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TALUS FEATURES OF THE MIDDLE COLUMBIA RIVER: TYPOLOGICAL AND LOCATIONAL ANALYSES

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TALUS FEATURES OF THE MIDDLE COLUMBIA RIVER: TYPOLOGICAL AND LOCATIONAL ANALYSES

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by

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ABSTRACT

TALUS FEATURES OF THE MIDDLE COLUMBIA RIVER: TYPOLOGICAL AND LOCATIONAL ANALYSES

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The form and function of talus features of the Columbia Plateau are the subject of archaeological investigations and cultural resource evaluation and protection programs. Depressions excavated in talus slopes, most often circular to oval in shape, are called talus pits. Pit features are also located in colluvium and alluvial fans, and at the base of cliff overhangs. Over 568 of these features have been documented for 48 sites within the project area of the Priest Rapids and Wanapum reservoirs.

Pits may have been used for hunting blinds, storage (food and/or equipment), burial, and/or and spirit questing. The size of pits and the frequency of pits per site, combined with historic associations with human remains, suggest that most talus pit sites are cemeteries. Pits and pit sites are found in higher than expected frequencies on the west side of the Columbia River and on northeast and southeast facing slopes. The distribution of pits by river mile for the east and west sides of the river do not correspond to changes in the elevation of the river (rapids) or the amount of talus slopes or alluvial fans. The location of house features and house sites are compared to the distribution of

talus pits by average distance and by river section. There is only partial correspondence of house sites and talus site locations. The number of houses and number of talus pit features, and reported location of ethnohistoric settlements, are not well correlated. Some talus pits and house features are found in the middle stretch of the project (Vantage-Rocky Coulee). However, overall, talus features, house features, and historic settlement locations concentrate on the upper (Colockum Creek-Cabinet Rapids) and lower (Priest Rapids) ends of the project area. This distributional pattern best fits the interpretation that sites with large number of pits are cemeteries associated with separate communities.

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CHAPTER I

INTRODUCTION

Talus pits are part of the archaeological landscape of much of the interior Pacific Northwest. For the purposes of this study, a “talus pit” is defined as a pit feature created by removing loose boulders and stacking them around the margin. Talus pits are known to contain cremations and flexed burials, and many were marked with cedar stakes (Greengo 1982; Smith 1910). Walker (1973) notes that pits in talus slopes were used for storage. Several sources note the use of talus pits and rock enclosures for hunting and vision questing (Connolly et al. 1997; Smith 1910).

Talus pits are often recorded during archaeological inventories within the Middle Columbia River Valley (Greengo 1982; Hackenberger 2003; Swanson 1962). However, at this time, there are no studies that examine the distribution of these features across the landscape. Often talus pits are noted near prehistoric house settlements (Greengo 1982; Mack 2013; Smith 1910), but the spatial connection between talus pit sites and settlements has rarely been investigated.

My goal is to study the distribution of talus pits and talus sites in order to interpret the cultural landscape of this historically significant area of the Columbia Plateau. Examining the relationship of talus pits sites, and/or the number of talus pits, with total talus area, river elevation (rapids) and house settlements may reveal the nature of economic and/or ritual associations of talus pits as part of the cultural landscapes of the Middle Columbia River.

Problem

The economic transformation of hunting-gathering-fishing communities is often explained by the shift from the forager (residential mobility) to collector strategies (logistical mobility). On the Middle Columbia, these transformations began between the Vantage and Frenchman Springs phases (4000 years ago) (Campbell 1985; Chatters 1987, 1995; Chatters and Prentiss 2005; Galm et al.1981; Nelson 1969; Rice 1968). However, the full transition to collector strategies is best documented for the Cayuse Phase (2000 years ago) (Chatters 1995; Chatters and Pokotylo 1998).

Talus pits (for storage, burial and/or questing features) are no doubt part of the archaeological record of this transition. The more permanent settlements became along the Middle Columbia River, the more concentrated talus pit sites and talus pits should have become. Whether the features are for storage or burial, larger number of pits should have accumulated on especially chosen landforms. Semi-permanent winter house settlements grew as populations increased and subsistence included storage of roots and fish, and/or the equipment used to capture and process these resources. As settlements became more permanent and surrounding landscapes were demarcated, burial rituals and/or vision questing would become more localized.

Although it remains to be determined when, where, and how these features developed on the landscape, it is assumed that most of the features are associated with

Late, or Protohistoric/Historic period settlement. Harlan Smith (1910:7-8) was the earliest anthropologist to investigate talus pits and graves (rock slide graves), along areas of the Yakima and Naches River. He also explored along the Columbia River in the vicinity of Sentinel Bluffs and the head of Priest Rapids near the ethnohistoric settlement of *Wapixie*. According to Smith (1910:140) some of the rock-slide graves appeared to be older, but many are Protohistoric/Historic period based on artifacts found within them. Some remains were cremated and some buried in flexed positions (Smith 1910).

This study examines the problem of where talus pit sites were located and how talus pits and talus pit sites functioned in relationship with house settlements. Research methodology was designed to address the following four questions:

1. What types of variability are found in the size and shape of talus pits?
2. How are talus pits distributed in relationship to talus and fans on the east and west sides of the river (amount of talus, talus slope and aspect)?
3. Is there a correlation between the location of rapids and talus pit sites by river mile?
4. What is the spatial relationship between talus pit sites (number of sites and/or pits) house sites, and settlement size (archaeological and ethnohistoric)?

Purpose

The purpose of this thesis is to collect and analyze data for talus pit and house features, and talus pit and house sites. Archaeological site form information was reviewed to build a database for talus pits and talus pit sites, and house sites. All relevant attributes and dimensions of the talus pit features were included. The location of features and sites was characterized by elevation, slope and aspect. Using Environmental Systems Research Institute's (ESRI) ArcGIS (software) the locations of the talus pits and talus pit sites were analyzed, by river section, to determine the possible relationships between burial and storage features with house settlements (both archaeological and ethnohistoric). This research was performed in order to answer questions about types and locations of storage and burial features, and the relationship of these features and sites to house settlements.

Most of the feature and site data used in this study originate from historic property inventory projects mandated by the Section 106 and Section 110 of the National Historic Preservation Act (NHPA). Much of this work has been conducted by the Grant County Public Utility District (GCPUD) as part of their relicensing of hydroelectric dams by the Federal Energy Regulatory Commission (FERC). As part of this research, recommendations for future site documentation and site protection are proposed.

Significance

This research supports both evolutionary ecological studies of the Columbia Plateau and interpretation of cultural landscapes, by creating a database of these features and sites and identifying spatial patterns. The database will serve ongoing inventory and evaluation of archaeological sites along the Middle Columbia River.

Additionally, this study contributes to basic knowledge about an important category of features and sites. Investigating possible relationships between distribution of talus pit features/sites and house settlements adds to our understanding of subsistence adaptations along the Middle Columbia River. If talus pits are primarily used for remote (off-site) storage, then their association with house settlements supports evidence for logistic strategies of collectors. If talus pits are primarily used for burial, or other ritual purposes, then their distribution can help interpret cultural landscapes. These interpretations may pertain to the meaning of death, and/or relationships between neighboring communities.

It is valuable for the data to be reviewed and compiled using techniques and methods that give context for evaluation of site (historic property) types and integrity. Ecological theory and landscape perspectives build frameworks for evaluating the scientific and cultural significance of otherwise enigmatic talus features and sites.

CHAPTER II

BACKGROUND

Project Area

The project area is located in central Washington, within portions of Chelan, Douglas, Kittitas, Grant, and Yakima counties, near the communities of Quincy, Vantage, and Mattawa (Figure 1). The area of interest is focused along the floodplain of both banks of the Columbia River from the tailrace below the Priest Rapids Dam at River Mile (RM) 395, north to Rock Island Dam at RM 453. This area includes portions of the Priest Rapids Hydroelectric Project (PRHP), consisting of two hydroelectric dams (Wanapum and Priest Rapids). The PRHP is managed by the GCPUD under license from FERC (GCPUD 2010).

Both developments consist of reservoirs, power generation facilities, transmission lines, and other necessary facilities and resources (GCPUD 2010). Planning and construction of the PRHP began in 1954. Priest Rapids Dam was completed in 1961 and the Wanapum Dam was completed three years later (Bruce et al. 2001). The Priest Rapids Reservoir extends 18 miles upstream to the Wanapum Dam, and covers some 8,000 acres. The Wanapum Reservoir extends 38 miles upstream to Rock Island Dam, and covers approximately 14,000 acres. The acreage of land within the project area outside the reservoirs is approximately 11,000 acres and consists of a mixture of private, Federal, state, and county lands (GCPUD 2010).

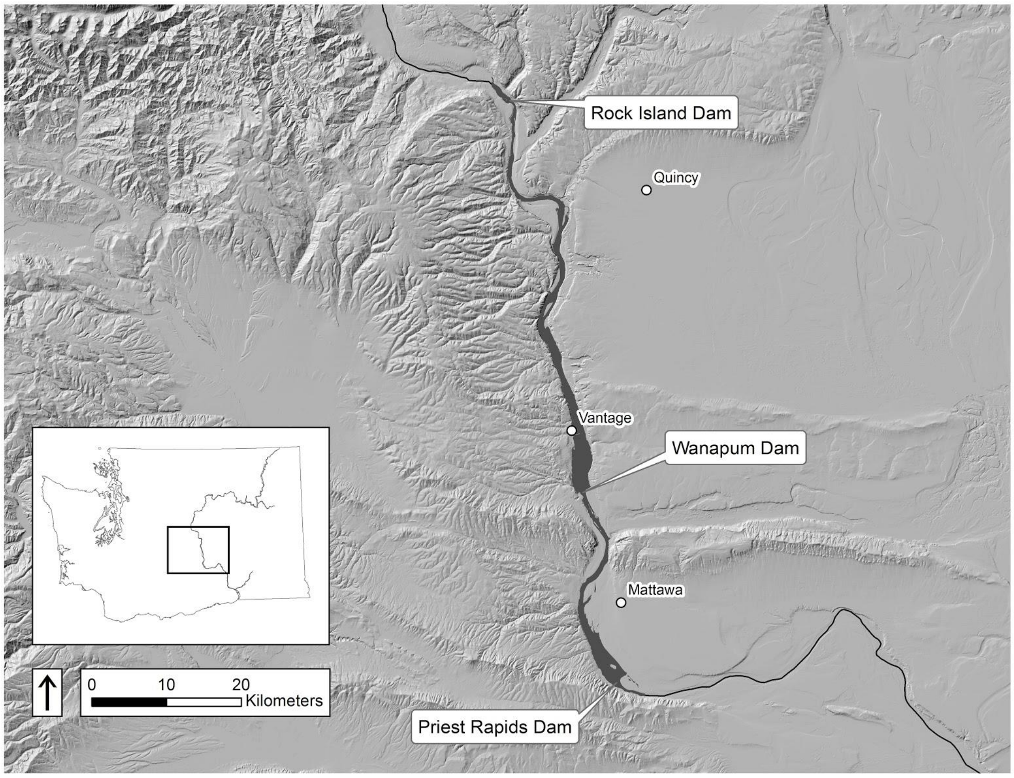


Figure 1. The project area location showing the Priest Rapids and Wanapum Reservoirs in central Washington.

Environmental Context

The project area is located within the central western portion of the Columbia Basin physiographic province (Figure 2). The Columbia Basin is an intermontane basin situated between the Cascade Range on the west and the Okanogan Highlands to the north. The Columbia Basin is bounded by, the Bitterroot Mountains of Idaho to the east and south by the Blue Mountains in Oregon (Bruce et al. 2001). The basin is an area of high relief that includes undulating hills, moderately high ridges, and areas of steep

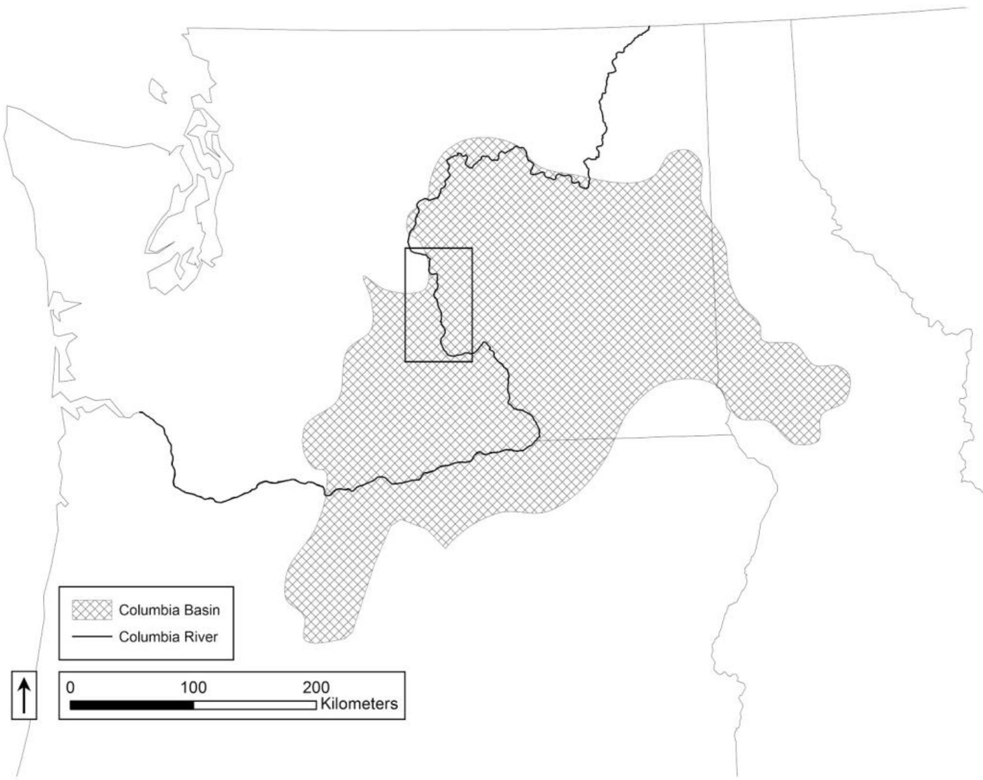


Figure 2. Map showing the general location of the Columbia Basin (shaded area) and project area (within box).

slopes, isolated basaltic buttes, and deep canyons. Elevations range from 100 meters above sea level around the Columbia River, to ridges over 600 meters high (Franklin and Dyrness 1973). The project area lies within the rainshadow of the Cascade Mountains and is the driest part of the Columbia Basin (Bruce et al. 2001). Climate data recorded in the vicinity of Quincy for the period of March 1, 1941 to June 7, 2016 reports average annual precipitation was 19.76 cm (7.78 in.), occurring mostly in the winter. Average annual temperatures fluctuated from 3.4℃ (38.2°F) to 16.6℃ (61.9°F) (Western Climate Research Center 2017).

Within this portion of the Columbia Basin, the topography of the Columbia River Valley consists of a deeply incised channel. The west bank is characterized as steep mountainous terrain deeply incised with numerous drainages. The east bank is more varied, bounded by steep cliffs and high rocky benches in the north but slowly changing to a broad open valley at the southern end of the project area. Only a few large drainages enter the valley from the east. North to south these include Moses Coulee, Crater Coulee, Potholes Coulee, Frenchman Coulee, and Crab Creek Coulee. Several southeast trending ridges provide spectacular topographical relief through the project area. They included the low rounded Frenchman Hills, and the anticlinal structures of the Saddle Mountains and Umtanum Ridge. Elevations within the project area, along the floodplain, range from the 122 meters below Priest Rapids Dam to 183 meters near Rock Island Dam (Bruce et al. 2001).

The Columbia River floodplain was a vastly different place before hydroelectric development. The pre-dam Middle Columbia River Valley funneled the largest combined volume of water draining from the United States to the Pacific Ocean (Bruce et al. 2001). The river course was marked by a series of rapids and mid-stream islands formed by erosion resistant basalt. Rapids were significant locations historically as they impeded the movement of spawning salmon and facilitated harvesting (Hunn 1990). The most prominent of these rapids was the now submerged Priest Rapids (Greengo 1986). Consisting of a series of seven cataracts that extend for about seven miles above the present dam location, Priest Rapids was a one of the more significant historic fisheries in the region (Hunn 1990; Relander 1956). Nixon and Cabinet Rapids in the vicinity of Moses Coulee, Quilomene Rapids below West Bar, Island Rapids below Whiskey Dick Creek, and Cohasset Rapids near Sand Hollow in the Wanapum Reservoir, were also significant rapids within the project area and formed focal points for intensive riverine resource procurement (Greengo 1986).

Greengo (1986) examined whether there was a significant association with the locations of rapids and various site types. He anticipated that fishing sites would be more likely located by rapids, where salmon could be taken more easily. Contrary to his assumptions, he found no apparent association between rapids and any of the site types he examined. He concluded, historically, salmon were so abundant they could be caught easily anywhere along the river. Building on Greengo's (1986) work, Johnson (2013) performed a statistical analysis of 118 habitation sites to determine if they are clustered around rapids. His results suggest habitation sites are likely correlated with three rapids; Nixon and Cabinet Rapids in the northern area, and south at Priest Rapids.

Geology

Exposed bedrock within the project area was formed from numerous stratified Miocene-aged basalt flows that erupted from fissures near the Idaho/Oregon border 17 to 5.5 million years ago (Reidel et al. 2003). These flows are referred to collectively as the

Columbia River Basalt Group (CRBG) and consist of around 300 individual flows that vary in thickness from inches to hundreds of feet thick (Reidel et al. 2003). Sedimentary deposits comprising the Ellensburg Formation intercalated with these flows provides evidence of lakes and marshlands that developed between successive eruptions. Exposed portions of these sedimentary deposits provided people of the region with material to create flaked tools (Bruce et al. 2001).

Beginning approximately 10 million years ago, the landscape encompassing the project area went through periods of folding and faulting under north-south directed compression creating a series of anticlinal ridges and synclinal valleys with northwest to southeast structural trends. This structural region is referred to as the Yakima Fold Belt subprovince and covers some 14,000 m^2 (Reidel et al. 2003).

The project area was further shaped by numerous Pleistocene floods originating from erupted ice dams that impounded Glacial Lake Missoula in eastern Montana. These successive floods had the effect of deeply scouring canyons and then depositing giant river bars of cobble and gravel, as well as slackwater sands and silts (Atwater 1986). Evidence for at least 89 flood outbursts, dating between 40,000 and 13,000 years ago, indicates there were changes in the frequency and erosive power of the floods (Atwater 1986; Benito and O'Connor 2003). Once exposed by the scouring action of the Pleistocene floods the basalt cliffs were susceptible to mass wasting that formed the deposits of coarse material ideal for constructing talus pits.

Talus Landforms and Talus Pits

Talus is a slope landform that exists below a cliff or rock outcrop (see Figure 3). However, the term talus and scree are often used interchangeably to describe both the deposit and the material that comprise it (Ritter et al. 2011). Talus form is defined by its planview and profile shape. Selby (1982) categorizes talus into three general forms of deposits: simple talus slopes, talus cones, and compound talus slopes. Simple talus slopes have a more or less uniform surface along an entire wall resulting from a uniformly retreating rock face and are generally rare. More often are talus cones that form below dissections or gullies formed in a selectively weathered rock face or mountain side. Talus cones that coalesce laterally form compound talus slopes. Additionally, long tongues of debris can form from high energy events such as rockslides, and rock avalanches (Rapp 1960). The talus accumulation, regardless of form is referred to as the talus mantle (Selby 1982).

The supply of material to talus slopes is controlled by weathering along mechanical discontinuities in the cliff rock, predominantly by features such as joining, bedding, and foliation; the size and shape of material in talus is dependent on the characteristics of the parent cliff rock (Ritter et al. 2011). In the case of the Columbia Basin, talus material varies depending on the portion of the flow (entablature, columnar, vesicular) and the specific basalt flow that is eroded (Powell and Powell 2001).

Most talus studies focus on periglacial and high mountain landforms located in alpine settings (Akerman 1984; Rapp, 1960). Studies have compared talus development in arid environments (Albjar et al. 1979) and by different meteorological factors (Akerman, 1984). Albjar et al. (1979) observed differences in talus forms between arid and periglacial settings related to slope profile, particle shape-transport relationships, particle size, and orientation. Arid talus slopes were irregular to concave while periglacial examples were convex. Higher alluvial activity in the past possibly transported finer debris away from talus slopes (Albjar et al. 1979). Particle size decreased downwards (towards toe) in arid talus slopes while periglacial talus slopes it increased downwards suggesting that they are formed by more of a fall type transport. Although particle form was heavily dependent on parent bedrock, the orientation of particles within arid talus slopes suggests they are little influenced by creep movement or fall sorting but more influenced by alluvial processes; this is converse to periglacial talus slopes that are greatly influenced by creep movements in its upper part and are sorted by fall movement (Albjar et al. 1979).

Talus slopes within the Columbia Basin tend to be concave in profile where talus pits are located. Material in talus slopes exhibit gradation with finer materials located towards the toe (Powell and Powell 2001). Akerman (1984) notes differences in rockfall magnitude and material size between east and west facing slopes exposed to different amounts of sun exposure. West slopes have high frequency low magnitude pebble and rock fall while the east side has lower frequency but higher magnitude rock falls and debris flows. However, within this portion of the Columbia Basin, talus slopes rarely exhibit a difference based on exposure (Karl Lillquist, personal communication, 2012).

