DIGITAL INVENTORY OF FLOOD-PLAIN MINES IN WASHINGTON STATE

by Loren R. Baker,
Karl W. Wegmann,
Donald T. McKay, Jr.,
David K. Norman,
and Chris N. Johnson

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES

Digital Report 3
March 2003

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands

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Doug Sutherland—Commissioner of Public Lands

DIVISION OF GEOLOGY AND EARTH RESOURCES

Ron Teissere—State Geologist
David K. Norman—Assistant State Geologist

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Publications
Washington Department of Natural Resources
Division of Geology and Earth Resources
PO Box 47007
Olympia, WA 98504-7007
Phone: 360-902-1450
Fax: 360-902-1785
E-mail: geology@wadnr.gov
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Contents

FIGURE

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Washington Division of Geology and Earth Resources
PO Box 47007; Olympia, WA 98504-7007

INTRODUCTION

Sand, gravel, and rock are important economic resources, essential for building everything from foundations for single-family homes to the miles of highways that cross Washington State. In order to mine these materials, many surface mines have been and continue to be sited on the flood plains of primary and tributary river systems in Washington (Fig. 1). River systems such as the Chehalis, Cowlitz, and East Fork Lewis Rivers on the west side of the Cascade Range and the Yakima River on the east side have large concentrations of mine-created ponds and lakes on their flood plains. Activities on flood plains in Washington are regulated primarily by the Shoreline Management Act of 1971 (chapter 90.58 Revised Code of Washington [RCW]), which is administered by local jurisdictions. Many other laws regulate mining in Washington (Norman, 2000), one of which is the Washington Surface Mining Act (chapter 78.44 RCW), enacted in 1970 and administered by the Washington Department of Natural Resources (DNR), Division of Geology and Earth Resources (DGER).

This digital inventory delineates and categorizes all flood-plain mines of Washington identified through 2001. For the purposes of this report, the flood plain is defined as "the strip of relatively flat land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks. It is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. A river has one flood plain and may have one or more terraces representing abandoned

