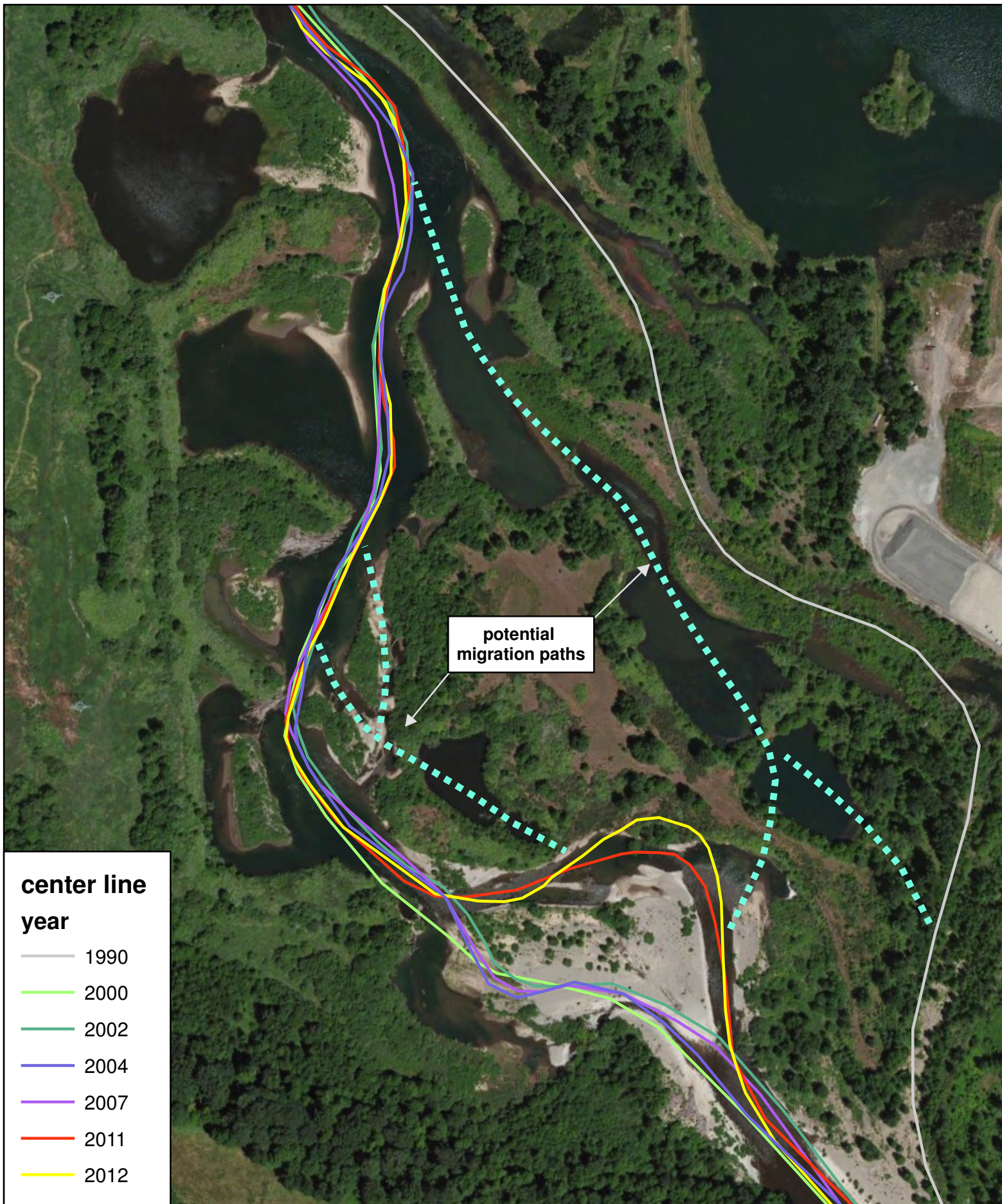
0 100 200 400
Feet

Ortho Imagery - 2011

Figure 5
Pit Analysis Boundaries
Ridgefield Pits - EF Lewis River

Figure 6
Infill rate - Actual and Predicted
Ridgefield Pits





0 100 200 400
Feet

Ortho Imagery - 2011

Figure 7
Comparison of Historic Stream Centerlines
EF Lewis River - Ridgefield Pits

Appendix B. Photographic Log



Photo 1: Looking northeast at the southern extent of Pit 1.



Photo 2: Looking downstream (north) at eastern portion of Pit 1.



Photo 3: Looking west towards Pit 2, near western boundary of Pit 1.



Photo 4: Streambed material, left bank of Pit 1.



Photo 5: Looking east from Pit 1, towards Pit 9.



Photo 6: Looking downstream (west) towards downstream extent of Pit 2.



Photo 7: Streambed material, left bank of Pit 2.



Photo 8: Looking north, western edge of Pit 2. Note gravel delta deposition on right of photo. Sand deposition is predominant left of the gravel delta.



Photo 9: Looking downstream towards Pit 3 from exit of Pit 2.



Photo 10: Looking downstream towards entrance of Pit 3.



Photo 11: Looking west from mid section of Pit 3.



Photo 12: Looking north, western edge of Pit 3.



Photo 13: Looking upstream (south) at exit of Pit 3.



Photo 14: Looking north at the downstream extent of Pit 3. Note the formation of apex log jam on west side of the channel.



Photo 15: Looking upstream (south) at entrance of Pit 4. Note apex jam on right.



Photo16: Looking downstream from entrance of Pit 4. Note the formation of a second apex log jam on west side of the channel near the exit.



Photo 17: Looking southeast (upstream) from the right bank of Pit 4.



Photo 18: Looking upstream at Pit 4 from Pit 5.



Photo 19: Looking northeast from entrance of Pit 5. Note sandbar formation which separates main channel from the backwater area of Pit 5.



Photo 20: Looking northwest at backwater area of Pit 5.



Photo 21: Looking southwest at southern boundary of Pit 6.



Photo 22: Looking west at Pit 6. Note that Pit 6 is currently cut off from the active channel of the EF Lewis River.



Photo 23: Looking north at Pit 6 from eastern boundary.



Photo 24: Looking downstream toward the mid section of Pit 7. Note this section is active channel.



Photo 25: Looking upstream from entrance of Pit 7 towards Pit 5.



Photo 26: Looking south at the backwater section of Pit 7.



Photo 27: Looking upstream at entrance to backwater section of Pit 7.



Photo 28: Looking upstream at the downstream extent of Pit 7.