Talus slopes along this portion of the Columbia River are only as old as the last Pleistocene flood that passed through the area. The scouring effect of the floods would have transported existing talus downstream leaving the coulees with clean sides (Powell and Powell 2001). Relative dates may be able to be assigned to talus slopes across portions of the channeled scablands because the Pleistocene flood waters travelled different channels at distinct times. Since talus material continuously accumulates over time through weathering, one can compare the height of talus slopes relative to the channel's cliff faces (Soennichsen 2008). For example, if in two distinct channels talus slopes were each half the height of the two channel's cliff faces then they likely would be about the same age (Soennichsen 2008:87). It is certainly likely that talus development since the floods blocked entrances to some of the oldest caves and rockshelters (Bruce et al. 2001; Greengo 1982) and destroyed older pits, if they existed.

Talus pits are also constructed in many of the alluvial fans found within the project area. Alluvial fans are some of the most extensively investigated landforms, particularly within arid environments (Ritter et al. 2011). They develop at the mouths of steep drainages and canyons and represent the lower end of an erosional-depositional system in which debris is transferred from one portion of the watershed to another (Ritter et al. 2011). Alluvial fans are broad, fan shaped and symmetrical in plan view.

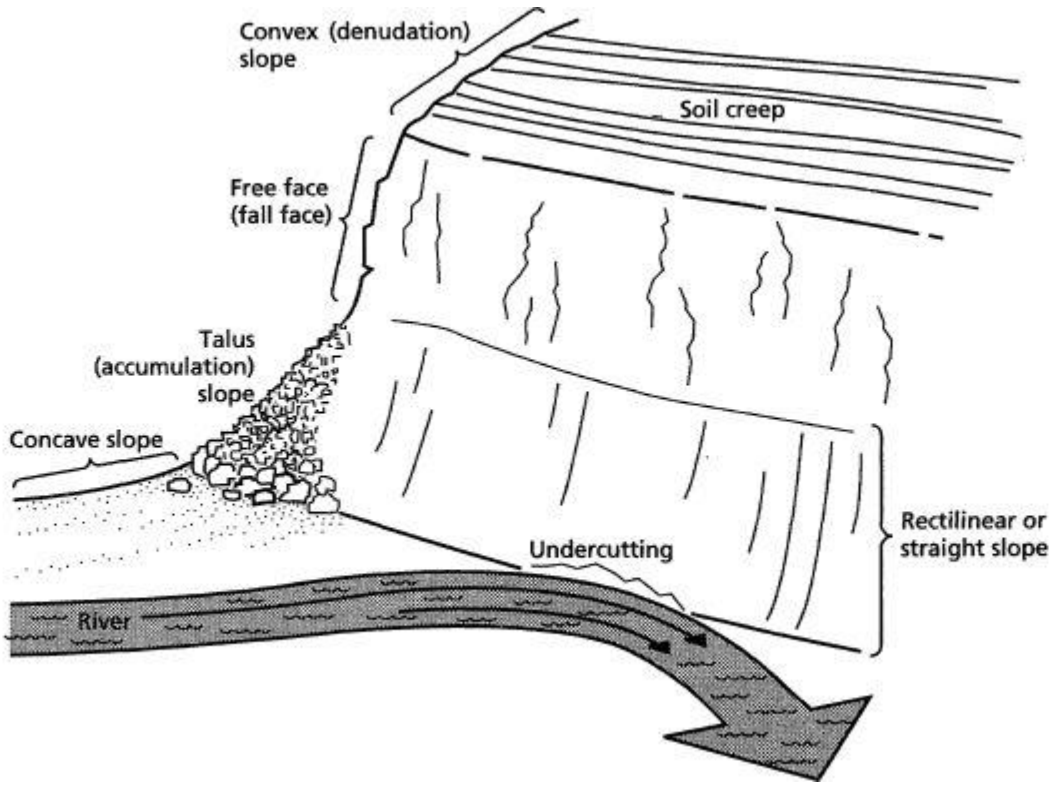


Figure 3. Conceptual diagram of a talus slope. Adapted from Prezi (2017).

Within the project area, alluvial fans developed in the Holocene after the last of the Missoula floods and were hospitable places for temporary habitation (Bruce et al. 2001). Greengo (1986) examined the association of archaeological sites with alluvial fans between the two reservoirs. He noted that there are more tributaries with alluvial fans, both absolutely and relatively, in the Wanapum Reservoir than in Priest Rapids Reservior: 22 as compared to 6. Wanapum has .58 fans per river mile, while Priest Rapids is much less dense at .33 per river mile. Seven (24%) of the Priest Rapids camps are associated with fans, and there are fourteen (41%) in Wanapum. However, because of the greater density of camps in Priest Rapids, he observed no significant difference between the two reservoirs in the number of camps on fans (Greengo 1986).

Cultural Context

The study area was settled by both Middle Columbia River Salish and Sahpatin speakers (Ruby and Brown 1992; Schuster 1898; Spier 1936; Teit 1928). The Columbia are Interior Salish speakers who have both cultural and linguistic similarities to the Wenatchi, Chelan, and Methow. The Wanapum are Sahaptin speakers. According to Rigsby (1965), the Wanapum were closest in language to the Palus (Palouse), Walla Walla, and Wawyukma. The aforementioned groups comprised the Northeast Dialect Cluster. Population estimates range from 1000 to 2,500 (120 lodges) per band. Seasonal gatherings of bands from combinations of Middle Columbia populations may have been as high as 10,000 (Ross 1904). Campbell (1989) has suggested that smallpox epidemics (ca. A.D. 1520) may have marked the beginning of pandemic diseases that decimated the Northwest. Populations were greatly reduced from estimates of the prehistoric densities along the Columbia River. Galm (1994) suggests depopulation resulted in the reorganization of societies based on kinship, marriage ties, and residential preferences forcing congregation in the most resource rich areas.

During the Historic Period significant amounts of fishing and settlement occurred along the Priest Rapids. Nonetheless, Schalk (1982) suggests that group size was smaller than in other areas and communities may have remained relatively mobile to take advantage of seasonal resources. In fact, other rapids and islands in the project area were not recorded as major fishing stations. *Lomatium* species are important as a food staple for the Wanapum people and a variety of these plants are available on the slopes and benches of the river valley and surrounding uplands (Hunn 1981, 1990; Hunn and French 1981; Hunn et al. 1998).

Chronologies for the Columbia Plateau have been compared and summarized in many studies. Table 1 includes a summary from Galm et al. (1981) for the Middle and Late Holocene, as excerpted from King and Putnam (1994:15-17). After 4000 years ago resource intensification involves storage of fish and plant resources (Ames et al. 1998). This collector system, with the exception of the use of the horse, establishes the ethnographic Columbia Plateau Pattern.

Models of Southern Plateau settlement have placed varying emphasis on several different factors that might have led to winter sedentism by 5000 or 4000 BP (Chatters and Prentiss 2005). These factors include: 1) migration of Salish speakers into the Columbia River Basin; 2) social investment in areas central to multiple resources; 3) trade; 4) improvements in salmon spawning; 5) innovative fishing technology; 6) human population growth; 7) storage technology, as well as; 8) intensification of root gathering, root storage, and root propagation.

Ames (various), Chatters (various) and Schalk (various) have debated the role of population growth, and resource intensification (roots vs. salmon) (Kimball 2005). Most now acknowledge that combinations of these factors were at work, and resulted in diverse settlement patterns. Reid (1991) was among the first to recognize that evidence of both houses and storage features were key to defining sedentary adaptations. Endacott (1992), Blukis-Onat et al. (1996) and Hicks (various) have documented storage facilities along the Snake River.

Table 1. Middle to Late Period Archaeological Phases (From King and Putnam 1994).

Phase	Description
Cascade/Vantage (8,000-4,500 BP)	Vantage Phase peoples were highly mobile, opportunistic foragers adapted primarily to riverine environments (Chatters 1986, Galm et al. 1985). Archaeological data from this phase suggests that fish had become an important subsistence resource. Archaeological sites of the Vantage Phase are generally discovered along river and stream margins. Projectile points diagnostic of this phase include large, shouldered and unstemmed lanceolate forms.
Tucannon/Frenchman Springs (4,500-2,500 BP)	The Frenchman Springs Phase is characterized by the introduction of semi-subterranean houses and the presence of specialized stations for hunting, root collecting, and plant processing. Archeologists have suggested that the ethnographic Plateau pattern emerged by the end of this phase (e.g., Nelson 1969). Several styles of smaller, contracting stemmed projectile points are diagnostic of this period.
Harder/Cayuse (2,500-200 BP)	During the Cayuse Phase, inhabitants of the Columbia Plateau wintered in large, nucleated villages of 50 houses or more (Chatters 1986). In the spring, people dispersed to gather roots, and in the fall and winter small parties established hunting stations in the uplands. This seasonal round became increasingly diverse and better organized over time, and trade with coastal groups was common. Between 500 and 200 years ago, the introduction of diseases and reduced Native American populations, and combined with the introduction of the horse, led to significant changes in the settlement and subsistence patterns of native Columbia Plateau groups (Campbell 1989).

Mid-Columbia and Wanapum peoples used dip nets but also relied on the spear, nets from boats, and fish traps (weirs) (Relander 1956). Four species were most important: chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kistuch*), sockeye (*Oncorhynchus nerka*), and steelhead trout (*Oncorhynchus mykiss*). Two other species were also important: white sturgeon (*Acipenser transmontanus*), and Pacific lamprey (*Lampetra tridentate*) (Bruce et al 2001). Chinook runs extend from spring into fall (Fulton 1968). Spring chinook runs were larger than fall chinook runs (Schalk and Mierendorf 1983). Coho ran in late August and sockeye ran in July (GCPUD 1997). Sturgeon, once anadromous, now spawn in the Hanford Reach. Lamprey over-winter in rocky areas, spawning in sandy gravel of riffles in June and July. Other resident fish included chub, whitefish, suckers, and rainbow and cutthroat trout. Two species of mussels *(Margaritifera falcate* and *Gonoidea angulata)* were abundant and important source of food during seasons of low stream flow (Bruce et al. 2001).

One of the most productive microhabitats are lithosols which support many roots and bulb bearing plants, particularly *Lomatium* (biscuit root), *Lewisa* (bitterroot), and *Allium* (wild onion). Other important microenvironments include draws and canyons where talus slopes and ground water support other important food resources: *Crataegus* (hawthorn), *Prunus* (Chokecherry), *Rosa* (rose hips), and *Amelanchier* (serviceberry).

CHAPTER III

LITERATURE REVIEW

Researchers indicate that talus pit features have been used for a wide variety of activities. Pits functioned for locations of burials (Greengo 1982, 1986; Smith 1910), for storage (Walker 1973), and for hunting and vision questing (Connolly et al. 1997; Smith 1910). The following discussion provides a summary of our current understanding of these uses and the research that led to the development of this understanding. Additionally, regional burial practices and house settlement archaeology are also discussed.

Rock Feature and Talus Pit Archaeology

Talus pits are often grouped with other structural features composed of rock (rock features). Rock features include pits and trenches, linear, and semi-circular walls, as well as mounds (Smith 1977). Researchers have devoted efforts to classify and document the associations of various types of rock features and their relationship with settlements. Smith (1977) investigated mesa sites in adjacent areas of the Columbia Basin and developed a rock feature classification that includes six general categories of structural basalt features (alignments, depressions, mounds, pits, cairns, and enclosures). Campbell (1985) categorizes sites along the Columbia River from RM 590 to the Grand Coulee Dam into two rudimentary classes of habituation sites (house villages, rockshelters, and open camps) and non-habitation sites (inhumations, pictographs, talus storage cysts, cairns, hunting blinds, and rock alignments). Chartkoff (1983) discuss six types of rock features identified in a complex of northwestern California mountains. These features include cairns, alignments, hearth rings, stone circles, rock stacks, and semicircular enclosures, referred to as *tsektsels*. Powell and Powell (2001) examined talus pit complex near Grand Coulee in eastern Washington to determine if talus pits are anthropogenic or created through natural processes. They develop criteria to distinguish between natural and human made or modified. Authors conclude that while many talus pits are created by humans, there are many geomorphic processes that can create talus pits. Kelly (2007) investigated rock cairns in eastern Washington and developed a methodological approach that included both the physical and cultural landscape. Specific cairn characteristics, including number of rocks, style of construction, and their relationships with other features on the cultural and physical landscape were recorded and classified. All of the above types of investigations have resulted in better inventory and protection of rock features as monuments.

The Mosier Site of the Lower Columbia Gorge is one of the best examples of large scale rock monument complexes and the problematic nature of their interpretation. Connolly et al. (1997:298) map and interpret the Mosier complex walls, cairns and talus pits. They interpret the monuments as securing and legitimizing the local community's place on the landscape. The purpose of the large walls at the site is not given detailed attention. Cairns and rock rings may have been stacked rock features that were dissembled or the result of excavating talus. Some twenty talus pits were documented without rock rings. After full review of archaeological and ethnographic sources, they conclude, “There appear to be several possible purposes for these constructions, including their use as cemeteries, for the training and conditioning of youths, vision quests, and hunting and food storage (Connolly et al. 1997:297).” Krieger (1927) described the Mosier Site as one of two major ‘‘rock-slide burial grounds’’ in the Columbia Gorge.

The presence of human remains suggests that mortuary practices were an important part of the function of the site as a public monument in the Late Prehistoric and Protohistoric/Historic periods. They tie the development of the larger scale monuments to the integration of regional communities with institutions supporting ranked social organization. The Mosier complex and cemetery is compared to the terraced rock-slide graves in the Yakima Valley of Washington (Smith 1910:13–14) and Teit’s (1928:127) tiered rows of rock-slide graves created by the Middle Columbia River Salish (of unspecified location). Smith (1910) notes the rock features in talus consisting of large number of shallow parallel nearly horizontal ditches below each of which is a low ridge or terrace of the angular slide rock is present (Smith 1910:140).

Talus pits possibly functioned as locations for storage of foodstuffs and other resources. Storage of provisions was a critical subsistence system of the southern Plateau (Chatters 2004). If talus features are primarily for storage, then investigating these features can add to our knowledge of resource intensification (Ames 2002; Chatters 1995;

Reid 1991). Storage in talus pits or caves outside of villages could be evidence of increased conflict within the region (Chatters 2004:75). Corn (2011) examined talus pits along the Snake River in order to test the probability that talus pits were mostly used for storage. He calculated the insolation of areas along the Snake River and compared the values of pixels. His expectations were that talus pits would most likely be located in locations with low insolation if they were used for storage. The graphic results indicate that talus pits were distributed throughout areas of low, medium, and high insolation.

If talus features more often served ritual purposes, such as burial and spirit questing, then the distributions and site configurations of pits may help us interpret cultural meanings. Ray (1939) and Strong et al. (1930) cite numerous burial types. They conclude ‘‘talus slopes and gravel banks provide the most common sites for burial in the southern Plateau.’’ Sprague (1959, 1963, 1967) and Combes (1968) have published archaeological reviews of trends in burial practices along the Lower Snake River. They observe a variety of burial practices and conclude that the only common long term pattern has been primary inhumation with grave goods. Rice (1969) has proposed that burials along the Middle Columbia and Snake Rivers shifted from primary inhumation to secondary burial and/or cremation by the climax of the Late Period. Schulting (1995) concludes researchers have under emphasized the significant diversity of different burial forms that are found in any one time period and/or locale. Secondary burials, cremation, and cairn burials occur in both the Middle and Late Prehistoric periods (Schulting 1995).

Hackenberger and Deleon (2000) compiled a database of burials for the Upper Columbia Region (n = 33) and the Southern Columbia Plateau Region (n = 104). Burial treatment was categorized as cremations, talus slope burials, pit inhumations, single inhumations, multiple inhumations, or mass burials. According to Hackenberger and Deleon (2000), the majority of all documented burial sites have Late Prehistoric Period and Protohistoric/Historic Period burials. All documented talus pit burials belong to the Late Period, or Historic/Protohistoric Period. Of the 33 burial sites on the Upper Columbia, only 2 have records of talus pit burials. Of the 104 sites on the Columbia Plateau, 16 have talus pit burials (Hackenberger and Deleon 2000). Hackenberger and Deleon (2000) also discuss burial orientation. The common orientation reported for individuals in burials is W-E or E-W (54 sites). NE-SW or SW-NE orientations (24 sites) are also reported. N-S and S-N orientations (28 sites) are not uncommon. Therefore, roughly half of the sites have burials with E-W or W-E orientations.

Talus pits and rock-ring cremations are described in Smith (1910) and Simmons (Hackenberger 2009). Smith (1910) reports “refiled” rock slide graves (3-8 feet in diameter and up to 5 feet deep) and cremations from circular charnel features/houses (up to 15 feet in diameter). He cataloged over 20 of these sites, including several he excavated. Most all features contain remains of more than one person, some remains are cremated, and most of the burials contained Protohistoric and Historic period items. Most of the sites and features he documents are in the Yakima River Basin; however, three burial sites are located in the vicinity of Priest Rapids and Sentinel Bluff. Simmons

(Hackenberger 2009) shares notes on nine Late Prehistoric or Protohistoric and Historic period cemetery sites. Two of these sites contain multiple cremations in larger charnel features. Two sites appear to represent cairn burials and two have talus pit burials. One of the later sites is described as a 4 foot diameter. “well” like feature with several individuals in sitting positions.

Seventeen sites are identified as cemeteries, burials, and/or cairns in the Wanapum Project. Only 10 such sites have been recorded in the Priest Rapids Project (Bruce et al. 2001). Greengo (1986) identified 22 burial sites in the two reservoirs and noted burials in conical depressions made by displacing boulders in talus slopes marked with upright cedar boards. One such undisturbed burial was also reported (Greengo 1986). Greengo describes the vandalism of several sites and speculated that many more talus burials are obscured by post-burial talus fall. Swanson (1962) reported talus pit burials, some with western red cedar planking, ranging from 3.2 m (10 ft.) in diameter and 1.2 m (4 ft.) deep (two with remains). He speculated that planks may have been laid across the top of pit as a cover, as well as stood up as markers. One individual was in a flexed position with heads pointed southwest (tangent to down river). Artifacts recovered from five pits include: over a dozen *Olivella* beads, iron knife blade, and eight fragments of a cord (woven cedar strips). One pit yielded several flaked tools including projectile points of yellow chert and red ochre identified (Swanson 1962:62). He attributes talus burials to the Cayuse III phase (Swanson 1956; 1958; 1962).

Archaeology of House Settlements

Studies of house settlements along the Middle Columbia River have a long history (Campbell 1950; Krieger 1928a, 1928b; Smith 1910; Swanson 1962). John Campbell (1950) in the late 1940s recorded house sites within the Priest Rapids and Wanapum areas. Holmes (1966), Nelson (1969), Solland (1967), Kidd (1964), and Greengo (1982) excavated house features in advance of the reservoirs.

The table, in Appendix A summarizes the types of information on house settlements compiled through pre-reservoir surveys and salvage excavations during the 1940s, 1950s and 1960s, as summarized from Swanson (1962) and Greengo (1982). Between the Priest Rapids and Wanapum development areas, 35 sites are large habitations or house sites and 17 of these sites have been excavated.

Nelson (1969) proposed that the intensification of winter house settlements was associated with the expansion of Salishan speaking populations from the Upper Columbia River down into the Middle Columbia River. Holmes also concluded that house occupations at the Schakke Site (45KT17) represented habitation by Salish speaking peoples (Holmes 1966). Greengo (1982) proposed stylistic preferences for some projectile points north of the Saddle Mountains may develop as the result of a Salish expansion. However, Greengo (1982) also suggested that the intensification of settlement and fishing could also have occurred in place among both Salish people and Sahaptian speaking people.

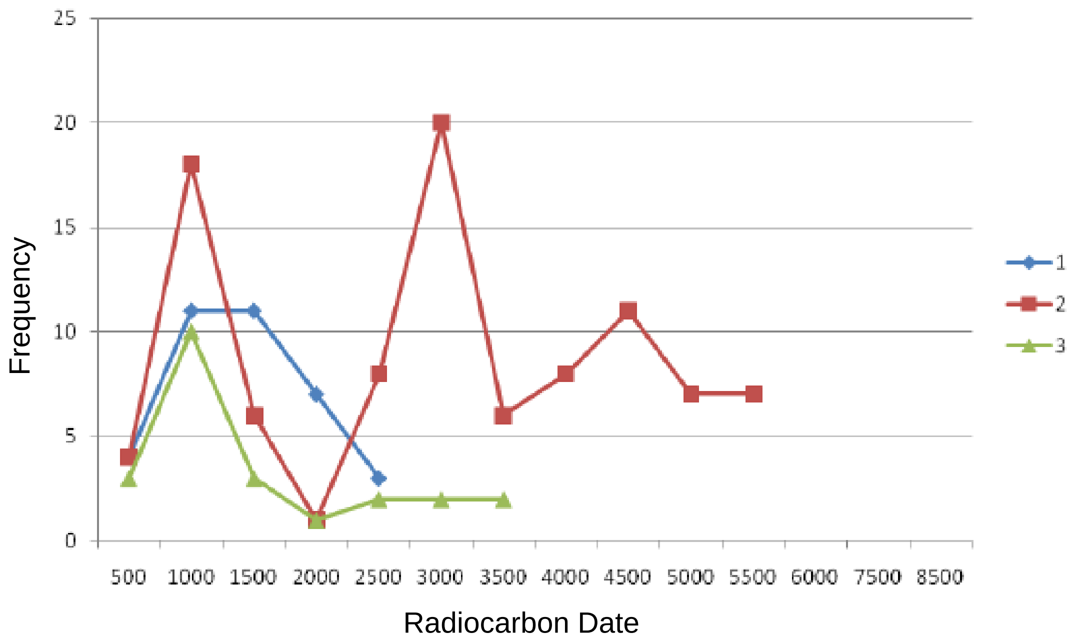


Figure 4. Radiocarbon dates from houses by 500 year intervals (Risdon 2011:Figure 13).

