SALMONID ENTRAPMENT ASSESSMENT

FOR THE PROPOSED KUNZLER TERRACE PIT

Prepared for
Granite Construction Company
1324 South State Street
Ukiah, CA 95482

Prepared by
Stillwater Sciences
850 G Street, Suite K
Arcata, CA 95521

20 December 2007
# TABLE OF CONTENTS

1 INRODUCTION ................................................................................................................. 1
2 PURPOSE .......................................................................................................................... 2
3 PROJECT AND AREA DESCRIPTION .............................................................................. 2
4 PROJECT ALTERNATIVES AND IMPACT ANALYSIS ................................................ 3

   4.1 Alternative A ............................................................................................................ 4
   4.2 Alternative B ............................................................................................................ 5
   4.3 Alternative C ............................................................................................................ 5
   4.4 Alternative D ............................................................................................................ 6
   4.5 Attraction Flow (Alternatives B and C) ..................................................................... 6
   4.6 Floodplain Construction and Native Planting Activities (Alternatives B and C) ........ 7
5 SUMMARY ..................................................................................................................... 9
6 REFERENCES .................................................................................................................. 10

**Tables**

Table 1. Period of Record Peak Flow Occurrence. ................................................................. 4

**Appendices**

Appendix A. Figures.
1 INTRODUCTION

There are currently one active and three inactive floodplain gravel mining pits on the east side of the Ukiah Reach of the Russian River that are owned by Granite Construction Company (Granite). The pit operations are used to supply aggregate for a variety of construction activities ranging from road and highway construction to building foundations, sidewalks, and bridge footings.

Coho and Chinook salmon and steelhead trout are listed as “threatened” under the Endangered Species Act in the Russian River basin and any projects that may affect these species are given heightened scrutiny. The primary fisheries issue associated with floodplain pit operations is the potential for the pits to entrap salmonids during extreme flood events. Entrapment could result in the mortality of an undetermined number of juvenile or adult salmonids. Because floodplain pits are already present on the Russian River floodplain and there is a continuing demand for aggregate products, it is advisable to develop plans to avoid or minimize adverse effects to listed or unlisted species should overtopping flood events occur.

Stranding or entrapment of salmonids and other fish species on floodplains is a natural phenomenon and is one of the many impediments to survival that fish in the freshwater environment must contend with. Stranding could occur whenever a fish-bearing creek or river overflows its banks and floods adjacent lands. Salmonids, in an effort to find refuge from high water velocities in the river channel, seek areas of relatively quiet water in which to hold prior to continuing their migration upstream or downstream. As flows subside, the majority of fish re-enter the channel. However, a number of fish may become trapped in landscape features such as topographic depressions and isolated secondary and high-flow channels. Entrapment of salmonids can be exacerbated by a variety of human activities. These include rapid downramping of discharges in response to hydroelectric power demand and production, floodplain residential and agricultural development, as well as floodplain pit mining.

Stranding and entrapment of salmonids occur on a regular basis within the Russian River valley in both natural and human-altered environments. For example, the Wohler constriction downstream of Healdsburg naturally restricts flood flows and causes floodwaters to be backed up and flood adjacent lands. Juvenile salmonids and other species can be observed trapped in natural isolated secondary channel pools in the Alexander Valley and Middle Reaches of the Russian River and several other northcoast rivers (Stillwater Sciences, pers. obs.). Salmonids are periodically trapped, and subsequently rescued, by the Sonoma County Water Agency (SCWA) at their infiltration ponds.

Granite proposes to develop the Kunzler Pit located on the west side of the Russian River, south of Ackerman Creek on a 65.3-acre parcel (Figure 1). The proposed pit and processing area will encompass approximately 30.2 acres and 4 acres respectively. The Reclamation Plan for the proposed project describes the establishment of a 250-foot wide buffer between pit and Russian River, a 150-foot wide buffer between the pit and Ackerman Creek, development of a flood control weir between the pit and creek, installation of a gate-controlled culvert to drain water from the pit, restoration of the buffer areas by removing grapevines and planting native vegetation, and construction of vegetated floodplains along the river and creek. The total acreage of the untouched riparian vegetation, revegetated buffers, constructed floodplain, and vegetated...
50-foot wide property line setback will be approximately 27.9 acres. The weir and access roads will be approximately 3.2 acres.