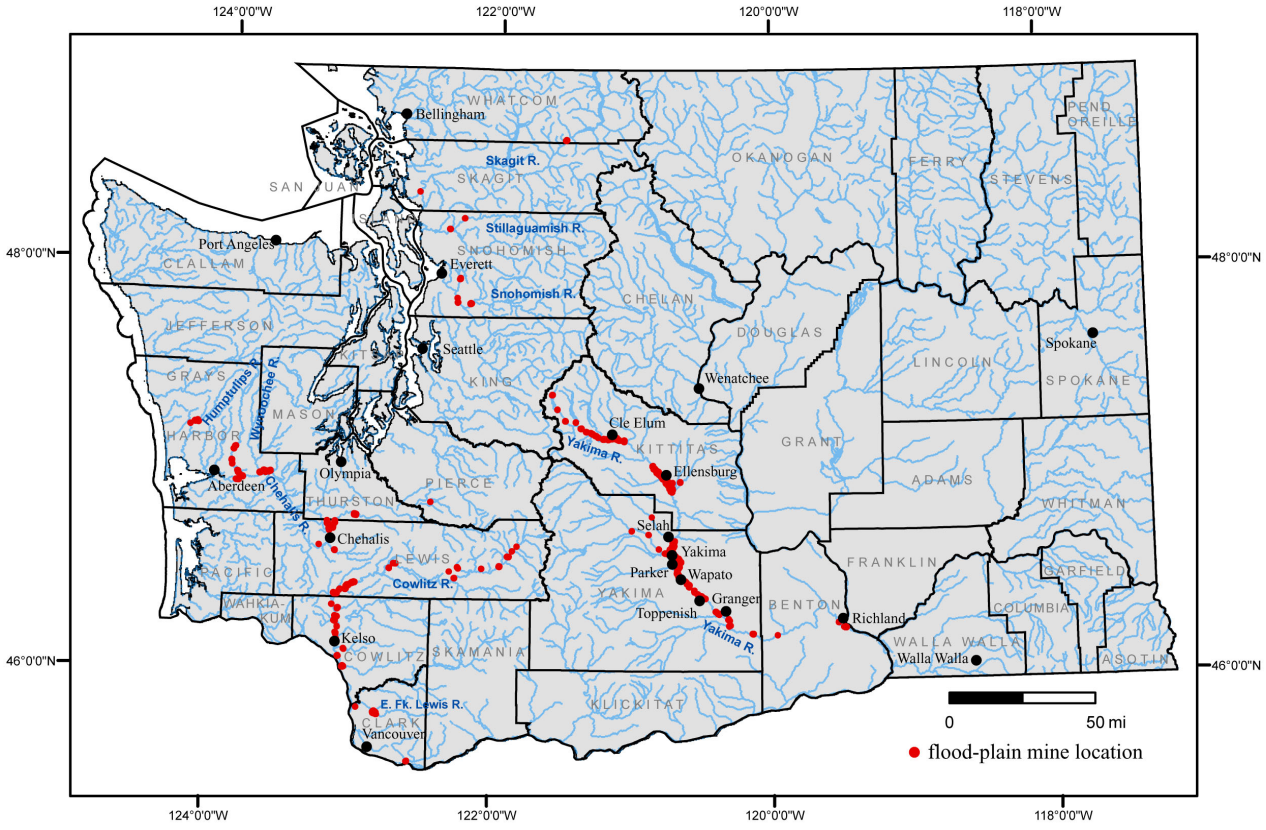

Figure 1. Locations of flood-plain mines included in this inventory.

flood plains" (Jackson, 1997). The areas mapped in this inventory are generally all contained within, or directly adjacent to, the boundaries of the 100-year flood plain.

IMPACTS OF FLOOD-PLAIN MINING

The impacts to riverine geomorphic, biotic, and ecologic systems by flood-plain sand and gravel mining in the Pacific Northwest have been extensively studied and documented by Norman and others (1998), Kondolf and Kelso (1996), Collins (1995), Cederholm and Scarlett (1991), and Collins and Dunne (1990), among others. Identified impacts include the creation of ponds and lakes, changes in water temperature, changes in the ground-water hydrology, and the potential for river avulsion. The post-mining benefits of these ponds and lakes can include increased terrestrial and aquatic wildlife habitat, including increased habitat for some fish species (Norman, 1998), and additional public recreational opportunities.

Previous studies as well as observations made during this project illustrate the potential benefit of flood-plain mine ponds as fish habitat. Numerous mine ponds and lakes visited during this project that had known connections to the adjacent river channels were observed to contain salmonid fry and fingerlings, and many that had no surface-water connection to the adjacent river were observed to contain trout and bass species. Cederholm and Scarlett (1991) report that salmonid species wintering in a natural off-channel pond are 25 percent larger than those wintering in-stream, and the same may be true in manmade ponds that mimic natural conditions. For more information on the use of flood-plain sand and gravel mines for off-channel salmon habitat, see Cederholm and Scarlett (1991), Norman and others (1998), and Norman (1998).

Gravel mine ponds and lakes adjacent to river channels are likely to be captured as a river meanders across its flood plain, especially during periods of river flooding. In 1996, river avulsions into flood-plain sand and gravel mines occurred on both sides of the Cascades during record flood events (Norman and others, 1998). In some locations, 1996 avulsion events were not corrected and near-channel flood-plain mines became new river channels (Norman and others, 1998). Many of the gravel mines that had rivers avulse into them continue to function as the active river channel. During our field reconnaissance in 2001, five years after the initial avulsions, we observed obvious in-filling of pits in the form of upstream sand and gravel deltas advancing into the pits, increased bank erosion, landsliding, downcutting of the channel upstream of the pits, and warmer water in the slackwater areas of the ponds. The impacts to fish and benthic macroinvertebrates were not documented. Physical changes to the river channel resulting from an avulsion event can affect adjacent manmade structures such as bridge foundations, surface roads, irrigation structures, sewage treatment operations, storm water fixtures, and dikes (Norman and others, 1998; Kondolf and Kelso, 1996; Collins and Dunne, 1990; Scott, 1973).

FLOOD-PLAIN MINE INVENTORY AND DATABASE

We identified 260 flood-plain mines in Washington (114 sites on the west side of the Cascade Range and 146 sites on the east side), using the following sources: (1) aerial photographs; (2) DNR Surface Mining Reclamation Permit files, which include mine-site inspection reports and permit-holder yearly mine activity reports; (3) interviews with DNR mine inspectors; and (4) lake survey reports from the Washington Department of Fish and Wildlife. Mine disturbance boundaries were digitized from DNR 1:12,000-scale digital orthophotographs and 1:24,000-scale U.S. Geological Survey (USGS) digital raster graphics (DRG) topographic maps using ArcView software (version 3.2a) to show the geographic relationship of each mine site to adjacent river channels, determine the distance from the mine site to adjacent river channels, and facilitate area and volume calculations. All river systems in Washington were examined; however, some former mine sites may not have been identified due to age, size, shallow depth, vegetation cover, location, and local geomorphology. Existing conditions were documented during field visits to representative mine ponds and lakes. Several of the flood-plain mine sites in this study include dredge-spoil pile sites that now fill in preexisting mines. The dredge spoils are accumulated from sedimentation in the Cowlitz River resulting from the 1980 eruption of Mount St. Helens. A few gravel bar "scalping" sites, resulting from the mining of exposed river bars during periods of low river flow, are also included in the inventory.