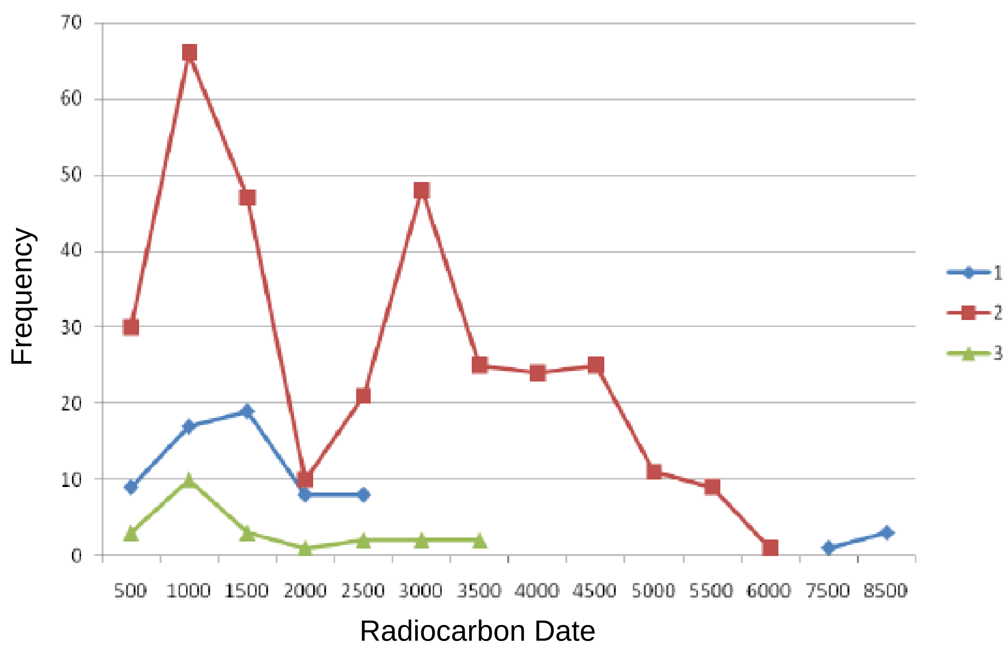


Figure 5. Number of sites with radiocarbon dates, including house dates, by 500 year intervals (Risdon 2011:Figure 14).

Risdon (2011) compared radiocarbon dates for house features for the Upper (Canada), Upper-Middle (Wells to through Lake Roosevelt) and Middle Columbia River (Wanapum through Rocky Reach). Figures 4 and 5 show that overall fewer sites are dated for the Middle Columbia and that within these sites house features date to 2000 to 500 years ago. Risdon (2011) concludes that these temporal patterns may reflect depopulation, settlement dispersion, and/or site preservation factors related to alluvial cycles.

Hackenberger collaborated with McGuire (2000) and Witkowski (2008) in studies of house features along the Middle Columbia River. The combination of radiocarbon dates obtained by McGuire (2000) and Witkowski (2008) strongly suggest that house occupations developed as part of the intensification of winter settlement during the Medieval Warm Period. Figure 6 shows the number of house dates with age estimates (2 sigma) that fall within 500 year periods before, during, and after the Medieval Warm Period. The majority of the dates have ranges that fall within the Medieval Warm Period and the onset of the Little Ice Age (n = 17). Some radiocarbon dates have ranges of age estimates that fall within the onset of the period (n = 8). Few date ranges fall within the onset of the Little Ice Age (n = 3).

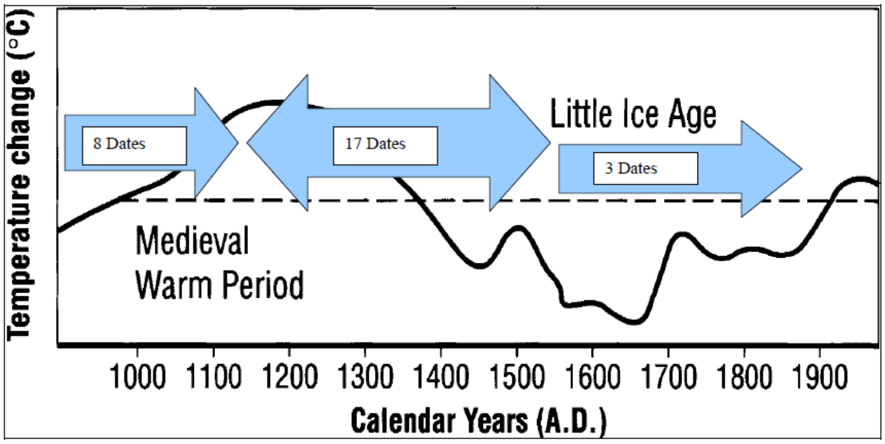


Figure 6. Post 1000 Cal B.P. radiocarbon dates overlaid with climate trends. Climate trends from Luckman (2000) (Witkowski 2008:Figure 31).

CHAPTER IV

JOURNAL ARTICLE

The student coauthored this manuscript with the committee, and it will be submitted to *American Antiquity*. The manuscript begins on the next page and will be the version submitted; the final manuscript (as accepted) may result in differences based the results of editorial and blind peer reviews.

TALUS FEATURES OF THE MIDDLE COLUMBIA RIVER: TYPOLOGICAL AND LOCATIONAL ANALYSES

Jeremy W. Ripin, Steve Hackenberger, Jennifer K. Lipton, and Katherine M. Kelly

Abstract

The form and function of talus pits in the Columbia Plateau are the subject of archaeological investigations and cultural resource evaluation and protection programs. Over 568 of these features have been documented for 48 sites within the project area of the Priest Rapids and Wanapum reservoirs. Pits may have been used for hunting blinds, storage (food and/or equipment), burial, and/or and spirit questing. A typological analysis of the form and size of pit features shows the uniformity of these features. Pits and pit sites are found in higher than expected frequencies on the west bank of the Columbia River and on northeast and southeast facing slopes. The distribution of pits by river mile for the east and west banks of the river do not correspond to changes in the elevation of the river (rapids) or the amount of talus slopes. There is only partial correspondence of talus pit sites and house sites. The locations of sites with large numbers of talus pits on east facing slopes that are closer to reported historic settlements fit with expectations that these are cemeteries. The large number of talus features, and their presumed Protohistoric/Historic period age, suggests high mortality and burial near established winter settlement locations. These few prominent cemeteries represent the strong sense of place and the respective kinship ties of the Middle Columbia and Wanapum bands.

Introduction

Rock features have wide distribution within the Pacific Northwest (Chartkoff 1983; Mack 2013; Smith 1910; Smith 1977). Rock features include pits and trenches, linear, and semi-circular walls, as well as mounds (Smith 1977). Pits in talus (talus pits), and other landforms, are found throughout the Columbia and Snake River basins (Corn 2011; Reid 1991; Smith 1910; Smith 1977). Talus pits are known to contain cremations and flexed burials, and many were marked with cedar stakes (Greengo 1982; Smith 1910). Pits in talus slopes were used for storage (Walker 1973). Several sources note the use of talus pits and rock enclosures for hunting and vision questing (Connolly et al. 1997; Smith 1910). Talus pits are found in large numbers within sites on the main stems of the Columbia and Snake rivers. Sites are known to contain upward of 75 pits; however, many sites have less than 12 pits. Talus pits are also located within the upper watersheds of tributary rivers such as the Yakima (Smith 1910), Okanogan (Campbell 1985), Clearwater, and Salmon Rivers (Roll and Hackenberger 1998).

Although it remains to be determined when, where, and how these features developed on the landscape, it is assumed that most of the features are associated with Late, or Protohistoric/Historic period settlement. Harlan Smith (1910) was the earliest anthropologist to investigate talus pits and graves (rock slide graves), along areas of the Yakima and Naches River. He also explored along the Columbia River in the vicinity of Sentinel Bluffs and the head of Priest Rapids, near the ethnohistoric settlement of *Wapixie*. According to Smith (1910) some of the rock-slide graves appeared to be older, but many are Protohistoric/Historic period based on artifacts found within them. Some remains were cremated and some buried in flexed positions (Smith 1910).

Talus pits (for storage, burial and/or questing features) are integral to the archaeological landscape of the Middle Columbia River Valley. No doubt, the more permanent settlements became the more concentrated talus pits and talus pit sites would have become. Whether the features are for storage or burial, larger number of pits would have accumulated on especially chosen landforms. Semi-permanent winter house settlements grew as populations increased and subsistence included storage of roots and fish, and/or the equipment used to capture and process these resources. As settlements became more permanent and surrounding landscapes were demarcated, burial rituals and/or vision questing would have become more localized.

This study seeks to answer four questions: 1) What types of variability are found in the size and shape of talus pits; 2) How are talus pits distributed in relationship to talus pit landforms (talus slopes and alluvial fans) on the east and west sides of the river (amount of talus, talus slope and aspect); 3) Is there a correlation between the location of rapids and talus pit sites by river mile; 4) What is the spatial relationship between talus pit sites (number of sites and/or pits) house sites, and settlement size (archaeological and ethnohistoric)?

Investigating possible relationships between the distribution of talus pit features/sites and house settlements adds to our understanding of subsistence adaptations along the Middle Columbia River. If talus pits are primarily used for remote (off-site) storage, then their association with house settlements supports evidence for logistic strategies of collectors. If talus pits are primarily used for burial, or other ritual purposes, then their distribution can help interpret cultural landscapes. These interpretations may pertain to the meaning of death, and/or relationships between neighboring communities. It is valuable for the data to be reviewed and compiled using techniques and methods that give context for evaluation of site (historic property) types and integrity. Ecological theory and landscape perspectives build frameworks for evaluating the scientific and cultural significance of otherwise enigmatic talus features and sites.

First, the significance of the Middle Columbia River Valley as a locus of social activity and aggregation among the Salish and Sahaptin of the southern Columbia Plateau is discussed. Talus pits are often recorded during archaeological investigations within the Middle Columbia River Valley (Campbell 1950; Freiberg 1997a, 1997b; Greengo 1982; Hackenberger 2003). However, at this time, there are no studies that examine the distribution of talus pits across the landscape. These features form the dataset for this analysis. Finally, the implications of how talus pits fit into the built landscape of the Middle Columbia River are considered.

Study Area: Middle Columbia River Valley

For the purposes of this project the Middle Columbia River Valley is defined as the land adjacent to the Columbia River from the Rock Island Dam south to the Priest Rapids Dam (Figure 7). This area includes portions of the Priest Rapids Hydroelectric Project (PRHP), consisting of two hydroelectric dams (Wanapum and Priest Rapids). The

PRHP is managed by the Grant County Public Utility District under license from the Federal Energy Regulatory Commission (Grant County Public Utility District [GCPUD] 2010). Topography varies across the project area. The west bank is characterized as steep mountainous terrain deeply incised with numerous drainages.

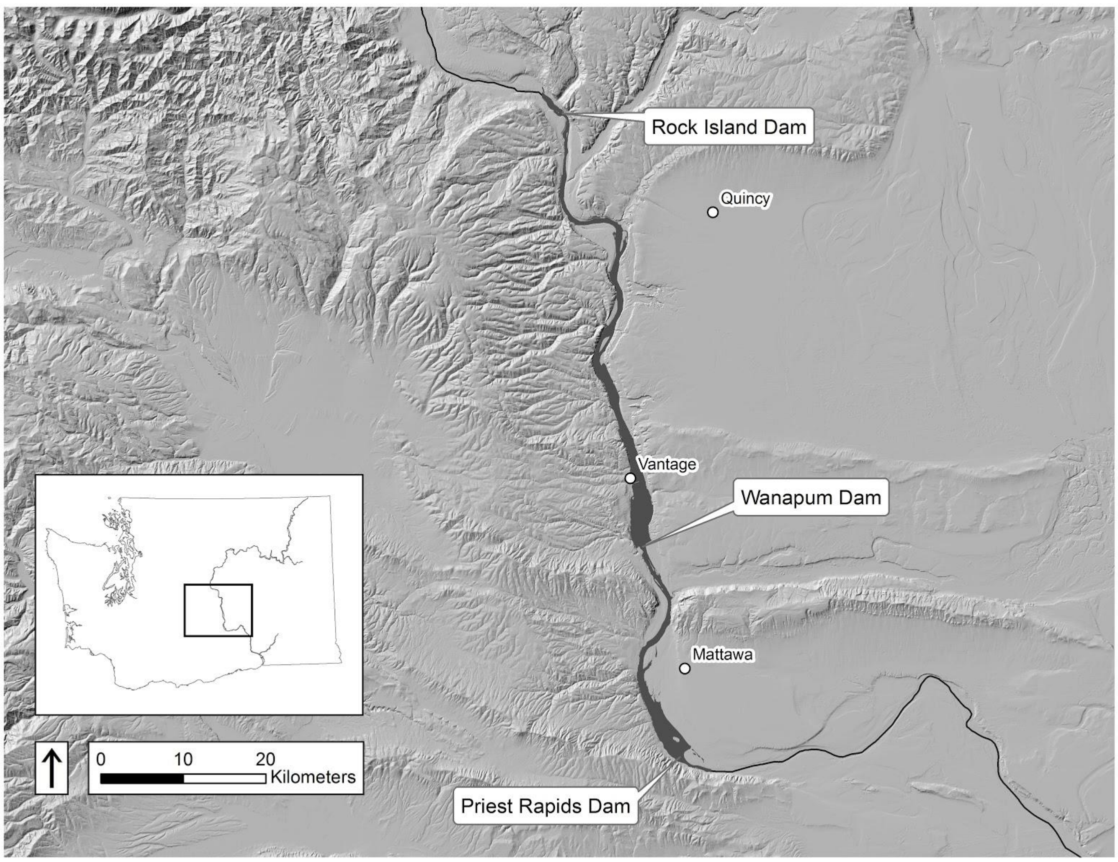


Figure 7. The project area location showing the Priest Rapids and Wanapum Reservoirs in central Washington.

The east bank is more varied, bounded by steep cliffs and high rocky benches in the north, but gradually changing to a broad open valley at the southern end of the project area. Only a few large drainages enter the valley from the east. North to south these include Moses Coulee, Crater Coulee, Potholes Coulee, Frenchman Coulee, Crab Creek Coulee. Several southeast trending ridges provide spectacular topographical relief through the project area. They included the low rounded Frenchman Hills and the anticlinal structures of the Saddle Mountains and Umtanum Ridge. Elevations within the project area range from 122 meters below Priest Rapids Dam to 183 meters near Rock Island Dam along the floodplain. Elevations rise to more than 610 meters on the Saddle Mountains and Umtanum Ridge (Bruce et al. 2001).

The project area lies within the rainshadow of the Cascade Mountains and is the driest part of the Columbia Basin (Bruce et al. 2001). Climate data recorded in the vicinity of Quincy for the period of March 1, 1941 to June 7, 2016 reports average annual precipitation was 19.76 cm (7.78 in.), occurring mostly in the winter. Average annual temperatures fluctuated from a low of 3.4℃ (38.2°F) to a high of 16.6℃ (61.9°F) (Western Climate Research Center 2017).

The Columbia River floodplain was a vastly different place before hydroelectric development. The pre-dam Columbia River Valley funneled the largest combined volume of water draining from the United States to the Pacific Ocean (Bruce et al. 2001). The river course was marked by a series of rapids and mid-stream islands formed by erosion resistant basalt. Rapids were significant locations historically as they impeded the movement of spawning salmon and facilitated harvesting (Hunn 1990). The most prominent of these rapids was the now submerged Priest Rapids (Greengo 1986).

Consisting of a series of seven cataracts that extend for about seven miles above the present dam location, Priest Rapids was a one of the more significant historic fisheries in the region (Hunn 1990; Relander 1956). While rapids were ethnographically documented fisheries, within the project area there is little direct archaeological evidence for rapids being preferentially selected (Greengo 1986; Johnson 2013).

Studies of house settlements along the Middle Columbia River have a long history (Campbell 1950; Krieger 1928a, 1928b; Smith 1910, Swanson 1962). John Campbell in the late 1940s recorded house sites within the Priest Rapids and Wanapum areas (Campbell 1950). Holmes (1966), Nelson (1969), Solland (1967), Kidd (1964), and Greengo (1982) excavated house features in advance of the reservoirs.

Radiocarbon dates for excavated house features suggest that winter settlement intensified from the middle to the end of the Medieval Warm Period. Few house occupations have been dated for the Little Ice Age (McGuire 2000; Witkowski 2008). This may be due to fewer houses, the transition to lodges with less obvious floor depressions, or factors affecting house preservation (McGuire 2000; Witkowski 2008).

Several large scale rock feature complexes have been reported, often containing burials (Connolly et al. 1997; Smith 1910). The Mosier Site of the Lower Columbia Gorge is one of the best examples of these and the problematic nature of their interpretation. Connolly et al. (1997) map and interpret the Mosier complex walls, cairns and talus pits. They interpret the monuments as securing and legitimizing the local community's place on the landscape. They tie the development of the larger scale monuments to the integration of regional communities with institutions supporting ranked social organization (Connolly et al. 1997). After full review of archaeological and ethnographic sources, they conclude that the features possibly served many different functions including their use as cemeteries, for the training and conditioning of youths, vision quests, and hunting and food storage (Connolly et al. 1997:297). The presence of human remains suggests that mortuary practices were an important part of the function of talus pits.

Talus pits possibly functioned as locations for storage of foodstuffs and other resources. Storage of provisions was a critical subsistence system of the southern Plateau (Chatters 2004). If talus features are primarily for storage, then investigating these features can add to our knowledge of resource intensification (Ames 2002; Chatters 1995; Reid 1991). Storage in talus pits or caves outside of villages could be evidence of increased conflict within the region (Chatters 2004:75).

Data and Methods

In order represent archaeological and environmental data within a GIS several steps were required to prepare the data for analysis. The first objective was to compile and review information collected from archaeological research projects and previous cultural resources surveys within the project area. Archaeological site data is available in the form of Washington State Archaeological Site Forms and cultural resource reports archived in Washington Information System for Architectural and Archaeological

Records Database (WISSARD). WISAARD provides a portal for information and documentation pertaining to tens of thousands of historic properties, including archaeological sites, queried through both a map and searchable database format (Department of Archaeology and Historic Preservation 2017). Talus pit and house pit site data was gathered from review of 1,240 site records within the project area compiled through work by the Smithsonian River Basin Survey (Campbell 1950), the University of Washington (Greengo 1982), and cultural resource management projects funded by the GCPUD (Freiberg 1997a, 1997b; Hackenberger 2003).

The information for some 568 talus pits was recorded for 48 separate archaeological sites. This study focused on talus pit complexes represented by 3 or more talus pits. Recorded sites that contained two or less talus pits were excluded (40 pits on 33 sites; 7.6% of the total number of features). Pits found below overhangs or within rockshelters/caves were not included as the locations of such places are determined by geology. A table was created in Microsoft Excel that includes locational and descriptive information for every talus pit identified (Table 1 in Appendix B). An example is included in Table 2, below. The table includes the site number the talus pit is associated with, feature number assigned to the talus pit during recording, and the UTM coordinates, and dimensions.

Table 2. Example of Talus Pit Database.

FID	Site	Feat No.	Width (m)	Length (m)	Depth (m)	RM	Bank	Slope[a]	Aspect[a]	Elev[b]
99	45CH00613	2	2	2	0.7	448	west	33.1	116.2	185.2
100	45CH00613	3	2.3	2.3	0.5	448	west	13.8	155.7	180.4
101	45CH00613	4	0.6	0.6	0.6	448	west	32.3	130.2	180.1
102	45CH00613	5	1.8	1	0.7	448	west	16.3	91.0	176.8
103	45CH00613	6	1.6	1.6	0.6	448	west	31.0	136.9	187.6
104	45CH00613	7	3	3	1.6	448	west	16.9	154.1	188.7
105	45CH00619	23	2	1.9	1	448	west	27.0	126.6	187.4
106	45CH00619	24	1.2	1.2	0.7	448	west	33.3	118.6	188.2
107	45CH00619	4	1.1	1.1	0.7	448	west	16.2	68.0	179.8

Note: Locational data omitted.
FID = feature identification number
RM = river mile
[a] = calculated from raster data from 1 meter LiDAR DEM
[b] = elevation calculated from 1 meter LiDAR DEM

Talus pits are often recorded with other archaeological components, such as lithic scatters, and official site boundaries often include these. It should be noted that only two sites (45KT12 and 45KT68) within the project area contained both talus pits and house features. In order to better represent only talus pit sites, site boundaries for the area covered only by talus pits, were created using the Minimum Bounding Geometry tool in ArcGIS. Minimum Bounding Geometry creates a feature class containing polygons which represent a specified minimum bounding geometry enclosing each input feature or each group of input features (Environmental Systems Research Institute [ESRI] 2017a). A buffer of 5 meters was added in order to encompass talus pits along the margins. A point was created within the center of the new site boundary to represent the location of the entire site.