2 PURPOSE

The purpose of this report is to evaluate the potential for adverse impacts to listed salmonids (Chinook salmon and steelhead trout) from the proposed floodplain pit mining operation. The analysis contained in this report is based, in part, on the hydrologic modeling and geomorphic information presented in Murray, Burns, and Kienlen (MBK 2005) and Swanson Hydrology and Geomorphology (SH&G 2007) as well as the Federal Emergency Management Administration Flood Insurance Report (FEMA 1992) and the United States Geological Survey (USGS) Russian River Ukiah gaging data.

Fisheries issues associated with this project relate to:

1. The potential for salmonid entrapment in the pit, which may occur due to creation of a river/pit connection during flood events or development of attraction flows as floodwaters recede.

2. Construction of the floodplain, which has the potential to introduce sediment into the channel from erosion of excavated surfaces as well as adversely impact the low flow fisheries habitat.

3 PROJECT AND AREA DESCRIPTION

The proposed project area is located on a 65.3-acre parcel that is currently being used as a vineyard. It is surrounded by perimeter elevations that generally vary from 610 feet at the southeast corner boundary to 618 feet on the northwest side. The northern border of the project area runs along Ackerman Creek with the east side adjacent to the Russian River. A drainage ditch flows along the southern boundary. Riparian vegetation bordering the creek and river consists of cottonwood, willow, bay, alder, and scattered live oak trees.

Ackerman Creek, adjacent to the project area, contains suitable rearing habitat for juvenile steelhead and serves as a migration route for adult salmonids on their upstream spawning migrations. The creek is contained in a U-shaped channel and has a history of going dry in the lower reach during the summer months. In 2005, following a wet winter, the instream habitat in the creek was composed of 51% pools, 31% flatwaters, and 18% riffles (Halligan 2005). Residual pool depths ranged from 1.6 to 2.4 feet deep. Spawning habitat quality was in poor condition and embedded with sand and fine sediment. Instream fish habitat cover was supplied primarily by overhanging willow vegetation, rootwads, and undercut banks. Shade canopy closure averaged 71% over the low flow channel and was supplied primarily by adjacent willow vegetation.

The top of bank elevation at the northeast corner of the project area is at 612.8 feet. This location begins to be overtopped during an approximate 20-year return interval flood (~19,985 cfs at the USGS Ukiah gage; SH&G 2007). The flooding is exacerbated by the backwater condition that develops as Ackerman Creek drains into the river. Gravel deposition that occurs during the backwater condition also raises the streambed elevation and contributes to the flooding (SH&G 2007).
As part of this project Granite proposes to construct a low elevation floodplain adjacent to Ackerman Creek and the Russian River (See Exhibits 7 and 9 of the Mining and Reclamation Plan 2007). The floor of the constructed floodplain along the Russian River would be 50 to 55 feet wide and 420 feet long with elevations ranging from 604 to 605 feet above mean sea level. The Ackerman Creek portion of the floodplain would be approximately 1,300 feet long and have elevations between 605 and 606 feet above mean sea level. The floor of the constructed floodplain would be below the 2-year return interval flood (~7,500 cfs) elevation. The side slopes of the floodplain would be graded toward the terrace at a 3:1 horizontal to vertical angle. The constructed floodplain and associated side slopes would amount to about 3.9 acres. The floor of the floodplain would be planted with a variety of riparian trees that gradually grades from willows near the watercourses to mixed riparian forest species such as alders, cottonwoods, and California walnut. The terrace surface would be converted from vineyard agriculture to a valley oak savanna vegetation type. It is expected that the floodplain construction and riparian/upland revegetation program will significantly improve winter period fish habitat and year-around wildlife habitat. See the Mining and Reclamation Plan (2007) for the floodplain construction and planting plan specifics.