This digital inventory consists of a single ArcView shapefile (floodplainmine.shp) projected in the Washington Coordinate System of 1983 (WCS 83) and an associated database (floodplainmine.dbf). If the user does not have a geographic information system (GIS) in which to view the shapefile, ESRI's ArcExplorer software can be downloaded for free (see http://www.esri.com/software/arcexplorer/index.html). Base maps are not provided as a part of this digital inventory. If the user does not have digital base maps upon which to display the shapefile, they may be obtained from several sources, such as: (1) Washington State Department of Natural Resources, Division of Information Technology (see http://www.wa.gov/dnr/base/publications.html#data), (2) USGS in the form of DRG files (see http://mcmcweb.er.usgs.gov/drg/), or (3) private companies selling DRG files.

The database (floodplainmine.dbf) contains site-specific information for each mine site such as name, permit

status, location, permitted acres, mined acres, pit depth and volume, distance to adjacent river, and whether or not there is a surface connection between the river and mine pit. The database file is in DBASE IV format and can be used alone (in a spreadsheet program such as Microsoft Excel or Corel Quattro Pro) or in a GIS with the ArcView shapefile. For detailed information on the data files, please see the associated metadata file (metadata.htm).

(Note: If you know of flood-plain mine locations not included in this inventory, please contact DGER so that the inventory may be corrected and updated—see back of title page for contact information.)

STATEWIDE DISTRIBUTION OF FLOOD-PLAIN MINES

Western Washington

West of the Cascade Range, a total of 115 flood-plain mines are found on 17 different river systems: Cowlitz River (42 mines), Chehalis River (21), Skookumchuck River (8), Wynoochee River (8), East Fork Lewis River (6), Humptulips River (6), Kalama River (4), Pilchuck River (3), Skagit River (3), Skykomish River (3), Satsop River (2), Coweeman River (2), Stillaguamish River (2), Washougal River (2), Lewis River (1), Mashel River (1), and Newaukum River (1). The majority of these sites are located immediately adjacent to Interstate Highway 5 (Lewis and Cowlitz Counties) and Highway 12 (Grays Harbor County). Other scattered mine sites are located in Skagit, Snohomish, and Whatcom Counties. Many sites date to the 1970s; however, other small-scale mining occurred between 1940 and 1960 (Collins, 1995). Many western Washington sites have public access for recreational opportunities, administered by either the Washington Department of Fish and Wildlife or county government.

Eastern Washington

East of the Cascade crest, flood-plain mines are located almost exclusively on the upper (77 mines) and lower (63) Yakima River, with a few on the Naches River (4), Tieton River (1), and Wenas Creek (1). Mining on the greater Yakima River began in the 1950s (Collins, 1995). Concentrations of ponds and lakes resulting from flood-plain mining are found near the communities of Cle Elum, Ellensburg, Selah, and Yakima. Other large mine lakes are located on the lower Yakima River in the Parker, Wapato, Toppenish, and Granger areas. A large percentage of these sites are located adjacent to Interstate Highways 90 and 82 (Kittitas, Yakima, and Benton Counties), and were mined as sources of sand and gravel aggregate for nearby highway construction. The Washington Department of Fish and Wildlife maintains public fishing and hunting access at many of the mine sites on the Yakima River.

INVENTORY SUMMARY

As of 2001, identified flood-plain mines occupied slightly more than 5,300 acres statewide. The estimated volume of material removed from the 122 flood-plain mines where the mine depth is known (47% of identified mines) exceeds 177 million cubic yards. The total mined volume for all of the identified flood-plain mines may be twice as large as that reported (assuming that the average volume per mine is similar for the 53% of mines for which we were unable to determine the volume), or approximately 350 million cubic yards. A total of 37 mines (approximately 14% of flood-plain mines statewide) were confirmed to have surface connections to adjacent rivers, due in large part to river avulsion events. Future avulsion events are certain to occur at historic, current, and future flood-plain mines given the dynamic nature of braided and meandering alluvial river systems. It is expected that additional flood-plain mine locations will be identified by the mining industry and general public after this report is published.

ACKNOWLEDGMENTS

The authors wish to thank Karen Meyers for design and editorial support and the DNR GIS support staff for technical assistance with geographic information systems.

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