For the purposes of this analysis house sites are archaeological sites with reported semi-subterranean house features. Of the 28 house sites recorded, 16 sites are now inundated and 12 sites remain at or above operating reservoir levels. A table of the house sites was created in Microsoft Excel that included locational and descriptive information including the number of house features recorded (see Table 2 in Appendix B). An example is included in Table 3, below. The actual locations of individual house features were not available for all sites and the representative point corresponds to the coordinates reported on site records to locate the entire site. In most cases (26 of 28) sites reported the number of house features. A total of 118 house features were reported in site forms and survey reports. Some are estimates; however we trust the number as many of these sites were the focus of survey efforts along the floodplain prior to inundation (Greengo 1986). It is likely that many house features were eroded away by normal fluvial process, before being surveyed (Bruce et al. 2001; Campbell 1950; Greengo 1986).

Archaeological data was imported into ArcMap using the “X” and “Y” UTM coordinates to spatially reference each talus pit and house site as a point. The study area straddles two separate UTM Zones, (10 and 11). In order to create a single shapefile that contained the talus pit data across the entire length of the project area it was necessary to convert all of the coordinates into the Washington State Plane South (meter) projection using the NAD 83 Datum.

Table 3. Example of House Site Database.

FID	Site	House Features	RM	Bank
01	45GR00064	25	433	east
02	45GR00130	34	436	east
03	45GR00137	1	404	east
04	45GR00140	30	428	east
05	45KT00010	2	421	west
06	45KT00013	30	423	west
07	45KT00027a	21	435	west
08	45KT00084	7	440	west
09	45KT00085	2	440	west

Note: Locational data omitted.
FID = feature identification number
RM = river mile

Archaeological data was imported into ArcMap using the “X” and “Y” UTM coordinates to spatially reference each talus pit and house site as a point. The study area straddles two separate UTM Zones, (10 and 11). In order to create a single shapefile that contained the talus pit data across the entire length of the project area it was necessary to convert all of the coordinates into the Washington State Plane South (meter) projection using the NAD 83 Datum. A landform data layer was created to represent the two general types of landforms within the study area that talus pits are most often located in: talus and alluvial fans (Figure 8). Landforms were classified by following a set of decision rules based on morphology and geomorphic principles. Slopes, like talus deposits, range

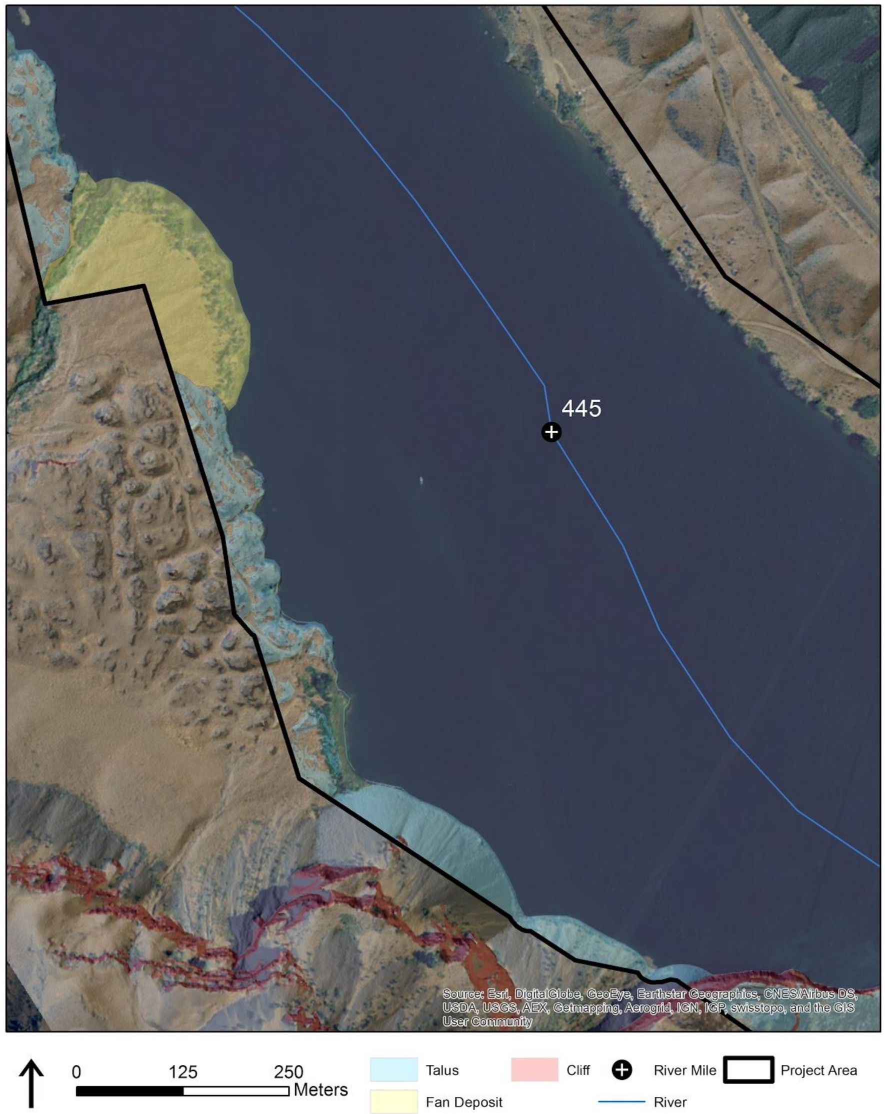


Figure 8. Detail map of project area near river mile 445. Areas classified as talus are light blue, fan deposits are yellow, and cliffs (≥ 45°) are red. Image overlaid with LiDAR derived hillshade. Aerial imagery provided by ESRI (2017b).

range from 5 to 45 degrees (Ritter et al. 2011:Figure 4.63), accumulate below cliffs or rock outcrops (Ritter et al. 2011), and are devoid of vegetation (Powel and Powel 2001). Alluvial fan deposits develop at the mouths of steep drainages and canyons below mountains areas (Ritter el al. 2011); and they are broad, fan shaped and symmetrical in plan view (Ritter et al. 2011:Figure 7.3).

Classification only took place in areas that were not inundated by the reservoirs and certainly portions of talus slopes and alluvial fans are submerged. Classification was completed within an ArcGIS 10.4.1 platform using a combination of hillshade and slope raster data derived from 1 meter resolution LiDAR digital elevation models (Mark Deleon, personal communication, 2012), as well as high resolution (0.3 to 1.0 m resolution) aerial imagery (ESRI 2017b). To create the talus landform data layer a slope raster was reclassified to only include slopes between 5 and 45 degrees. Slopes 0 to 5 degrees were considered flat; slopes 45 to 90 degrees were regarded as cliffs and were excluded.

The raster was converted to vector data (Raster to Polygon tool) to create a polygons representing only between 5 and 45 degree slopes. The polygons were then overlaid aerial imagery augmented with, a hillshade and contour lines to distinguish landforms. Using the editing function in ArcGIS, the slopes not covering talus were deleted. The alluvial fan data layer was constructed in a similar procedure however instead of removing areas over non-fan deposit areas polygons were constructed over them. Again a hillshade and contour lines were helpful in delineating alluvial fans. Once the two landform data layers were completed, they were bisected into two halves by the center line of the river; they were dissected by river mile; and clipped to fit the project area.

Site distribution was compared by river mile. River mile is an arbitrary measurement intended to facilitate pattern recognition and is often used this way when analyzing site distributions along the Columbia River (Campbell 1985; Greengo 1986). To divide the project area by river mile, we downloaded a shapefile of the river miles. A River Mile shapefile is based off of river miles plotted on United States Geological Survey 7.5 minute series topographic maps (United States Geological Survey [USGS] 2017). River miles increase from the mouth of the river to its source. In order to determine the river mile location a line was created at each river mile point, extending outward perpendicular to the centerline of the river. Not all river miles are a statute mile in length, and because the river bends sharply in a number of places, spatial units are not necessarily of equal area, but sufficient for making comparisons.

Results

The analysis of talus pits as individual features demonstrates the over uniformity of their size and shape. Patterns are found for their location by elevation and slope. By comparing the aspect of slopes with and without talus pit sites, it is obvious that slopes were chosen for talus pits with azimuths between 60 and 120 degrees (northeast and southeast facing). The distribution of talus pit sites along both banks of the river reveals an obvious preference for using talus on the west bank of the river, even when large amounts of talus are found on the east bank. Analysis of locations of talus pits and sites by river mile show limited correspondence with the distribution of talus slopes and alluvial fans, river gradient, house sites and house frequency, or ethnohistoric settlement locations.

Features by Size, Elevation, Slope, and Aspect

Talus pits range in shape from circular to oval and dimensions vary greatly (Table 4). Features range between .5 m and 4.6 m in diameter. The mean diameter is about 2 meters (Figure 9 and 10). Although field crews try to standardize measurements, some variation is probably explained by how a tape measure is positioned on the rim or inside the rim of a pit (Powell and Powell 2001). Depth of pits varies from small .1 meters to 2.6 meters deep. Mean depth is around .6 meters.

Table 4. Dimensions of Talus Pits

	Diameter* (m)	Depth (m)
Minimum	.50	.10
Maximum	4.60	2.60
Mean	1.86	.60

*diameters are the mean on length and width measurements (n = 555).

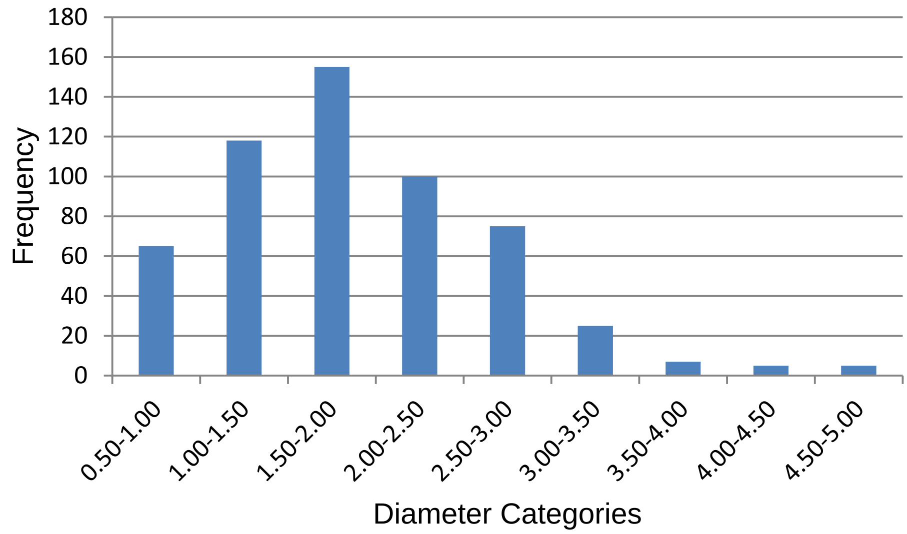


Figure 9. Histogram showing the unimodal distribution of talus pit size.

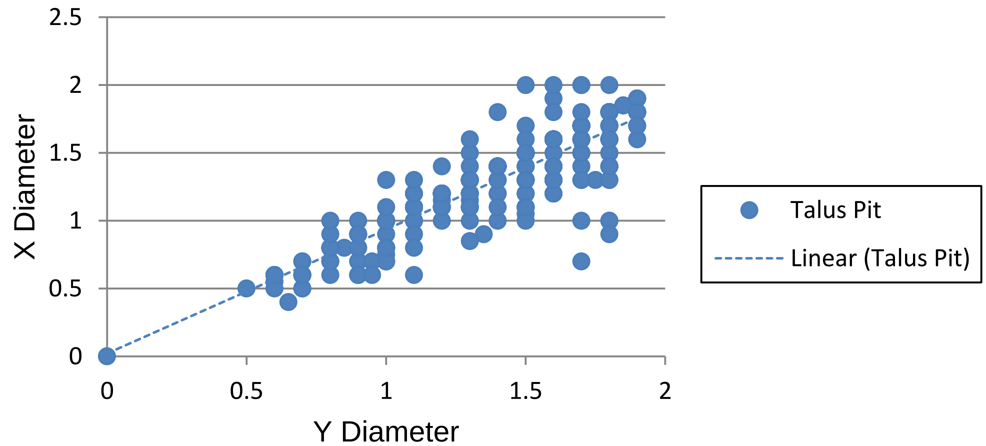


Figure 10. Scatter plot showing the uniformity of circular to oval shapes across small to large size pits. All points above or below the dotted line for the linear equations are essentially oval.

Talus pits are located between 453 ft. to 830 ft. (138 to 253 m) a.s.l., with a mean elevation of 591 ft. (180 m) a.s.l. The historic river elevation within the project area ranges from 547 ft. (167 m) a.s.l. at its northern end to 397 ft. (121 m) a.s.l. at its southern end (United States Geological Survey [USGS] 1947). This is a decrease of 150 ft. (45.7 m) over its 58 mi. (93.3 km) length. That equals approximately 2.5 ft./mi. (.7 m/km). As you can see in the Figure 11, talus pits are generally recorded about 100 ft. (30.2 m) above the historic river elevation.

We assume the assemblages of talus pit features are representative of actual distribution of the landscape, and not caused by reservoir inundation or survey bias. Certainly the reservoir has inundated some talus pits sites. However, these would be rare as most talus slopes are located above and away from the river. Furthermore, the project survey boundaries may not include all of the upper slopes of high talus. However, surveys were conducted with strategies that would allow for the inventory of most talus pit sites (Hackenberger 2003).

Talus pits (n = 567) are located on slopes ranging from 0 to 87 degrees with a mean slope of 20.5 degrees.   Approximately 97% of all pits range between 5 and 45 degrees. One talus pit was excluded as it was located within a pixel with a value of "-1" and represents a flat area.The great majority of talus pits have aspects (azimuths) towards the east. Some 381 out of 568 (67 %) talus pits are on slopes with azimuths between 30 and 120 degrees (northeast and southeast). This can be expected given that most talus pits (n = 516) are located on the western side of the river. Only 4 or .08% of talus pits face between 270 and 360 degrees. The mean azimuth of slopes with talus sites is consistent with results for individual pits. Some 29 out of 48 (60%) talus pits sites are on slopes with azimuths between 30 and 120 degrees.

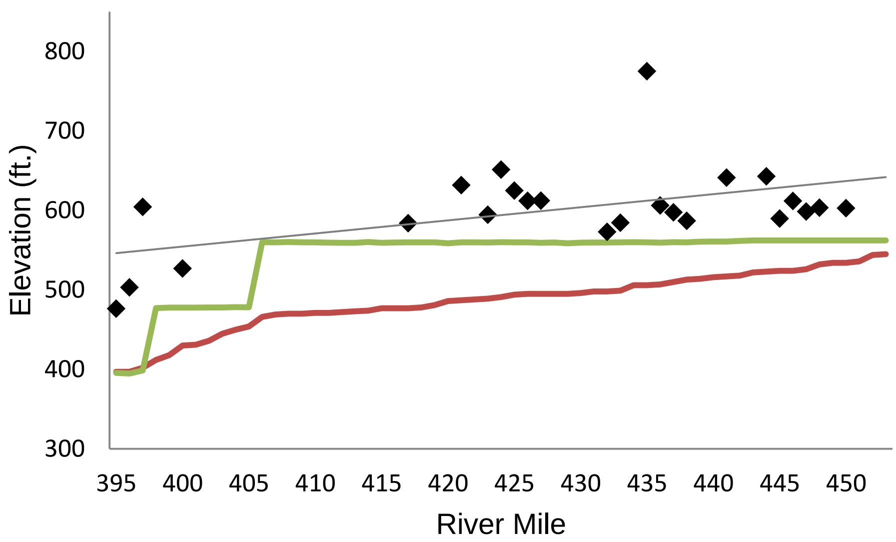


Figure 11. Mean elevation of talus pits (black) with trendline (grey) compared with the contemporary reservoir levels (green) and documented historical river elevation (red) in feet. Reservoir level data is from Columbia Basin Research (2017a, 2017b); historical river data is from USGS (1947).

The rose diagram, in Figure 12, shows that there are relatively more talus pit sites facing east as compared with random samples of talus slopes. There is a greater frequency of talus pit sites that face southeast as compared with the random sample. The rose diagram on the left shows the frequency of 48 talus pit sites by increments of 30 degrees. The rose diagram on the right shows the frequency for 50 random locations averaged across ten sampling events.

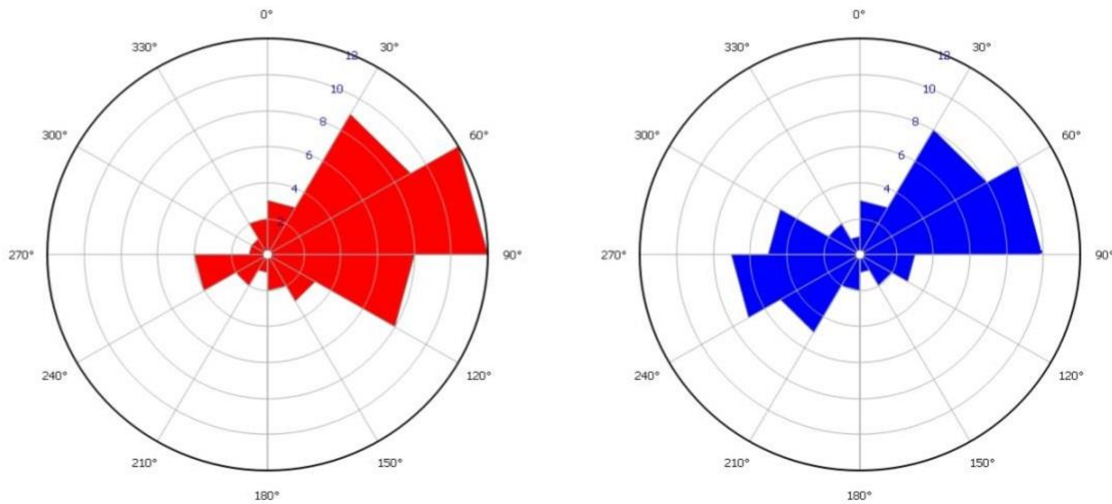


Figure 12. Rose diagram for aspect (azimuth) of 48 talus pit sites (left) as compared with average of ten rounds with 50 random sites (right). Rose diagram created with GeoRose Ver. 0.5.1 (Yong Technology 2017).

Figure 13 shows talus pit sites (n = 48) by categories of aspect (30°) in red bars. These data are compared to the distribution of randomly generated sites (n = 50) averaged across ten sampling trials in blue bars. More talus pit sights are found on aspects between 90 and 120 degrees then are generated by 10 trials with random talus locations. Fewer talus pit sites are found on aspects of 180 to 240 degrees than expected. We know there is more talus landform on the west bank and therefore more talus has an east facing aspect. However, overall talus pit sites are relatively more frequent on slopes with 30 to 90 degree azimuths than expected.

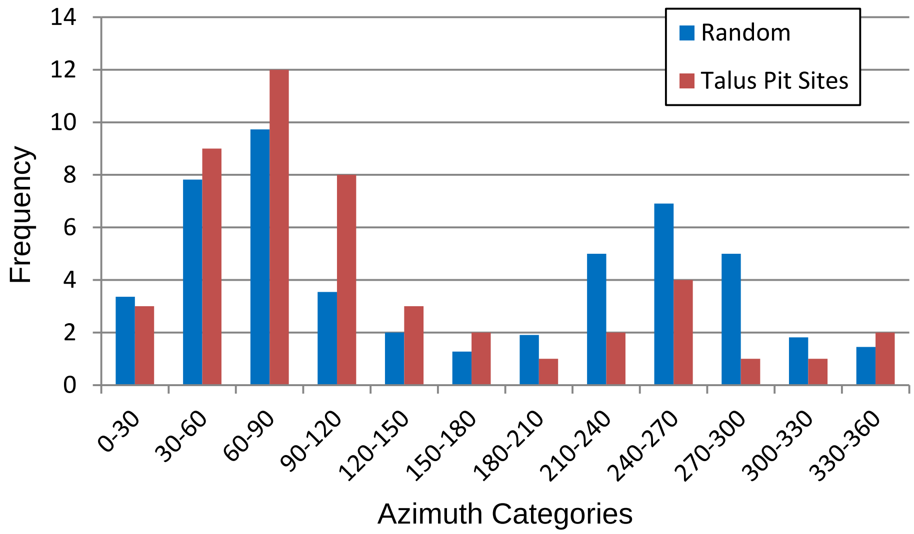


Figure 13. Histogram with talus pit sites (n = 48) by 30 degree increments of azimuth (red bars) and the distribution of randomly generated sites (n = 50) averaged across ten sampling trials (blue bars).

Locational Analyses of Talus Pits and Talus Pit Sites by River Mile

Some 516 talus pits are located on the west bank (98%) and only 52 talus pits are located on the east bank (2%). The density of total talus pits per river mile is 9.96. Total numbers of talus pits spike at river miles 396, 423, 436, and 448 (Figure 14). There are very few talus pits between river miles 401 and 420. Total talus pits do not correspond to the total surface area of talus landform or alluvial fan deposits (Figure 15) in the project boundaries as compared by river mile. Total talus pits do not correspond with drops in river elevation (rapids) (Figure 16).