Granite also proposes to develop a terrace pit mine within the project area. The proposed mine footprint will cover approximately 30.3 acres and be developed in three phases (See Exhibits 6a-6c of the Mining and Reclamation Plan 2007). Phase 1 of the project will include the floodplain and weir construction, development of the processing facility, and mining in the northeast corner of the pit. The Phase 2 area will include the southeast corner of the pit. Phase 3 will be located in the northwest portion of the property and will be mined in a westerly direction. The floor of the pit will be at an elevation averaging 547 feet. The pit will have sideslopes excavated on at least a 2:1 (horizontal:vertical) slope along the south and west side with 2.5:1 slopes along the north and east sides.

The proposed project would also incorporate a flood control weir along the northern edge of the pit. The purpose of the weir is to prevent terrace overtopping flood flows from eroding the buffers separating the pit from the watercourses. The floor of the weir would be set at an elevation of 608.5 feet, which is about the 12,100 cfs elevation. The weir would be constructed during Phase 1 of the mining schedule.

4 PROJECT ALTERNATIVES AND IMPACT ANALYSIS

The following fisheries analysis was conducted to consider the potential impacts for four different alternatives. The alternatives included:
- Alternative A is the current condition associated with the project area.
- Alternative B includes construction of an armored flood control weir between the pit and Ackerman Creek that has a base invert elevation at 608.5 feet.
- Alternative C includes construction of an armored flood control weir with a base invert elevation at 608.5 feet, a fuse plug set in the weir at an elevation of 612.3 feet, a gate-controlled culvert set below the base of the weir, floodplain construction along Ackerman Creek and the Russian River at the 605- to 606-foot elevation, and native riparian planting in the buffer strip between the pit and watercourses.
Alternative D includes floodplain construction along Ackerman Creek and the Russian River and native riparian planting in the buffer strip between the pit and watercourses, but no flood control weir.

The project design and hydraulic analysis (SH&G 2007) and fisheries impact assessment required the use of flood hydrographs and peak flood discharges. Peak flood discharges were used in steady state hydraulic modeling, and flood hydrographs were used for the unsteady (time varied) hydraulic modeling. Swanson Hydrology and Geomorphology conducted the modeling exercises using HEC-RAS Version 4.0 Beta (USACE 2006b). The steady state analysis was used to determine the sensitivity of varying discharges on the water surface elevation along Ackerman Creek. The unsteady analysis was used to develop the weir and fuse plug design elevations as well as provide the basis (flood hydrograph/discharge duration) to assess impacts to fish. This analysis utilized 10- and 100-year hydrographs that were modeled for conditions in the Russian River just downstream of Ackerman Creek. See SH&G (2007) for detailed information on the hydraulic model development and results.

The annual peak flows for the entire period of record at the Russian River Ukiah, East Fork Russian River, and Hopland Russian River USGS gages occur during November through March (Table 1). This suggests the peak flows tend to occur either prior to, or at the start of, the downstream juvenile salmonid migration. Therefore, in general, the migrating juvenile salmonid population may not be significantly affected by the current condition of the terrace or proposed project condition. The groups of salmonids that may primarily be exposed to the weir would be those juveniles (steelhead or Chinook) that happen to rear in the vicinity of the project area or adults on their spawning migration.

<table>
<thead>
<tr>
<th>Gage Location</th>
<th>Gage #</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>Total # Peak Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian R. Ukiah</td>
<td>11461000</td>
<td>4</td>
<td>10</td>
<td>21</td>
<td>14</td>
<td>5</td>
<td>54</td>
</tr>
<tr>
<td>East Fork Russian R.</td>
<td>11461500</td>
<td>3</td>
<td>9</td>
<td>26</td>
<td>16</td>
<td>7</td>
<td>61</td>
</tr>
<tr>
<td>Russian R. Hopland</td>
<td>11462500</td>
<td>1</td>
<td>9</td>
<td>24</td>
<td>23</td>
<td>8</td>
<td>65</td>
</tr>
</tbody>
</table>