The comparison of the graphs in Figure 14 through Figure 16 show that there are no overall relationships between changes in river elevation (rapids), talus pits (east and west), and/or total area of talus lands or alluvial fan deposits. However, when river mile

396 and 395 (lower Priest Rapids) are combined we can see that the drop in the river (16 feet) is associated with both more talus landforms and more talus pits (n = 79). Large numbers of talus pits (n = 208) are present between river miles 448 and 444. Here only moderate amounts of talus landform and limited amounts of fan deposit are recorded, and the river drops only a few feet in elevation (9 feet or 1.8ft./mile). Talus deposits spike dramatically at river mile 415 but there are no recorded talus pits.

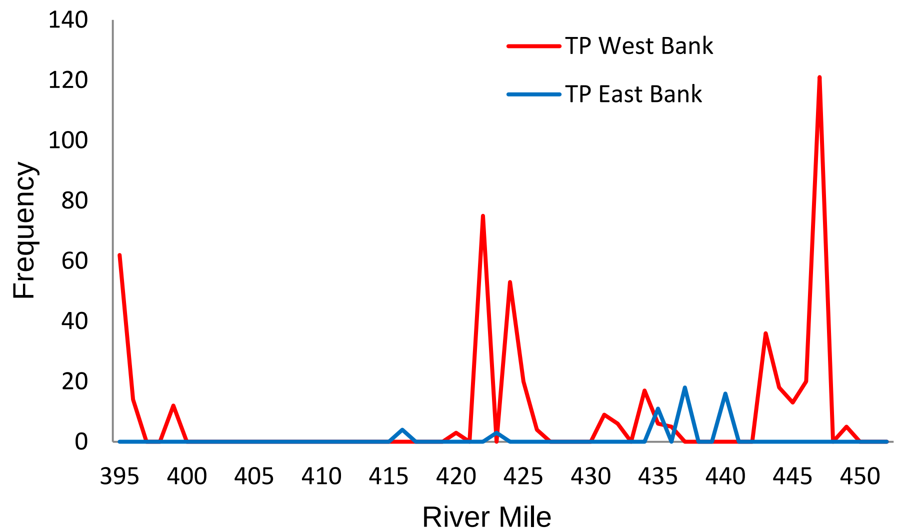


Figure 14. Total number of talus pits by river mile for west (red) and east banks (blue).

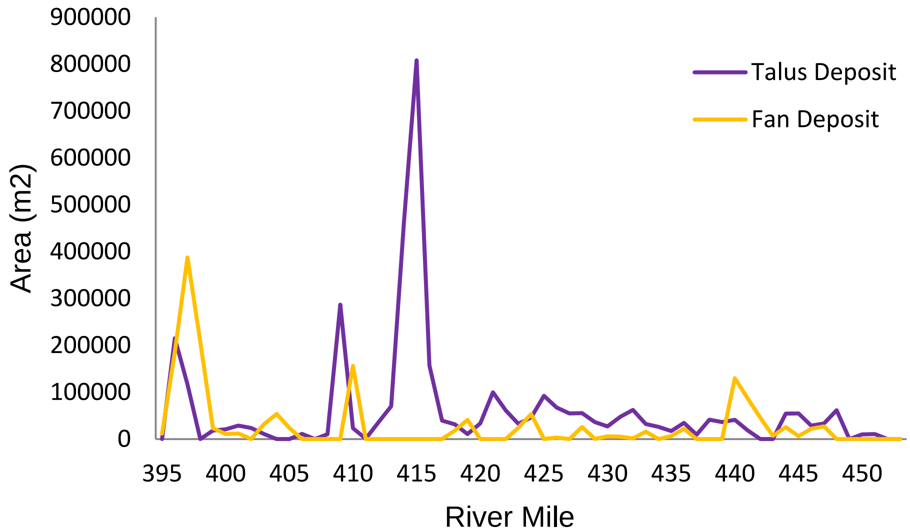


Figure 15. Total area (m²) of talus (purple) and fan deposit (yellow) landforms by river mile.

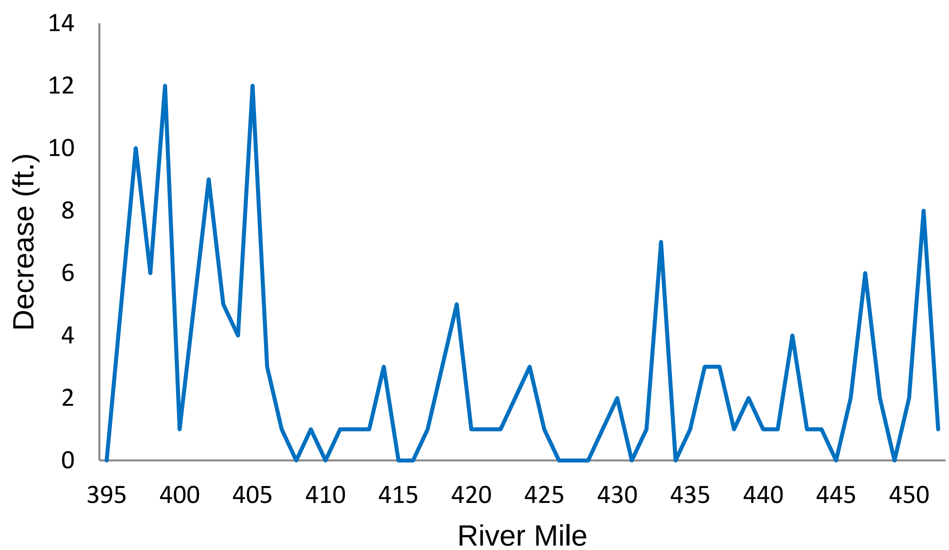


Figure 16. Change in river elevation (feet) by river mile.

Talus Pits and Settlement Locations

River maps (Figure 17), and graphs with site and feature counts per river mile (Figures 18 and Figure 19), present complicated pictures of the relationship between talus pits and house sites. The maps and graphs do not show patterns, or predictable, associations between talus pit sites and house sites.

In general, the majority of talus pit sites and house sites are located in the northern (upstream) half of the project area. Concentrations do occur along four reaches of the river. There are no recorded sites between river mile 416 and 407.

Figure 19 shows a comparison of talus pits (top) to house features (bottom) by river mile. By order of magnitude, only river miles 427 through 423 show an overlap in larger numbers of talus pits and house features. In this stretch most of the talus pits are on the west bank and the house features are located on both banks and the river only drops a few feet.

A comparison of graphs (Figures 14 - 19) do not reveal obvious relationships between total house features, talus pits (east and west), and/or total talus landform or fan deposits. There are also no apparent relationships with changes in river elevation (rapids).

Points to point measurements were made in GIS for the distance between house sites and talus pit features. These measures were made up and down and/or across the river. Figure 20 shows the number of talus pits that fall within distance intervals of house sites. Some 99% of talus pits are located within 4 kilometers of one or more house sites.

Only 62% of talus pits are within one kilometer of a house site. Not accounting for the sides of the river sites are located on, it appears that talus pits (93%) were typically located within two kilometers of a site with recorded house features. This assumes that archaeological sites with houses are of the same age as most talus pit features.

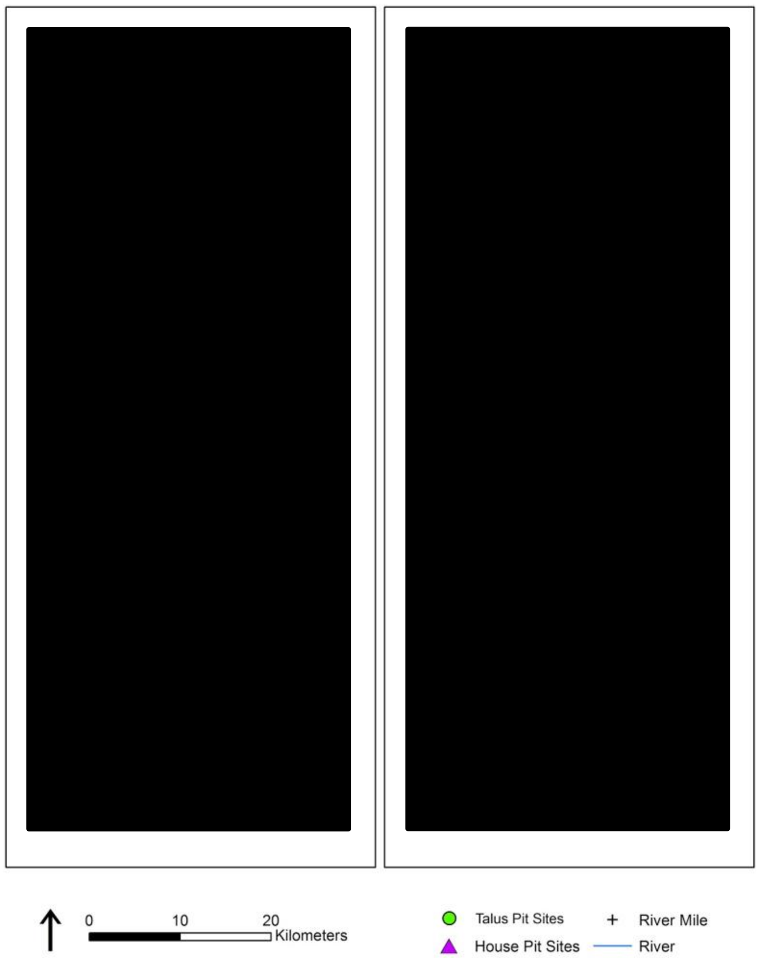
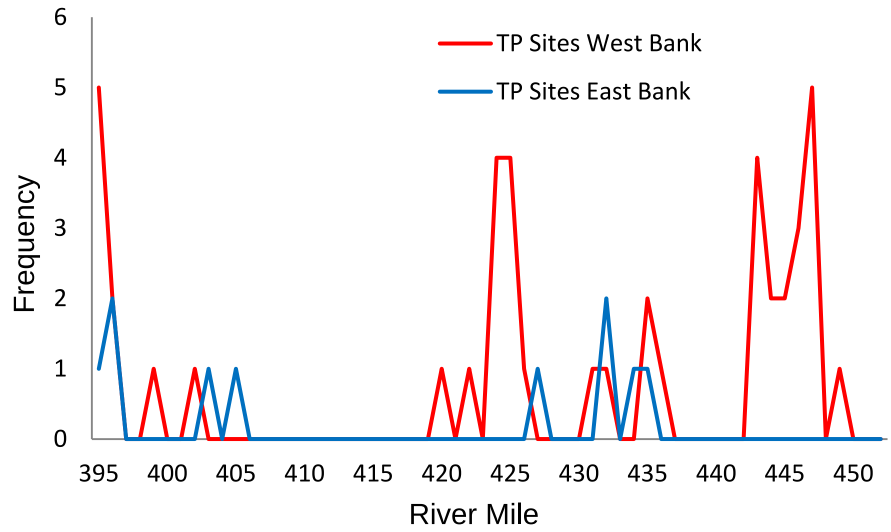


Figure 17. Maps showing distribution of recorded talus pit sites (left) and recorded house sites (right). Due to site proximity and map scale site locations may overlap. This figure will be blacked out before being published online.



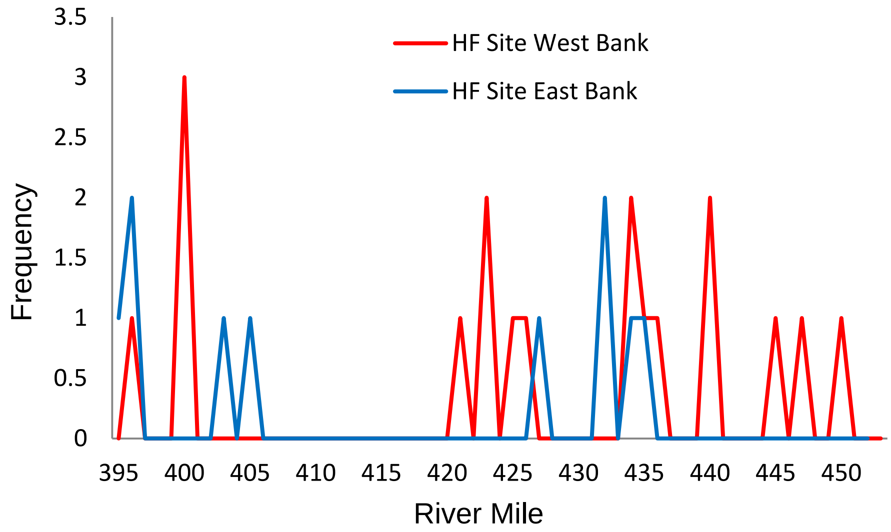
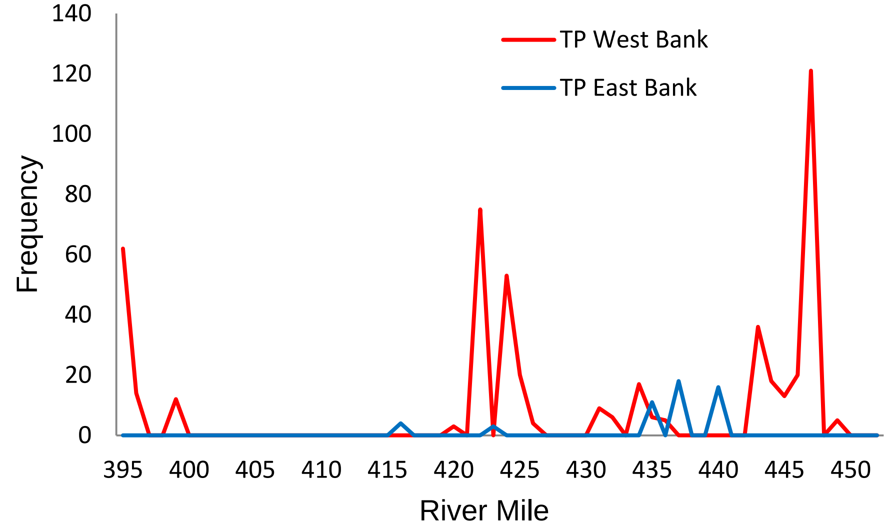


Figure 18. Total number of talus pit sites (top) and house sites (bottom) by river mile for west (red) and east banks (blue).



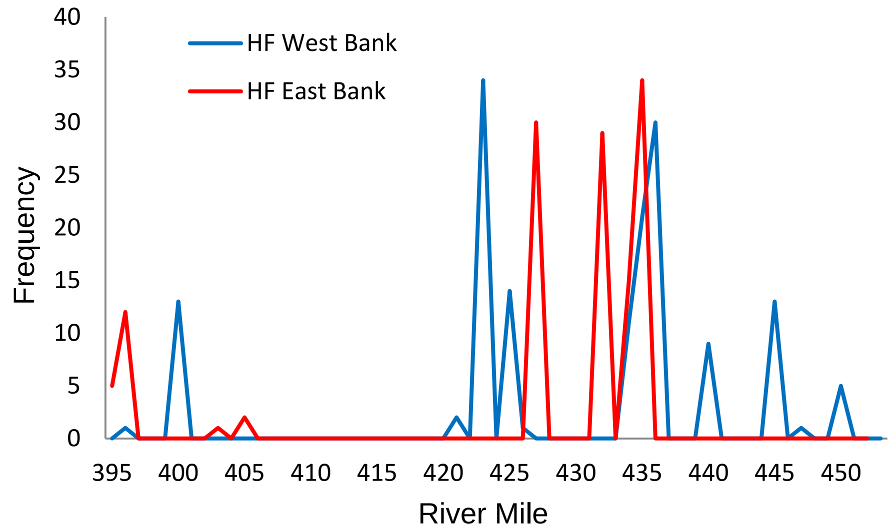


Figure 19. Total number of talus pits (top) and house features (bottom) by river mile for west (blue) and east banks (red).

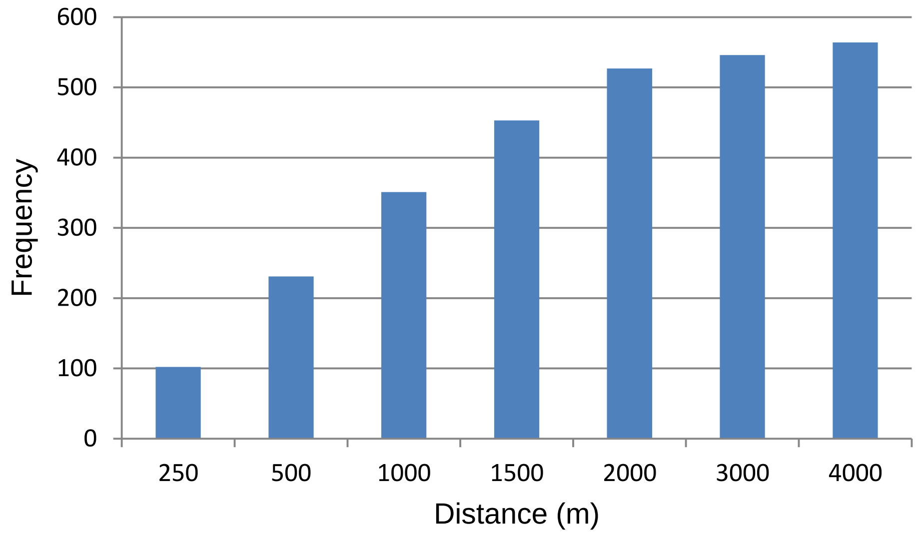


Figure 20. The number of talus pits by intervals of distance (meters) from house sites.

Figure 21 shows comparison of the total number of talus pits (top) with the rank order (1 - 4) of the ethnohistoric settlements (bottom) inventoried by Smith (1982). These are compiled from Ray (1974) but cross referenced with other sources (see Appendix C).

Large numbers of talus pits on the west bank correspond with the location of two ethnohistoric settlements, each with 100 people (Rank 2). One site is at Colockum near the talus pit sites. The Moses Coulee settlement on the east bank may be near talus pits that have not been inventoried, or the settlement location has been misattributed to an area north of the talus pits in river mile 440 to 435.

Settlements ranked between 1 and 4 and noted for river miles 415 to 405, are not associated with talus pit sites or archaeological sites with house features. This is the border area between the Columbia Band and the Wanapum Band. The stretch includes

Crab Creek and winter settlements no doubt spread up the creek, so talus features may also be located up this drainage.

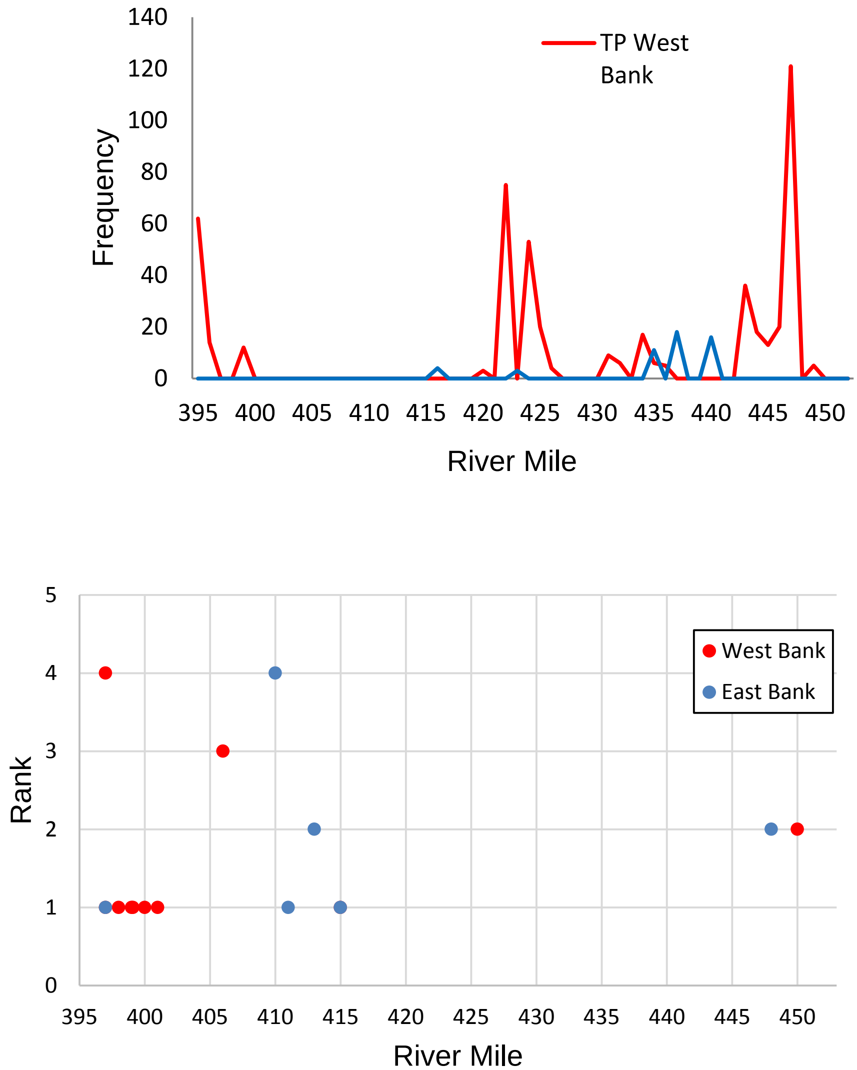


Figure 21. Total talus pits (top) compared with rank size of ethnohistoric settlements (1-4) (bottom). Settlement locations and rank sizes are estimated from Allan Smith (1982). River mile 410 (including Crab Creek) is on the border of the Columbia Band (up river) and Wanapum Band (downriver).

The largest settlement at Priest Rapids (river mile 396) is associated with higher frequencies of talus pits. This stretch of rapids also includes locations of older and newer, but lesser settlements (river mile 397 to 398). Therefore, with the noted exception of possible missing talus pit information between river miles 415 - 405, talus pit frequency seems to best correspond to ethnohistoric settlement locations.

Discussion

The results of this analysis indicate that there is an obvious preference for using talus landforms on the west bank of the river, even when large amounts of talus landforms are found on the east bank. The majority of house sites and ethnohistoric settlements are located on the west bank, but not as unevenly as talus pits. Slopes were chosen for talus pits with azimuths between 60 and 120 degrees (northeast and southeast facing). The exposure of talus pits has several implications. For functional reasons, if talus pits are used for storing fish or roots from spring over summer, then aspects with lower insolation (northeast) should be chosen. If these provisions are stored over winter, then perhaps slopes with higher insolation, or more protected and, thus drier conditions (southeast), might be preferred. However, talus pits are not concentrated around rapids, except for three instances, Nixon and Cabinet Rapids in the North, and Priest Rapids in the south. From a ritual perspective, if pits are located to face azimuths of the rising sun in summer and or winter, then northeast and southeast slopes should be chosen. This practice may link with preferences for burial orientation and/or spirit questing.

Analysis of locations of talus pits and sites by river mile show limited correspondence with the distribution of talus slopes and alluvial fans. Areal estimates of talus landforms was included in an attempt of quantify greater areas where talus pits can be expected. Not all areas classified will be suitable for talus pits construction. Additionally, not all river miles are full statue miles since the river has many bends along its course. River mile unit sizes will vary; however, overall patterns should still be present.

Distributions of talus pits, talus sites, house features, house sites, and ethnographic villages do not exhibit strong correspondence. However, the archaeological sites (talus pits and house features) are concentrated at both ends of the project area and site frequency drops between river miles 416 and 407. Ethnographic settlement locations are fewer and the gap between up river and down river locations is larger (between river miles 448 and 416).

Conclusions

Our typological analysis of the form and size of pit features shows the uniformity of these features. Pits and pit sites are found in higher than expected frequencies on the west bank of the Columbia River and on northeast and southeast facing slopes. The distribution of pits by river mile for the east and west banks of the river do not correspond to changes in the elevation of the river (rapids) or the number of talus slopes. There is only partial correspondence of talus pit sites and house sites. With the exception of the middle stretch of the project more talus features, house features, and historic settlement locations concentrate on the upper (Colockum Creek-Cabinet Rapids) and lower (Crab Creek-Priest Rapids) ends of the project area.

The locations of sites with large numbers of talus pits on east facing slopes that are closer to reported historic settlements fit with expectations that these are cemeteries. The large number of talus features, and their presumed Protohistoric/Historic period age, suggests high mortality and burial near established winter settlement locations. These few prominent cemeteries represent the strong sense of place and the respective kinship ties of the Middle Columbia and Wanapum bands. More certain identification of these sites as cemeteries, on top of their past desecration, call for stronger protection and active preservation.

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APPENDIX A

Summary of House Features

Summary of House Features Reported in Swanson (1962) and Greengo (1982) From Hackenberger (2009:40).

	House features	Estimated age
E. Swanson (1962)		
45KT17 Schaake Site	23-27 houses	Swanson (1958) Houses 15, 16, 18, 22 (same numeric sequence?)
		(Holmes) Houses 15, 16, 17, 18, 19, 20, 21, 22 Vantage Phase to Historic
45KT71	1 mat lodge, 1 house	Frenchman Springs Phases I, III
The Lee Site	4 houses	Cayuse Phase III
R. Greengo (1985)		
45CH4	5 houses	protohistoric/ early historic
45GR30	1 mat lodge	
45GR41	11 houses	UW excavation 56
45GR68 Crescent Bar	2-4 houses	Solland (1967) House 1 and 2
		1250+/-70 (UW48)
45GR71	5-6 circular houses, one oval lodge?	mid -19th Century
45GR124	2 houses	1850-1870 based on military buttons
45GR126 (akaGR-73)	15 houses	1070 ± 70 (UW-38)
45GR130 (aka GR77)	29-35 houses	1715 ± 60 (UW-22)
45GR140	30 houses	no excavation
45DO6	1 house	no excavation
45KT10	1-2 houses	late prehistoric
45KT12 Whole-In-Wall	4 houses	Kidd (1964) House 4

45KT13 French Rapid	13-30 houses	Kidd (1964) 13 houses 10 pits
		House 3, 4, 10, storage pit 4 UW61
45KT16	8 houses	no excavation
45KT27	21 houses near KT28	Swanson-Solland (1967) late prehistoric
45KT28 Sunset Cr	33 depressions; 25+ houses	Solland (1967);1100+/- 65, 1170 +/- 200, 1130+/-60 (various)
45KT54	9 houses	no excavation
45KT68 Scammon	13-14 houses	no excavation
45KT70	1 house	no excavation
45KT75	1 + houses	no excavation
45KT83	2 houses	no excavation
45KT84	5 houses	no excavation
45KT85	2 houses	no excavation
45YK4	3 houses	no excavation
45YK6	2 houses	late prehistoric to historic
45YK13	1?	Historic lodge?

APPENDIX B

Talus Pit and House Site Data Used in Study

Table 1. Talus Pit Database.

FID	Site	Feat No.	Width (m)	Length (m)	Depth (m)	RM	Bank	Slope[a]	Aspect[a]	Elev[b]
0	45CH00444	1	3	2	0.8	450	west	25.8	75.8	186.4
1	45CH00444	2	1.3	1.5	0.4	450	west	29.8	63.2	182.8
2	45CH00444	4	1.5	1.5	0.5	450	west	22.6	112.2	180.7
3	45CH00444	5	1.7	1.7	0.7	450	west	29.5	153.9	182.2
4	45CH00444	3	2.1	1.4	0.5	450	west	39.6	88.0	186.5
5	45CH00442	30	1.5	1.5	0.6	448	west	17.5	85.0	185.2
6	45CH00442	1	1	0.7	0.4	448	west	19.8	95.0	184.5
7	45CH00442	2	2.1	2.1	0.4	448	west	18.3	97.6	184.9
8	45CH00442	4	2.7	2.7	0.8	448	west	16.4	101.0	185.0
9	45CH00442	5	-	-	-	448	west	23.4	99.5	184.6
10	45CH00442	12	1	1	0.4	448	west	25.3	97.9	183.4
11	45CH00442	6	1.8	1.8	0.8	448	west	18.8	92.9	184.3
12	45CH00442	7	1.85	1.85	0.8	448	west	27.9	83.9	185.0
13	45CH00442	8	1.85	1.85	0.8	448	west	21.6	88.0	184.9
14	45CH00442	9	1.1	1.1	0.6	448	west	17.6	63.5	184.5
15	45CH00442	10	0.8	0.8	0.5	448	west	17.0	82.7	184.7
16	45CH00442	11	1	1	0.3	448	west	27.7	83.6	183.4
17	45CH00442	13	1.9	1.9	0.7	448	west	22.1	94.6	183.8
18	45CH00442	14	1.6	1.6	0.8	448	west	12.8	106.0	183.1
19	45CH00442	15	2	2	0.8	448	west	20.4	104.4	182.9
20	45CH00442	16	0.9	0.9	0.5	448	west	26.8	67.2	183.0

21	45CH00442	17	1.7	1.7	0.9	448	west	21.7	82.2	183.2
22	45CH00442	18	1	1	0.6	448	west	19.3	97.6	185.8
23	45CH00442	19	2.4	2.4	0.9	448	west	22.1	127.8	185.6
24	45CH00442	24	0.7	0.7	0.5	448	west	8.5	230.4	183.8
25	45CH00442	25	1.1	1.1	0.5	448	west	9.3	254.1	183.7
26	45CH00442	20	2.1	2.1	0.7	448	west	23.6	83.3	184.8
27	45CH00442	29	1.5	1.5	1	448	west	11.0	148.7	184.7
28	45CH00442	21	1.8	1.8	0.9	448	west	28.0	114.2	185.4
29	45CH00442	22	2.2	2.2	0.9	448	west	21.9	91.8	185.0
30	45CH00442	23	1.8	1.8	0.8	448	west	27.3	107.5	185.9
31	45CH00442	26	1.2	1.2	0.4	448	west	12.1	64.2	181.3
32	45CH00442	28	1.5	1.5	0.5	448	west	8.9	96.4	179.6
33	45CH00442	27	1.4	1.4	0.4	448	west	12.5	73.6	179.5
34	45CH00442	40	1.4	1.4	0.5	448	west	13.4	205.1	180.4
35	45CH00442	41	0.8	0.8	0.5	448	west	16.1	194.5	180.4
36	45CH00442	44	1	0.8	0.45	448	west	16.1	155.1	183.2
37	45CH00442	45	1.3	1.15	0.35	448	west	26.7	157.5	182.4
38	45CH00442	46	1.2	1.15	0.35	448	west	26.7	157.5	182.4
39	45CH00442	47	0.7	0.6	0.35	448	west	18.7	155.5	181.8
40	45CH00442	48	1.5	1.05	0.35	448	west	24.5	135.0	181.8
41	45CH00442	49	1.1	0.6	0.65	448	west	24.8	137.9	181.9
42	45CH00442	50	1	0.7	0.45	448	west	18.6	97.9	181.7
43	45CH00442	51	0.65	0.4	0.4	448	west	17.3	120.9	181.1
44	45CH00442	52	1.1	1	0.7	448	west	23.2	114.5	182.2
45	45CH00442	53	0.9	0.6	0.5	448	west	21.3	117.6	182.2
46	45CH00442	54	0.9	0.6	0.35	448	west	17.0	121.0	182.0
47	45CH00442	55	1.35	0.9	0.55	448	west	13.7	116.8	182.5

48	45CH00442	56	2.4	2.4	0.5	448	west	24.3	111.7	182.5
49	45CH00442	57	0.85	0.8	0.3	448	west	1.5	188.1	183.7
50	45CH00442	58	2.4	2.3	0.9	448	west	16.3	136.0	184.2
51	45CH00442	59	2.9	1.6	0.66	448	west	12.2	95.3	184.8
52	45CH00442	60	1.3	1.2	0.4	448	west	17.3	179.3	185.2
53	45CH00442	61	1.7	1	0.7	448	west	23.0	171.5	186.0
54	45CH00442	62	1.2	1.1	0.6	448	west	30.0	107.1	183.9
55	45CH00442	63	0.9	0.7	0.8	448	west	18.3	110.4	182.0
56	45CH00442	64	1.7	1.3	0.6	448	west	17.7	95.0	182.9
57	45CH00442	65	1.6	1.3	0.65	448	west	17.5	113.9	182.9
58	45CH00442	66	0.8	0.6	0.7	448	west	24.6	113.3	183.8
59	45CH00442	68	0.7	0.6	0.5	448	west	16.7	84.5	183.6
60	45CH00442	69	0.9	0.8	0.6	448	west	25.4	99.8	184.7
61	45CH00442	70	1.75	1.3	0.75	448	west	11.2	68.1	181.5
62	45CH00442	71	0.9	0.6	0.4	448	west	10.9	87.8	181.4
63	45CH00442	72	0.7	0.6	0.6	448	west	23.8	104.1	182.5
64	45CH00442	73	0.8	0.8	0.55	448	west	17.9	88.9	182.4
65	45CH00442	74	3.5	1.2	0.5	448	west	20.9	121.4	182.6
66	45CH00442	75	1.3	0.85	0.35	448	west	14.9	93.5	182.4
67	45CH00442	76	0.6	0.55	0.3	448	west	18.0	76.2	182.0
68	45CH00442	77	2.2	1.8	0.3	448	west	19.7	91.8	182.5
69	45CH00442	78	2.7	2.4	0.7	448	west	17.3	92.5	182.7
70	45CH00442	79	1.5	1.4	0.8	448	west	8.1	134.3	182.7
71	45CH00442	80	0.8	0.7	0.45	448	west	13.6	86.7	183.3
72	45CH00442	81	0.95	0.7	0.4	448	west	9.2	90.9	182.0
73	45CH00442	82	0.8	0.7	0.35	448	west	22.5	147.8	184.0
74	45CH00442	83	1.5	1.3	0.3	448	west	15.3	130.5	182.9

75	45CH00442	84	0.95	0.6	0.5	448	west	25.7	104.0	183.7
76	45CH00442	85	0.6	0.5	0.45	448	west	20.7	89.8	182.4
77	45CH00442	86	1	0.75	0.45	448	west	20.2	84.7	182.5
78	45CH00442	87	1.1	1	0.65	448	west	11.3	84.6	182.0
79	45CH00442	88	1.9	1.7	0.25	448	west	18.5	100.6	184.0
80	45CH00442	93	1	0.9	0.4	448	west	5.8	122.9	185.8
81	45CH00645	10	1	0.7	0.3	448	west	18.0	83.8	182.6
82	45CH00645	6	2.3	2	0.9	448	west	9.4	107.1	186.2
83	45CH00645	7	3.3	2	0.6	448	west	13.0	90.3	187.1
84	45CH00645	8	3	2.4	1.1	448	west	11.6	125.1	187.6
85	45CH00645	9	3	2.4	0.7	448	west	35.9	105.6	195.5
86	45CH00645	2	2.5	2	1.1	448	west	28.9	75.6	184.6
87	45CH00645	3	1.5	1.5	0.3	448	west	11.2	100.9	182.0
88	45CH00645	4	1.3	1.2	1	448	west	19.0	59.0	184.9
89	45CH00645	5	1.9	1.6	0.8	448	west	3.5	104.0	184.9
90	45CH00645	1	2.9	1.8	1	448	west	28.5	68.4	183.3
91	45CH00642	6	0.9	0.9	0.6	448	west	31.4	140.0	181.2
92	45CH00642	3	2	2	0.3	448	west	15.2	107.4	183.8
93	45CH00642	4	2.7	2.4	0.7	448	west	35.8	105.4	185.3
94	45CH00642	5	1.4	1.4	0.4	448	west	26.6	100.2	189.3
95	45CH00613	1	2.1	1.6	0.7	448	west	34.0	103.7	183.1
96	45CH00613	2	2	2	0.7	448	west	33.1	116.2	185.2
97	45CH00613	3	2.3	2.3	0.5	448	west	13.8	155.7	180.4
98	45CH00613	4	0.6	0.6	0.6	448	west	32.3	130.2	180.1
99	45CH00613	5	1.8	1	0.7	448	west	16.3	91.0	176.8
100	45CH00613	6	1.6	1.6	0.6	448	west	31.0	136.9	187.6
101	45CH00613	7	3	3	1.6	448	west	16.9	154.1	188.7

102	45CH00619	23	2	1.9	1	448	west	27.0	126.6	187.4
103	45CH00619	24	1.2	1.2	0.7	448	west	33.3	118.6	188.2
104	45CH00619	4	1.1	1.1	0.7	448	west	16.2	68.0	179.8
105	45CH00619	5	1.1	1.2	0.7	448	west	15.2	96.9	180.3
106	45CH00619	6	2	2	0.6	448	west	19.3	151.1	182.0
107	45CH00619	7	0.8	0.8	0.7	448	west	11.3	125.9	181.7
108	45CH00619	8	1.8	1.6	0.6	448	west	19.1	108.7	184.3
109	45CH00619	9	2	1.8	1	448	west	22.7	136.0	185.0
110	45CH00619	10	1.8	1.7	0.5	448	west	30.4	147.2	185.8
111	45CH00619	11	1.8	1.4	0.8	448	west	17.2	130.1	185.7
112	45CH00619	12	1.3	1.1	0.7	448	west	14.6	165.0	185.8
113	45CH00619	13	1.6	1.2	0.8	448	west	15.9	168.6	186.0
114	45CH00619	14	1.5	1.4	0.6	448	west	17.2	126.1	185.5
115	45CH00619	15	3.5	2	0.8	448	west	18.5	127.7	185.8
116	45CH00619	16	1.3	1	0.6	448	west	37.1	150.9	187.6
117	45CH00619	17	2.9	1.7	1.3	448	west	25.3	127.1	187.2
118	45CH00619	18	1	1	0.8	448	west	14.9	141.5	181.7
119	45CH00619	21	2.5	1.8	0.8	448	west	28.6	154.1	188.9
120	45CH00619	22	1.2	1	0.7	448	west	28.6	140.0	188.3
121	45CH00619	25	1.5	1.5	0.6	448	west	24.6	145.0	185.3
122	45CH00619	19	2	1.7	1	448	west	17.6	108.6	186.6
123	45CH00619	26	2	1.5	0.4	448	west	20.7	139.8	184.3
124	45CH00619	27	0.7	0.5	0.4	448	west	15.8	111.8	184.4
125	45CH00619	28	0.6	0.6	0.4	448	west	22.9	143.7	184.9
126	45CH00646	2	1.6	1.3	0.8	447	west	36.5	118.8	186.5
127	45CH00646	3	2.3	2.3	0.3	447	west	36.8	127.8	185.0
128	45CH00646	1	1.7	1.7	0.9	447	west	38.6	100.7	188.9

129	45KT02508	12	1.8	1	0.5	447	west	37.0	87.9	184.1
130	45KT02508	11	1.8	1.6	0.7	447	west	30.8	88.4	180.3
131	45KT02508	8	1.5	1.5	1	447	west	35.7	92.6	180.3
132	45KT02508	9	1	1	1	447	west	37.9	97.1	180.3
133	45KT02508	10	2	1.5	1	447	west	36.0	92.9	180.5
134	45KT02508	6	2.7	2.3	0.7	447	west	37.6	86.4	180.0
135	45KT02508	7	2.5	1.7	0.5	447	west	34.8	76.6	179.4
136	45KT02508	5	3	2.5	0.8	447	west	37.0	91.1	182.9
137	45KT02508	13	1.3	1.3	-	447	west	21.6	84.9	175.6
138	45KT02508	14	2.2	1.7	-	447	west	29.3	93.2	177.9
139	45KT02508	1	2.6	2.3	0.7	447	west	32.6	114.8	182.3
140	45KT02508	2	1.8	1.6	0.6	447	west	24.5	107.5	177.3
141	45KT02508	3	2.7	2.1	0.8	447	west	24.0	102.5	177.4
142	45KT02508	4	1.1	2.4	1	447	west	28.3	95.6	178.7
143	45KT01146	3	2	2	0.8	447	west	39.6	41.7	190.9
144	45KT01146	1	0.8	0.8	0.7	447	west	33.8	65.1	189.0
145	45KT01146	2	2.5	2	0.8	447	west	30.7	64.1	190.9
146	45KT02507	6	2	2	0.5	446	west	25.8	70.2	180.5
147	45KT02507	7	2.7	2	0.5	446	west	22.7	75.1	178.9
148	45KT02507	8	2.3	2	0.5	446	west	26.1	80.6	177.3
149	45KT02507	5	3.5	3	1	446	west	26.4	98.5	181.9
150	45KT02507	4	2.8	2.1	1.7	446	west	37.1	83.4	183.2
151	45KT02507	2	3.3	2.7	0.8	446	west	38.4	100.7	182.3
152	45KT02507	3	2	2	0.4	446	west	28.4	130.1	178.2
153	45KT02507	1	4.5	4	0.6	446	west	32.8	102.2	180.0
154	45KT02386	6	2.2	1.9	0.3	446	west	3.6	14.9	192.1
155	45KT02386	5	1.8	1.7	0.6	446	west	3.6	302.1	191.8

156	45KT02386	3	2.7	2.7	0.3	446	west	40.1	99.2	200.1
157	45KT02386	1	1	1	0.8	446	west	34.6	105.5	198.5
158	45KT02386	2	3.7	2.7	1	446	west	31.1	90.5	199.7
159	45KT02502	3	2.1	1.7	0.9	445	west	35.7	88.9	179.9
160	45KT02502	1	1.6	1.6	0.5	445	west	18.4	105.3	179.2
161	45KT02502	2	1.5	1.2	0.7	445	west	11.5	308.0	182.3
162	45KT01149	14	2.5	2.5	0.8	445	west	24.6	92.2	183.0
163	45KT01149	15	3.5	2.3	0.8	445	west	25.2	83.6	180.9
164	45KT01149	16	1.9	1.8	0.6	445	west	18.2	63.5	185.0
165	45KT01149	17	1.5	1.5	0.4	445	west	22.9	56.1	185.5
166	45KT01149	13	2.3	2.3	1	445	west	23.6	76.1	182.0
167	45KT01149	11	1.8	1.8	0.4	445	west	37.8	61.0	183.1
168	45KT01149	10	1.9	1.9	0.7	445	west	34.3	59.1	179.7
169	45KT01149	3	1	1	0.3	445	west	14.6	72.1	175.7
170	45KT01149	5	1.3	1.3	0.5	445	west	31.1	59.4	177.3
171	45KT01149	6	1.7	2	0.4	445	west	14.3	60.7	174.8
172	45KT01149	7	2.8	2.8	0.4	445	west	9.0	63.8	174.7
173	45KT01149	8	2.5	2.5	0.8	445	west	11.6	55.9	175.1
174	45KT01149	9	2.2	2.2	0.5	445	west	28.9	52.7	175.9
175	45KT01149	1	2	2	0.7	445	west	47.3	57.0	182.2
176	45KT01149	2	2	2	0.6	445	west	28.3	74.3	178.6
177	45KT02370	11	2	2	0.6	444	west	35.0	158.8	181.5
178	45KT02370	16	1.4	1.4	0.4	444	west	29.0	224.8	182.4
179	45KT02370	8	2.4	2.4	0.5	444	west	34.6	192.6	186.7
180	45KT02370	9	3.5	2	0.3	444	west	15.7	59.6	178.9
181	45DO00539	8	2	1.8	0.6	441	east	12.3	323.9	198.8
182	45DO00539	10	1	0.8	0.2	441	east	15.1	295.5	196.7