4.1 Alternative A

Alternative A is no project and so there would be no change over the current condition. The project area would continue to be flooded during any event that exceeds a discharge of 19,985 cfs, or about a 21-year return interval flood. Based on the modeled 100-year return interval flood hydrograph produced by SH&G (2007), the river would have a connection to the proposed pit site for about 10 hours (Figure 3) during these events. Fish would still have the potential to be trapped within the vineyard as likely currently occurs.
4.2 Alternative B

Alternative B would incorporate the construction of an armored flood control weir with a base invert elevation at 608.5 feet. The unsteady hydraulic model for the 100-year return interval flood, produced by SH&G (2007), indicates that the invert would be inundated for approximately 18 hours (Figure 3) during these events. The discharge necessary to make the river/pit connection would be approximately 12,100 cfs (approximately 5-year return interval flood). The unsteady hydraulic model also indicates the weir invert would be inundated at the 10-year return interval for approximately 9.5 hours (Figure 4). This alternative would increase the potential river/pit connection over the current condition by about 8 hours during a 100+-year flood event and 9.5 hours during a 10-year event. Fish would be able to exit the pit during the recession of floodwaters, but some would likely remain trapped.

4.3 Alternative C

Alternative C includes: (a) construction of an armored flood control weir with a base elevation at 608.5 feet between the creek and pit; (b) a “fuse plug” within the weir at the 612.3-foot elevation (~20-year flood elevation); (c) a gate-controlled culvert; (d) about 1,720 feet of low elevation floodplain construction along Ackerman Creek and the Russian River; (e) native riparian planting in the constructed floodplain, in the buffer strip between the pit and watercourses, and along the perimeter of the pit; and (f) an outlet culvert to drain water between the weir invert and summer water surface elevation.

Similar to Alternative B, this scenario would result in floodwaters entering the pit more frequently than the terrace currently overtops. However, the fuse plug, constructed out of erosive material, would breach and erode when overtopped during a flood event that exceeds 19,700 cfs (Brian Smith, pers. comm.). Once the fuse plug is overtopped and eroded during the ascending limb of the hydrograph, the river/pit connection would continue until the water surface elevation drops below the 608.5-foot invert elevation during flood recession. The unsteady hydraulic model for the 100-year return interval flood indicates that the duration of this event would be approximately 15 hours (Figure 3). This alternative would increase the potential river/pit connection at the proposed site by about 5 hours over the current condition. However, no connection would be made until discharge exceeds 19,700 cfs, which is only 285 cfs below the terrace overtopping flow. Therefore, nearly all the increase in connection time between Alternative A and C would occur once the flood exceeds the 20-year recurrence interval. Fish would be able to exit the pit during the recession of floodwaters, but some would likely remain trapped.

Granite also proposes to install a 190+ foot long reinforced concrete pipe culvert at the base of the weir that is fitted with a one-way flap gate on the outlet. The outlet would be set at an elevation of 595 feet. The inlet of the culvert, which would be fitted with a manually operated gate valve, would be set at an elevation of approximately 598.6 feet. The one-way flap gate and manually operated gate valve would prevent water and fish from entering the pit during the rising limb of the hydrograph. The gate valve would be opened on the receding limb of the hydrograph once the Ackerman Creek water surface elevation dropped below 597 feet or the top of the outlet flap gate. The culvert would drain the approximately 263 acre-feet of water that is between the weir invert and the 598.6-foot water surface elevation in about 126 hours. It would take about 41 hours to reach 602 feet.
The intention of this culvert is to allow water in the pit that potentially contains entrapped salmonids to drain back into Ackerman Creek. Flood waters, and presumably fish, would exit the pit during the receding limb of the hydrograph through the weir and then the culvert. The smooth bore of the culvert would provide little refuge for fish from the high water velocities within. The outlet of the culvert would empty onto a flat concrete and riprap apron, which would create a shallow, high velocity sheet flow. As the water elevation in the pit drops so would the culvert discharge and water velocity. Coincident with the decrease in outfall discharge would be a lowering of the water depth in the sheet flow over the apron. The length, discharge velocities, and construction design of the culvert and apron would constitute a highly effective barrier and keep fish from entering the pit while it is in operation.