183	45KT02505	1	1.5	1	0.4	444	west	51.9	175.3	242.2
184	45KT02505	2	2.9	2.7	0.9	444	west	32.1	131.8	243.6
185	45KT02505	3	2.3	2.2	0.5	444	west	29.7	149.7	245.1
186	45KT02505	4	1.4	1.2	0.4	444	west	34.5	118.3	247.4
187	45KT02505	5	2.8	2.8	1	444	west	39.2	129.9	250.3
188	45DO00539	3	2.8	2	0.7	441	east	24.4	195.0	195.6
189	45DO00539	4	0.5	0.5	0.4	441	east	25.4	200.6	197.6
190	45DO00539	5	2	2	0.6	441	east	24.0	228.6	198.6
191	45DO00539	6	3.3	3	1	441	east	17.7	196.9	194.4
192	45DO00539	7	2	1.6	0.6	441	east	20.2	216.4	195.1
193	45DO00539	9	3	3	0.6	441	east	2.7	103.7	204.9
194	45DO00539	13	2.1	1.8	0.6	441	east	2.9	119.1	205.1
195	45DO00539	2	2	2	0.6	441	east	13.1	211.4	193.9
196	45DO00539	11	0.6	0.6	0.3	441	east	29.0	218.4	197.6
197	45DO00539	1	4	3	0.8	441	east	16.1	176.0	194.8
198	45DO00672	3	1.3	1.3	0.3	441	east	10.8	142.5	195.8
199	45KT01150	1	3.7	2.2	1.4	444	west	34.8	42.4	229.2
200	45KT01150	2	2.3	2	0.3	444	west	36.6	56.0	228.5
201	45DO00672	4	1.4	1	0.3	441	east	35.1	171.4	184.9
202	45KT01150	3	2	2.4	0.7	444	west	28.8	70.9	193.1
203	45KT01150	4	3.5	3.5	1.6	444	west	10.5	52.1	191.3
204	45KT01150	5	2.7	1.8	0.6	444	west	15.6	60.8	189.4
205	45DO00672	1	3	3	0.8	441	east	39.5	172.4	186.7
206	45DO00672	2	2	1.4	0.5	441	east	40.1	171.9	186.4
207	45KT01150	6	2.5	2.5	1	444	west	32.1	57.2	181.7
208	45KT01150	7	1.6	1.6	0.2	444	west	33.3	80.6	179.4
209	45KT00067	1	1.5	1.5	0.3	444	west	57.0	61.7	178.9

210	45KT00067	2	1	1	0.5	444	west	30.9	49.2	177.6
211	45KT00067	3	1.5	1.5	0.8	444	west	37.3	40.6	179.1
212	45KT00067	4	3.5	2	1.2	444	west	29.9	53.9	177.6
213	45KT00067	5	1.8	1.8	0.8	444	west	31.9	70.0	182.5
214	45KT00067	6	1.3	1.3	0.7	444	west	24.6	70.6	182.1
215	45KT00067	7	1.8	1.3	0.9	444	west	21.1	86.9	182.0
216	45KT00067	8	2.8	2	1.2	444	west	30.6	88.4	182.7
217	45KT00067	9	1.6	1.6	1	444	west	31.9	97.3	183.7
218	45KT00067	10	2.5	2.5	0.8	444	west	31.1	98.9	183.2
219	45KT00067	11	2.3	2.3	1	444	west	12.1	65.2	183.5
220	45KT00067	12	1	1	0.7	444	west	18.2	83.5	184.8
221	45KT00067	13	1.8	1.8	1.1	444	west	36.9	93.6	191.7
222	45KT00067	19	2.8	1.7	1.1	444	west	29.5	78.6	184.0
223	45KT00067	14	2.4	1.8	0.8	444	west	35.3	99.6	189.1
224	45KT00067	15	1.5	1.5	0.8	444	west	31.7	108.1	189.9
225	45KT00067	16	2.6	2.6	0.6	444	west	34.7	106.9	188.6
226	45KT00067	17	1.7	1.7	1.4	444	west	32.3	108.2	190.6
227	45KT00067	20	1.2	1.2	0.4	444	west	64.8	116.0	196.0
228	45KT00067	18	1.5	1.5	0.8	444	west	29.4	90.5	194.8
229	45GR00678	19	2.8	2	0.6	438	east	29.1	251.8	177.7
230	45GR00678	20	1	0.8	0.5	438	east	31.3	248.3	176.4
231	45GR00678	12	2.1	2.2	1.6	438	east	13.1	294.5	177.7
232	45GR00678	13	1.4	1.2	0.4	438	east	14.7	298.5	176.8
233	45GR00678	14	2	1.8	1.2	438	east	14.6	285.0	176.7
234	45GR00678	15	2.8	2.6	0.6	438	east	30.6	272.7	178.6
235	45GR00678	16	2.2	1.7	0.6	438	east	29.1	257.8	178.4
236	45GR00678	8	2.9	2.3	0.9	438	east	28.5	282.3	179.2

237	45GR00678	9	3.4	3	0.8	438	east	21.0	287.3	178.9
238	45GR00678	10	1.5	1.1	0.8	438	east	23.3	288.6	178.4
239	45GR00678	11	2.5	3	0.6	438	east	20.4	267.7	176.9
240	45GR00678	4	2.5	2.2	0.8	438	east	19.5	264.3	177.4
241	45GR00678	5	2.2	2.1	0.6	438	east	21.0	254.2	179.5
242	45GR00678	6	2.3	1.2	0.8	438	east	21.9	263.9	177.7
243	45GR00678	7	3.8	2.6	1	438	east	26.0	265.2	177.8
244	45GR00678	3	2.9	2.5	1.2	438	east	22.2	284.9	176.4
245	45GR00678	2	2.2	2.1	0.6	438	east	32.7	282.8	184.8
246	45GR00678	1	2.3	1.8	0.7	438	east	31.6	262.2	190.8
247	45KT02380	1	2.6	2.8	0.6	437	west	13.5	65.7	181.6
248	45KT02380	5	1.6	1.2	0.6	437	west	33.4	80.0	186.7
249	45KT02380	2	2.8	2	0.5	437	west	13.9	74.1	181.7
250	45KT02380	4	2	1.9	0.7	437	west	12.7	68.6	180.1
251	45KT02380	3	2.4	2.3	0.8	437	west	19.8	92.6	180.5
252	45GR00685	1	2.2	1.8	1.1	436	east	8.4	248.2	182.9
253	45GR00685	2	2	1.7	1.2	436	east	6.3	225.9	182.8
254	45GR00685	3	2	1.5	0.9	436	east	4.3	230.4	182.7
255	45GR00685	4	2.8	2.2	1	436	east	9.3	227.5	183.1
256	45GR00685	5	1.5	1.3	1.2	436	east	20.6	243.1	184.5
257	45GR00685	6	2.6	2.4	1.1	436	east	16.2	283.4	184.1
258	45GR00685	7	1.5	1.3	0.8	436	east	6.2	296.0	184.9
259	45GR00685	8	1.2	1.2	0.9	436	east	13.5	223.3	183.7
260	45GR00685	10	3.6	2.3	-	436	east	61.2	343.6	188.9
261	45GR00685	11	2.6	2.3	0.6	436	east	7.7	264.7	183.2
262	45GR00685	12	2.1	1.6	0.8	436	east	12.7	282.8	184.6
263	45KT01144	1	2.5	2.1	0.6	436	west	30.2	94.1	177.4

264	45KT01144	2	1.8	1.6	0.6	436	west	35.5	98.8	178.3
265	45KT01144	3	1.6	1.4	0.7	436	west	33.0	104.5	178.6
266	45KT01144	4	1.5	1.7	0.6	436	west	29.5	117.2	184.6
267	45KT01144	5	1.9	1.8	0.4	436	west	22.5	121.4	185.4
268	45KT01144	6	1.3	1.6	0.6	436	west	31.2	112.3	185.7
269	45KT02495	4	2.3	1.5	0.6	436	west	19.9	58.0	181.9
270	45KT02495	8	2.3	2.2	0.7	436	west	20.4	55.9	184.1
271	45KT02495	9	3.2	2.2	0.6	436	west	21.8	34.0	184.4
272	45KT02495	10	2.8	2.5	0.9	436	west	10.6	59.2	183.8
273	45KT02495	5	1.7	1.4	0.5	436	west	18.3	87.2	181.8
274	45KT02495	6	2.9	2.7	0.7	436	west	16.6	87.1	182.4
275	45KT02495	7	1.8	1.7	0.5	436	west	14.6	84.2	183.2
276	45KT02495	12	1.9	1.8	0.5	436	west	13.6	142.5	188.8
277	45KT02495	11	1.3	1.2	0.6	436	west	12.9	135.0	185.5
278	45KT02495	15	2.9	2.8	0.8	436	west	7.3	160.2	179.5
279	45KT02495	14	1.7	1.6	0.5	436	west	3.6	144.7	177.9
280	45KT02495	16	2.2	1.3	1.2	436	west	29.6	69.5	190.3
281	45KT02495	17	2.3	1.9	0.8	436	west	34.3	79.0	193.2
282	45KT02495	18	2.9	2.8	1.1	436	west	34.8	89.9	198.6
283	45KT02495	19	2.5	2.2	0.5	436	west	32.4	106.4	202.7
284	45KT02495	20	3.2	2.6	1.2	435	west	86.5	89.0	219.3
285	45KT02495	21	3.9	2.2	1	435	west	87.0	91.4	253.2
286	45KT02355	3	2.4	2.1	0.7	433	west	4.5	13.8	178.4
287	45KT02355	1	1.9	1.8	0.6	433	west	11.9	6.5	179.8
288	45KT02355	4	1.5	1.4	0.5	433	west	10.9	10.1	177.6
289	45KT02355	5	1	0.8	0.4	433	west	11.4	340.4	177.5
290	45KT02355	6	3.3	2.5	1	433	west	9.6	345.0	178.0

291	45KT02355	7	2.6	1.2	0.3	433	west	15.2	357.1	177.5
292	45KT00091	13	1.1	1.1	0.3	432	west	23.3	126.3	174.6
293	45KT00091	7	1.8	1.5	0.4	432	west	21.2	108.2	175.0
294	45KT00091	8	2	2	0.4	432	west	7.8	113.1	174.5
295	45KT00091	9	2	1.6	0.4	432	west	17.7	120.9	174.5
296	45KT00091	10	1.6	1.3	0.6	432	west	10.6	116.3	174.5
297	45KT00091	11	2	1.7	0.3	432	west	8.1	116.1	174.5
298	45KT00091	12	2	1.6	0.1	432	west	15.3	129.0	174.6
299	45KT00091	5	1.7	1.6	0.5	432	west	9.4	95.7	174.5
300	45KT00091	6	2.1	1.7	0.5	432	west	14.7	109.8	174.7
301	45KT02337	1	2.5	2.8	0.7	427	west	32.2	81.2	186.9
302	45KT02337	2	2.5	2.1	0.7	427	west	33.3	60.3	186.0
303	45KT02337	3	2	1.6	0.5	427	west	36.3	66.8	187.1
304	45KT02337	4	2.4	2	0.8	427	west	26.5	65.6	186.3
305	45KT01104	1	3.4	2.8	0.8	426	west	7.1	155.7	189.0
306	45KT01104	4	2	1.1	0.6	426	west	29.1	151.8	183.5
307	45KT01104	5	0.7	0.7	0.3	426	west	23.0	195.6	181.8
308	45KT01101	3	3	3	0.3	426	west	21.4	193.8	197.3
309	45KT01101	5	2.2	2	0.5	426	west	19.9	174.1	196.8
310	45KT01101	6	3	2.6	0.6	426	west	34.8	171.5	197.6
311	45KT01101	7	2	1	0.7	426	west	32.2	163.6	199.8
312	45KT01101	8	2.1	1.8	0.4	426	west	29.1	169.1	198.2
313	45KT01101	4	3.4	2.5	0.4	426	west	34.8	155.0	193.2
314	45KT01101	9	2.9	1.8	0.4	426	west	28.2	164.7	191.5
315	45KT00041	8	2.3	1.5	0.7	426	west	21.7	32.9	175.4
316	45KT00041	5	1.6	1.9	0.5	426	west	26.6	22.1	176.0
317	45KT00041	1	2.5	1.2	1.1	426	west	28.2	40.8	175.8

318	45KT00041	2	-	-	0.6	426	west	28.0	38.1	175.9
319	45KT00041	3	3.7	3.4	0.6	426	west	18.8	41.7	174.8
320	45KT00041	4	2.2	2.2	0.8	426	west	3.7	45.0	174.3
321	45KT02607	7	1.3	1.3	0.3	426	west	11.9	319.8	183.5
322	45KT02607	8	1.6	2	0.5	426	west	16.6	302.3	185.1
323	45KT02607	9	0.9	1	0.4	426	west	29.0	313.2	188.3
324	45KT02607	10	0.6	0.6	0.5	426	west	9.4	250.2	193.5
325	45KT02356	16	1.5	1.1	0.7	425	west	21.0	47.6	181.7
326	45KT02356	18	1.6	1.3	0.6	425	west	46.4	64.7	177.3
327	45KT02356	15	1.6	1.5	0.5	425	west	24.5	65.4	188.0
328	45KT00068	82	1.5	1.5	0.9	425	west	17.9	13.7	176.5
329	45KT00068	58	1.4	1.4	-	425	west	14.5	340.5	195.9
330	45KT00068	70	-	-	0.8	425	west	14.7	287.7	186.4
331	45KT00068	71	1.3	1.3	0.7	425	west	18.1	282.6	186.4
332	45KT00068	56	1.4	1.4	0.5	425	west	15.2	144.7	199.3
333	45KT00068	80	0.8	0.8	0.5	425	west	6.3	187.2	194.2
334	45KT00068	77	0.9	0.9	0.4	425	west	14.5	245.4	200.1
335	45KT00068	75	2	1.2	0.4	425	west	37.8	192.0	199.6
336	45KT01118	108	3.4	1.4	-	425	west	30.8	58.7	195.6
337	45KT01118	109	1.7	1.5	1	425	west	29.4	65.6	195.6
338	45KT01118	90	1.1	1.1	0.6	425	west	20.1	74.5	193.4
339	45KT01118	121	0.8	0.8	0.2	425	west	10.8	240.6	199.2
340	45KT01118	71	1.5	1.5	0.6	425	west	18.4	83.9	198.5
341	45KT01118	89	0.9	0.8	0.4	425	west	18.0	86.0	198.1
342	45KT01118	120	1.5	1.5	0.3	425	west	13.0	161.8	197.6
343	45KT01118	116	2	1.8	0.7	425	west	8.3	137.1	200.6
344	45KT01118	117	1.4	1.4	0.6	425	west	9.5	135.0	200.4

345	45KT01118	119	1.5	1.2	0.7	425	west	20.3	161.4	192.0
346	45KT01121	5	1.5	1.1	0.7	425	west	6.0	341.1	186.3
347	45KT01121	6	1.5	1.5	0.6	425	west	29.8	8.5	186.7
348	45KT01121	4	1.9	1.8	0.8	425	west	13.2	279.5	194.4
349	45KT01121	32	1.4	1.4	0.6	425	west	25.7	81.5	184.7
350	45KT01121	33	1.2	1.2	0.6	425	west	33.6	77.4	186.7
351	45KT01121	70	1.8	1.7	0.6	425	west	10.9	55.1	201.2
352	45KT01121	71	2.5	1.9	0.8	425	west	18.4	57.9	201.7
353	45KT01121	68	2.3	2.3	0.5	425	west	12.1	151.3	197.2
354	45KT01121	69	1.4	1.4	0.6	425	west	21.5	104.5	203.3
355	45KT01121	62	3	2.3	0.4	425	west	18.2	116.5	195.0
356	45KT01121	63	3	3	0.3	425	west	6.7	116.6	194.7
357	45KT01121	34	2.2	1.2	0.8	425	west	29.3	100.5	186.0
358	45KT01121	35	1.5	1.5	0.5	425	west	34.6	103.2	185.4
359	45KT01121	36	4.6	4.6	1.5	425	west	31.2	115.6	185.2
360	45KT01121	52	2	2.1	0.5	425	west	14.5	85.6	183.9
361	45KT01121	53	3	3	0.9	425	west	8.0	129.2	182.7
362	45KT01121	54	3.1	2.9	0.9	425	west	5.1	133.9	182.8
363	45KT01121	55	1.5	1.3	0.6	425	west	32.5	162.3	185.1
364	45KT01121	56	4.1	1.3	1	425	west	22.9	180.0	187.3
365	45KT01121	57	2.1	1.7	0.9	425	west	32.9	87.6	187.3
366	45KT01121	42	3.1	2.3	0.6	425	west	6.1	192.1	184.7
367	45KT01121	43	4.6	4.6	0.9	425	west	4.0	123.4	184.3
368	45KT01121	44	4.3	3.9	1	425	west	5.3	212.8	184.5
369	45KT01121	49	3.5	3.5	0.8	425	west	14.6	12.2	189.7
370	45KT01121	50	4.1	4.1	1.1	425	west	26.6	86.3	188.0
371	45KT01121	51	2.6	2.1	0.8	425	west	45.1	32.6	184.7

372	45KT01121	48	2.1	2	0.6	425	west	16.6	318.7	190.3
373	45KT01121	58	3.4	3.4	1.1	425	west	36.2	88.4	190.6
374	45KT01121	46	2.2	2.4	0.5	425	west	13.0	104.7	177.6
375	45KT01121	59	2.8	2.6	0.5	425	west	20.6	92.5	190.5
376	45KT01121	60	2.4	2.7	0.7	425	west	45.0	100.6	192.4
377	45KT01121	47	1.4	1.1	0.4	425	west	15.6	171.5	183.8
378	45GR00674	1	1.7	1.6	0.5	424	east	35.5	239.6	197.9
379	45GR00674	2	2	2	0.3	424	east	31.4	252.4	198.8
380	45GR00674	3	1.6	1.4	0.4	424	east	31.4	252.4	198.8
381	45KT00012	79	2.5	1.5	0.6	423	west	7.4	26.8	177.3
382	45KT00012	31	-	-	-	423	west	11.2	32.6	181.2
383	45KT00012	32	5	3	1	423	west	34.1	119.7	188.9
384	45KT00012	76	2.9	2.4	0.5	423	west	0.0	-1.0	174.7
385	45KT00012	77	0.8	0.8	0.4	423	west	6.3	34.8	180.6
386	45KT00012	26	2.6	2	0.9	423	west	9.4	80.4	182.8
387	45KT00012	27	2	2	0.6	423	west	14.6	11.1	182.8
388	45KT00012	28	1.8	1.4	0.7	423	west	20.7	25.9	181.0
389	45KT00012	29	2.6	2.5	0.4	423	west	13.5	47.9	180.5
390	45KT00012	30	1.2	1.1	0.5	423	west	17.0	341.4	181.6
391	45KT00012	33	1.6	1.3	0.5	423	west	4.8	10.3	181.7
392	45KT00012	35	2.1	1.8	0.9	423	west	20.3	36.5	180.1
393	45KT00012	36	2.6	2.3	0.7	423	west	19.7	39.0	179.0
394	45KT00012	38	2	2	0.6	423	west	6.2	76.1	175.4
395	45KT00012	73	4	2.8	0.8	423	west	12.2	97.9	182.1
396	45KT00012	74	2.1	1.7	0.6	423	west	23.3	64.0	180.7
397	45KT00012	75	1.5	1.5	0.6	423	west	22.3	37.3	179.5
398	45KT00012	78	2.1	1.9	0.5	423	west	4.8	45.0	176.4