This alternative includes the development of a low elevation floodplain and riparian vegetation planting program. The intention of the floodplain development and planting project is to improve winter survival of salmonids adjacent to the project area during relatively frequent (less than 2- to 20-year recurrence interval) flood events. This improved survival potential would be due to the significantly increased amount of high flow winter rearing habitat provided by the planted vegetation and wider low elevation floodplain. Revegetation of the high terrace buffer area would also provide very high flow refugia for salmonids during the larger than 20-year flood events. These improved winter salmonid habitat conditions are intended to help offset the impacts to fish that might result from the short-duration and infrequent overtopping events that flow into the pit.

4.4 Alternative D

Alternative D includes floodplain construction along Ackerman Creek and the Russian River at the 604- to 606-foot elevation, and native riparian planting in the buffer strip between the pit and watercourses, but no flood control weir. Similar to Alternative C, this scenario would likely significantly improve overwintering conditions and survival for salmonids than what is currently provided by the site. In addition, the overtopping frequency would be the same as under the current condition since the buffer elevation surrounding the pit would be unchanged. However, the lack of a flood control weir could seriously jeopardize the integrity of the buffer along Ackerman Creek and the Russian River during low frequency flood events. Floodwaters flowing into the pit would cause headcutting of the land side of the buffer (MBK 2005). Likewise, water draining from the pit back into Ackerman Creek could result in headcutting of the stream side of the buffer. This could lead to a breaching of the separation and more frequent inundation at lower flows until the breach was repaired the next spring or summer. The river/pit connection could last for an unknown and uncontrollable amount of time.

4.5 Attraction Flow (Alternatives B and C)

It is possible that an attraction to migrating adult salmonids could be created by receding floodwaters flowing through the Alternatives B and C weir. This attraction would result from water spilling over the armored weir back into Ackerman Creek on the receding limb of the flood. It must be emphasized that this potential is very limited in nature. The potential impact is based on the assumption that any flood event that spills into the pit has the ability to fill it above the base elevation of the weir. This is unlikely to occur due to the variation in the hydrographs of some flood events that don’t allow enough time for filling, especially when the pit is fully developed and has more storage capacity. For example, a discharge event that reaches the 20-
year return frequency and has a rapid rise and fall of stage may not necessarily fill the pit. By contrast, a flood of the same return interval, which has a more gradual rise and fall in stage, would be more likely to fill the pit. Therefore, the volume of water entering the pit, and any associated attraction potential, would vary depending on each particular flood’s hydrograph.

It is estimated that an attraction flow could be created when the terrace becomes exposed following a major flood event and the pit is draining through the weir. Using the modeled 100-year flood hydrograph (Figure 3), the weir would drain the pit on the receding limb of the hydrograph when water surface was between the terrace (19,985 cfs) and weir invert (12,100 cfs) elevations. This time period would amount to about 5 hours. Therefore, an attraction flow could be maintained through the weir for about 5 hours during a hypothetical 100-year event.

Discharge of flood waters through the culvert would not result in an attraction flow due to the barrier characteristics built into the design.

There is no attraction flow associated with the current condition. It is possible that an attraction flow could be created under Alternative D if there is a complete breaching of the buffer. However, the unknown finished elevation of the potential buffer breach renders analysis of Alternative D impossible.