399	45KT00012	80	2.3	2.3	0.7	423	west	8.8	18.4	182.1
400	45KT00012	8	1.7	1.7	0.6	423	west	16.6	41.3	187.8
401	45KT00012	19	-	-	-	423	west	17.5	67.1	185.2
402	45KT00012	20	1.7	1.5	0.9	423	west	22.0	79.3	181.7
403	45KT00012	21	2.6	2.1	0.6	423	west	10.2	65.8	184.0
404	45KT00012	22	2.7	2.6	1	423	west	15.5	94.1	183.6
405	45KT00012	23	2.5	2.5	0.7	423	west	15.9	26.9	181.9
406	45KT00012	25	3	2.3	1.1	423	west	18.4	61.4	183.1
407	45KT00012	39	1.7	1.7	0.6	423	west	12.7	114.6	175.0
408	45KT00012	40	2.4	2.4	0.6	423	west	10.1	65.2	177.2
409	45KT00012	57	1.4	1.4	0.5	423	west	16.7	41.6	176.0
410	45KT00012	58	2.8	2.8	0.5	423	west	15.3	85.3	176.9
411	45KT00012	59	1.6	1.6	0.6	423	west	11.3	75.2	176.2
412	45KT00012	60	1.8	1.8	0.4	423	west	10.8	71.6	174.9
413	45KT00012	61	2.8	1.8	0.8	423	west	11.5	48.5	175.3
414	45KT00012	2	3.5	3.2	0.8	423	west	17.7	69.6	176.9
415	45KT00012	5	1.8	1.8	0.8	423	west	9.2	134.4	188.8
416	45KT00012	6	1.7	1.7	0.5	423	west	10.1	101.8	188.8
417	45KT00012	7	3	3	1.2	423	west	8.8	72.1	187.6
418	45KT00012	9	2	2	0.7	423	west	10.2	52.3	187.6
419	45KT00012	10	1.8	1.3	0.8	423	west	10.0	101.0	187.1
420	45KT00012	11	1.9	1.9	1	423	west	16.0	115.9	187.1
421	45KT00012	12	1.7	1.5	0.9	423	west	13.7	138.7	185.8
422	45KT00012	13	1.6	1.6	0.5	423	west	21.4	95.5	185.1
423	45KT00012	14	2	2	0.8	423	west	5.8	97.1	184.1
424	45KT00012	15	2	1.2	0.7	423	west	8.4	66.0	184.1
425	45KT00012	16	2.3	2.3	1	423	west	16.6	140.1	183.7

426	45KT00012	17	2.1	2.1	1	423	west	11.3	149.9	184.1
427	45KT00012	18	4.7	4.5	1.2	423	west	8.7	83.5	186.6
428	45KT00012	41	1.7	1.7	0.6	423	west	8.6	34.2	177.6
429	45KT00012	62	2.6	2.1	0.6	423	west	13.7	110.1	176.8
430	45KT00012	63	1.4	1.4	0.5	423	west	14.9	104.7	177.0
431	45KT00012	70	1.8	0.9	0.8	423	west	11.2	100.6	187.7
432	45KT00012	3	1.5	1.5	0.6	423	west	11.3	188.6	197.4
433	45KT00012	42	1.8	1.8	0.7	423	west	14.0	125.6	182.7
434	45KT00012	43	1.3	1.3	0.5	423	west	14.3	150.7	180.2
435	45KT00012	44	3	3	1.3	423	west	8.1	91.0	180.3
436	45KT00012	54	1.8	1.8	0.5	423	west	16.6	94.3	177.8
437	45KT00012	45	1.4	1.4	0.7	423	west	8.3	89.0	180.8
438	45KT00012	46	1.6	1.6	0.7	423	west	8.8	100.2	180.8
439	45KT00012	47	1.7	1.3	0.7	423	west	7.8	76.8	181.0
440	45KT00012	48	1.5	1.5	0.7	423	west	7.0	121.8	180.0
441	45KT00012	49	1.5	1.5	0.7	423	west	3.2	83.7	179.5
442	45KT00012	50	1.7	1.7	0.9	423	west	12.3	113.0	179.0
443	45KT00012	51	1	1	1	423	west	11.8	137.4	178.7
444	45KT00012	52	3	3	1	423	west	18.5	75.5	177.8
445	45KT00012	53	2.1	2.1	0.3	423	west	18.4	129.5	176.5
446	45KT00012	55	1.3	1.3	0.5	423	west	9.8	96.2	176.9
447	45KT00012	64	2	1.6	0.6	423	west	13.4	43.7	177.1
448	45KT00012	65	1.4	1.4	0.8	423	west	14.2	137.8	178.7
449	45KT00012	69	2.6	2.1	0.5	423	west	8.1	160.9	176.1
450	45KT00012	4	1.5	1.3	0.8	423	west	5.6	88.5	190.3
451	45KT00012	67	1.7	0.7	0.3	423	west	9.7	58.2	175.6
452	45KT00012	71	2.5	2.1	0.6	423	west	10.6	59.8	175.4

453	45KT00012	1	-	-	-	423	west	36.3	34.3	191.9
454	45KT00012	56	2.5	2.5	0.5	423	west	16.1	57.3	175.1
455	45KT00012	82	3.1	2.6	0.7	423	west	13.0	84.4	178.7
456	45KT02392	6	1.6	1.6	0.4	421	west	21.9	13.5	190.1
457	45KT02392	7	1.6	1.6	0.4	421	west	4.7	20.7	193.9
458	45KT02392	7	1.6	1.6	0.4	421	west	8.5	343.4	193.5
459	45GR01680	1	4.3	3.3	0	417	east	41.1	289.0	178.6
460	45GR01680	2	3	1.2	0.6	417	east	44.0	280.2	178.1
461	45GR01680	3	-	-	-	417	east	40.2	277.1	177.5
462	45GR01680	4	2.2	2	0.6	417	east	36.6	277.8	177.5
463	45YA01008	9	1.5	1.3	0.3	400	west	27.1	140.9	157.3
464	45YA01008	10	1.3	1.1	0.3	400	west	34.9	154.7	157.8
465	45YA01008	14	1.2	1.2	0.5	400	west	31.6	206.2	165.5
466	45YA01008	11	1.2	1.1	0.3	400	west	23.7	168.2	162.5
467	45YA01008	12	0.7	0.5	0.3	400	west	22.3	184.4	163.6
468	45YA01008	13	1.1	0.9	0.2	400	west	17.9	172.7	164.3
469	45YA01008	8	2	2	0.6	400	west	31.1	48.2	156.0
470	45YA01008	5	2.8	2.8	0.5	400	west	39.6	73.2	157.8
471	45YA01008	6	2	2	1	400	west	34.8	75.9	161.5
472	45YA01008	7	1.4	1.4	0.7	400	west	31.4	65.3	160.7
473	45YA01008	3	1.8	1.8	0.5	400	west	28.9	75.3	161.2
474	45YA01008	4	2.5	2.5	0.5	400	west	29.6	69.9	159.2
475	45YA01011	2	1.1	0.8	0.7	397	west	17.9	11.1	193.0
476	45YA01011	3	2.9	2	0.8	397	west	9.3	25.4	193.5
477	45YA01011	1	2	1	0.3	397	west	6.9	357.1	193.8
478	45YA01011	4	3	1.5	0.6	397	west	14.3	11.9	193.5
479	45YA01011	5	2.8	2.3	0.7	397	west	6.0	314.0	193.7

480	45YA01011	6	2.8	2.3	2.6	397	west	14.0	68.5	194.1
481	45YA01011	7	2.4	2.6	0.8	397	west	8.2	75.4	194.6
482	45YA01011	8	3.2	3.8	0.3	397	west	6.1	63.4	195.5
483	45YA01009	1	2.4	2.3	0.6	397	west	22.0	63.7	168.0
484	45YA01009	2	2.5	2.3	0.6	397	west	18.8	32.1	163.1
485	45YA01009	3	2	2	0.6	397	west	25.4	23.4	170.8
486	45YA01009	4	2	1.9	0.8	397	west	20.6	45.0	175.0
487	45YA01009	5	1.4	1.8	0.3	397	west	20.6	45.0	175.0
488	45YA01009	6	2	2.2	0.9	397	west	20.6	45.0	175.0
489	45YA00999	5	1.5	2	0.6	396	west	36.0	51.6	150.4
490	45YA00999	2	4.5	4.5	1.1	396	west	14.9	44.6	145.8
491	45YA00999	3	3.4	3.4	1	396	west	15.1	31.3	146.6
492	45YA00999	4	1.5	1.5	0.5	396	west	27.9	54.6	147.4
493	45YA00992	2	2	2	0.8	396	west	3.3	342.3	152.3
494	45YA00992	3	1	0.8	0.3	396	west	24.4	354.6	154.9
495	45YA00999	1	2.1	2	0.9	396	west	17.7	46.9	145.6
496	45YA00992	1	2.5	3	0.7	396	west	19.2	36.0	156.9
497	45YA01005	11	1.8	1.5	0.5	396	west	12.6	36.8	146.6
498	45YA01005	8	1.6	1.6	0.5	396	west	6.0	63.7	147.9
499	45YA01005	1	1.3	1.1	0.3	396	west	8.2	59.2	146.4
500	45YA01003	1	1.4	1.3	0.2	396	west	10.5	32.9	160.6
501	45YA01003	2	1.4	1.3	0.3	396	west	12.7	57.2	162.7
502	45YA01003	3	4.6	2.4	0.6	396	west	10.7	21.3	163.6
503	45YA01003	4	2.6	2.1	0.7	396	west	7.4	21.9	163.8
504	45YA01003	5	1.6	1.4	0.4	396	west	9.9	43.3	164.3
505	45YA01003	6	1.2	1.4	0.3	396	west	7.6	7.5	164.0
506	45YA01003	7	2.3	1.9	0.6	396	west	14.6	35.2	167.1

507	45YA01003	9	1.2	1.1	0.5	396	west	9.5	49.9	167.2
508	45YA01003	10	0.7	0.6	0.4	396	west	12.2	51.5	168.0
509	45YA01003	11	1	1.3	0.3	396	west	13.6	56.0	168.2
510	45YA01003	12	1.2	1.2	0.4	396	west	12.5	35.4	169.1
511	45YA01003	8	1.2	1.2	0.4	396	west	14.2	37.0	167.9
512	45YA01003	13	1.4	1.4	0.5	396	west	11.7	51.4	172.6
513	45YA01002	16	1.7	2	0.5	396	west	14.4	79.0	145.4
514	45YA01002	17	2.2	2	0.6	396	west	14.5	108.6	148.0
515	45YA01002	18	1	1.1	0.2	396	west	14.5	69.6	148.8
516	45YA01002	9	3.4	2.4	0.4	396	west	10.0	102.3	144.1
517	45YA01002	10	2	0.6	0.5	396	west	15.0	84.9	144.7
518	45YA01002	11	1.7	1.8	0.8	396	west	13.5	117.5	145.3
519	45YA01002	14	1.5	1.5	0.7	396	west	11.8	70.0	145.9
520	45YA01002	15	1.8	1.7	0.6	396	west	7.3	34.6	145.8
521	45YA01002	19	2.6	2.4	0.8	396	west	11.2	83.8	149.0
522	45YA01002	20	2.4	2.3	0.7	396	west	15.0	80.9	149.9
523	45YA01002	21	2.3	2.4	0.7	396	west	13.0	77.8	149.5
524	45YA01002	22	2	2	0.5	396	west	15.4	82.5	149.1
525	45YA01002	23	1.9	1.8	0.5	396	west	6.1	125.5	149.1
526	45YA01002	24	2.3	2.2	0.6	396	west	12.8	93.5	149.7
527	45YA01002	25	2.1	2.3	0.6	396	west	18.4	89.6	150.6
528	45YA01002	26	0.9	0.9	0.3	396	west	14.2	72.5	150.8
529	45YA01002	27	1.8	2	0.8	396	west	18.3	92.6	151.6
530	45YA01002	28	2.1	1.9	0.6	396	west	16.6	99.9	152.9
531	45YA01002	29	1.8	1.4	0.6	396	west	15.6	113.0	153.5
532	45YA01002	30	1.3	1.4	0.5	396	west	12.8	100.8	154.2
533	45YA01002	31	1.3	1.2	1.2	396	west	15.7	80.8	154.8

534	45YA01002	32	1.5	1.6	0.5	396	west	10.2	75.9	157.7
535	45YA01002	39	1.7	1.6	0.4	396	west	10.0	94.1	141.1
536	45YA01002	12	2.3	2.2	0.6	396	west	20.8	114.3	145.3
537	45YA01002	13	1.6	1.8	0.6	396	west	16.5	106.1	146.2
538	45YA01002	33	0.8	0.9	0.5	396	west	12.9	82.5	152.8
539	45YA01002	5	1.3	1.3	0.3	396	west	22.1	19.8	148.6
540	45YA01002	6	2.6	3.1	0.7	396	west	27.9	353.6	147.5
541	45YA01002	7	2.5	3.6	0.6	396	west	16.6	330.1	145.5
542	45YA01002	8	2.8	2.2	0.7	396	west	19.0	9.6	145.4
543	45YA01002	34	2.2	1.9	0.6	396	west	11.9	85.2	148.1
544	45YA01002	35	1.3	1.1	0.5	396	west	13.5	312.1	152.5
545	45YA01002	3	1.8	1.6	0.6	396	west	30.0	2.9	156.1
546	45YA01002	36	0.8	1	0.5	396	west	23.3	6.3	153.7
547	45YA01002	37	1.1	1.2	0.4	396	west	14.9	7.0	153.6
548	45YA01002	38	1.1	1.3	0.5	396	west	17.3	21.2	153.7
549	45YA01002	1	2.5	2.1	0.7	396	west	27.6	4.7	159.7
550	45YA01002	2	2	2.3	0.6	396	west	27.2	18.6	166.2
551	45YA00993	1	1.8	1.6	0.4	395	west	30.8	10.9	138.2
552	45YA00993	2	1.5	1.1	0.3	395	west	8.1	5.6	139.5
553	45YA00993	3	2.8	3.8	0.4	395	west	17.4	7.1	143.9
554	45YA00993	4	3	2.5	0.4	395	west	12.2	303.2	145.9
555	45YA00993	5	2.1	1.6	0.5	395	west	12.2	37.0	145.8
556	45YA00993	6	1.4	1.4	0.2	395	west	12.6	34.5	147.5
557	45YA00993	7	1.9	1.7	0.4	395	west	8.3	53.3	147.5
558	45YA00993	8	2	2	0.6	395	west	13.4	96.0	147.4
559	45YA00993	15	1.8	1.4	0.4	395	west	10.7	5.3	142.4
560	45YA00993	16	2.2	2	0.6	395	west	8.8	52.2	141.0

561	45YA00993	17	2	1	0.4	395	west	11.0	25.9	139.2
562	45YA00993	9	2.1	1.8	0.6	395	west	12.1	61.8	149.4
563	45YA00993	10	1.5	1.5	0.4	395	west	12.8	65.6	148.7
564	45YA00993	11	2	2.4	0.4	395	west	14.1	75.0	148.7
565	45YA00993	13	2	1.3	0.4	395	west	18.6	29.4	147.3
566	45YA00993	12	2.3	1.7	0.4	395	west	17.4	35.3	149.2
567	45YA00993	14	2.5	1.7	0.6	395	west	10.1	41.0	146.4

Note: Locational data omitted.
FID = feature identification number
RM = river mile
[a] = calculated from raster data from 1 meter LiDAR DEM
[b] = elevation calculated from 1 meter LiDAR DEM

Table 2. House Site Database.

FID	Site	House Features	RM	Bank
1	45GR00064	25	433	east
2	45GR00130	34	436	east
3	45GR00137	1	404	east
4	45GR00140	30	428	east
5	45KT00010	2	421	west
6	45KT00013	30	423	west
7	45KT00027a	21	435	west
8	45KT00084	7	440	west
9	45KT00085	2	440	west
10	45YA00004	3	400	west
11	45YA00153	1 [a]	396	west
12	45CH00004	5	450	west
13	45KT00070	1	426	west
14	45KT00054	13	445	west

15	45KT00068	14	425	west
16	45GR01659	4	433	east
17	45GR00433	2	406	east
18	45KT00012	4	423	west
19	45GR00126	15	435	east
20	45KT00028	30	436	west
21	45KT00027b	6	434	west
22	45KT00027c	5	434	west
23	45CH00227	1 [a]	447	west
24	45YA00006	9	400	west
25	45GR00041	11	397	east
26	45GR00124	7	397	east
27	45GR00136	5	396	east
28	45YA00013	1	400	west

Note: Locational data omitted.
FID = feature identification number
RM = river mile
[a] = sites without feature information were counted as having 1 house feature.

APPENDIX C

Ethnohistoric Settlement Information

River miles are estimated by Ripin (this document).

Columbia Band settlements on the upper end of Wanapum Reservoir from Smith (1982) and Ray (1974):

1. S: Moses Coulee winter village (Ray 1974:428). East bank, RM 448.

2. S: Colockum Creek year round (Ray 1974:428). East bank, RM 450.

Columbia Band place names (N) and settlements (S) from north to south as listed from Smith (1982):

1. N: *Npaqn ‘t*: mouth of Rock Canyon, west bank of the Columbia River, said to be an approximate location of Rocky Coulee, near Vantage [Ray 1960:779; 1974: 429]. West Bank, RM 421.

2. S: *Pa nqo*: not located by Ray…Panko (in Relander 1956:32) to be the Wanapum designation for the locality where Vantage stood prior to the construction of Wanapum Dam. West Bank, RM 420.

3. S: *Qamuqwa ‘ tu:* ‘the muskrat dam that never washes away.’ A winter village of 50 to 100 persons located near Sand Hollow [Ray 1974:429]. East Bank, RM 419

4. S: *Qa ‘ tqat*: near the mouth of Johnson Creek near the foot of Ryegrass Mountain [Ray 1974:429]. West Bank; RM 415.

5. S: N muqwa ‘ st: a winter village of 50 to 100 persons, near Cohassett Rapids. A site between Johnson Canyon and Crab Creek [Ray 1974: 429]. East Bank, RM 415 to 410.

6. S: Unknown: near the mouth of the sink of Crab Creek. This was the village of the Columbia Band (*Sinkumkunatkuh*) [Curtis 1911, vol. 7: 66]. East Bank, RM 411.

7. S: *Loqa ' st n*: an important and populous village on the east side of the Columbia River, south of Crab Creek at the foot of Saddle Mountains. This village took its name from the name for the mountains [Ray 1974:429]. East Bank, RM 410.

Wanapum place names and settlements north to south (Smith 1982 in Bruce et al. 2001):

1. N: *Wasatos*, or wotash, (meaning spirit power place): Saddle Mountains where childrenwere sent on spirit quests [Relander 1956:23, 311]. East Bank, 409 to 410.

2. *N: Iques*, 'cottontail rabbit': river above "the head of the first riffle, so named because the whitecaps resemble rabbits scurrying for cover" [Relander 1956:311]. Whether the area was otherwise of interest to the Wanapum is not indicated [Smith 1982]. West/East Bank?, RM 406.

3. S: *Wapixie*. 'water drops fast': "near the head of the first riffles in Priest Rapids" [Relander 1959:311]. Kavanaugh [1975], reported that this village at one time supported up to 2000 gathered for winter feasts and dances (Smith 1982:95). West Bank, RM 406

4. N: *Tentutnamah*, 'willows around here': below the Kittitas-Yakima county line. The bark of the willows referred to was peeled and boiled to make a medicinal drink [Relander 1956:311]. RM 404.

5. S: *Xa txamtcanuwi ‘ tac*: village located by Ray [1936:151] (Smith 1982), West Bank; RM 401.

6. S: *Tamacsk’ uni’ skuni*: village one mile below site 5 and also on west side of the river [Ray 1936:119,151]. Relander [1956:43-44,310]…is presumably the same as Ray’s. It was the next site below “*towtomchana wetosh*” a summer and large winter camp [Smith 1982]. West Bank, RM 400.

7. S: *Waya ‘ new*: village on the west side of Columbia, one mile downriver from site 6 [Ray 1936:119, 151]. West Bank; RM 399.

8. S. *Panchaip*, ‘alkali place’: an old winter village at the foot of the bluff on which the cemetery was located [Relander 1956:44, 54]. West Bank, RM 399.

9. S: *Ca ‘ p ‘ t l k:* village still occupied in 1930’s (Ray 1936:119, 151). West Bank, RM 398.

10. Anhyi, ‘Sun Man’ a mythic figure: a small island one-half mile upstream from site 12 below. During the spring Chinook salmon run, some fish landed “on the island in a shallow stone depression” where they were clubbed to death [Relander 1956:309]. Island, RM 398.

11. *P‘ na’*: village site on the west side of the Columbia at Priest Rapids, about two miles below site 9 [Ray 1936:119, 151]. Mooney [1896:735] locates this village of ‘fish weir’ where Smowhala resided, on the west bank of the Columbia at the foot

of Priest Rapids [Smith 1982]. West; 397. Rigsby [1965:40] refers to this site as ‘an important [Wanapum] village on the Columbia near Priest Rapids.’ Relander [1956:32, 46, 180, 191, 268, 309-310] considers P‘na was the dominant village in the lower Priest Rapids (Smith 1982). West Bank, RM 397.

12. N: *Wotkloch*t, ‘holes in rock’: a salmon fishing place just downstream from *P‘na*. In the 1950s it was the site of a power plant [Relander 1956:180, 309]. West Bank, RM 397.

13. N: *Chalwash chilni*, ‘one-legged abalone man’: a large “sacred island of the Wanapum at *P‘na*, known for its petroglyph rocks, ancient burials, and stone piles made by boys on their guardian spirit quest [Relander 1956:25, 29-30, 41, 52, 268, 272, 283, 309]. Smith notes that the reference to ‘one-legged abalone man’ could be in reference to a giant shellfish, mythically or otherwise. Beyond that, he does not pretend to know what Relander means [See note 8 Smith 1982]. Island ,RM 397.

14. S: *Shapinchise*, ‘red mineral plant’: village once occupied by Smowhala on left bank of the Columbia [Relander 1956:309]. East Bank, RM 397.