### 4.6 Floodplain Construction and Native Planting Activities (Alternatives B and C)

Granite proposes to improve floodplain function by widening the Ackerman Creek and Russian River channel under Alternatives C and D. Construction will consist of creating a narrow (50- to 55-foot wide) floodplain that is approximately 7 feet and 11 to 12 feet above the low flow water surface elevations of Ackerman Creek and the Russian River, respectively. The sideslopes will be excavated at a 3:1 (horizontal:vertical) slope to the top of the bank. The footprint of the project would average 85 feet wide by 1,300 feet long on the south bank of Ackerman Creek and 70 feet wide by 420 feet long on the west bank of the Russian River. The base elevation of the constructed floodplain would be below the 2-year flood return interval. Native vegetation will be planted on the newly constructed floodplain and associated side slopes, high terrace buffer area, and pit/property line setback perimeter. The total area involved is approximately 32.8 acres.

Typical excavation projects have the potential to adversely affect salmonids and their habitat in a number of ways. Deposition of soil and other material during construction activities into the creek and river could affect spawning and rearing habitat. Erosion of the excavated surface could introduce sediment into the channel. Operations may result in harassment of listed salmonid species that may be in the vicinity. Loss of riparian trees could reduce canopy closure leading to increased water temperatures and loss of large woody debris recruitment. To address these concerns, this project will have a number of protection measures built into the project description that are designed to avoid, minimize, or mitigate potential adverse impacts to salmonids and their habitats.

Deposition of soil and other material into the creek and river would be avoided or minimized by incorporating a number of Best Management Practices during construction. A floodplain construction operating season of June 15 through October 15 would be established to reduce the potential for heavy rainfall events that could result in erosion and transport of sediment offsite. Silt fencing would also be placed during the construction process to minimize sediment movement offsite in the event a summer rainstorm occurs. Construction activities would avoid
disturbing the low flow channel bank as much as possible by maintaining an elevational offset of 7 to 12 feet above the low flow water surface elevation of the creek and river. This elevational offset will equate to about a 10 to 20-foot edge of water buffer. The dense willow vegetation along the low flow channel and within the edge of water buffer would be retained to maintain bank stability, filter sediment, and keep heavy equipment from encroaching into the channel. Post-construction erosion of the excavated surfaces would be minimized by placement of erosion control matting and silt fences, seeding and mulching of bare soils, and retention and planting of native riparian vegetation. Concentration of rainfall runoff from the adjacent original elevation terrace would be minimized by elimination of top-of-bank berms. The retention and incorporation of existing riparian trees into the grading plan would introduce roughness and topographic variability on the constructed floodplain. This variability would reduce winter runoff water velocities through the project area and help minimize erosion. Increases in water temperatures and reduction of large woody debris (LWD) recruitment would be minimized by incorporating existing trees into the grading plan. The retention of dense streamside willow vegetation will help maintain shade canopy over the stream. The riparian planting program would increase the number of native trees in the floodplain and adjacent buffer area, which would eliminate the long-term potential for water temperature increases and improve woody debris recruitment over the current condition. LWD from trees removed during grading activities would be placed on the graded surface so they can be mobilized at high flows and redeposited downstream. LWD may also be incorporated into the grading plan to help reduce water velocities on the constructed floodplain. Harassment of salmonid species would be minimized by establishing a seasonal operating season for floodplain construction activities that allows grading and excavating work only during the period of June 15 through October 15. This operating season would coincide with the end of the downstream juvenile salmonid migration season and prior adult spawners arriving in the construction area. No heavy equipment work will be conducted within the wetted channel. It is possible that, as in some years, the project reach of Ackerman Creek may be dry during the latter part of the construction season, which would eliminate the potential to harass salmonids. The lower elevation combined with the native planting program in the Ackerman Creek and Russian River constructed floodplain would increase the amount of frequently inundated high flow winter rearing habitat available for salmonids. This should significantly improve winter survival juvenile salmonids that might be rearing in the project vicinity. It is expected that improved survival during the frequent winter runoff events would offset the potential loss of salmonids in the pit during the less frequent (~13 return interval) overtopping events. It is also expected that fish would be more likely to utilize vegetated cover within the restored floodplain during flood events than enter and occupy the open water within the weir and pit. It is expected that many non-fish species would also benefit from the riparian planting program. As the planted trees mature, nesting opportunities for bird species would increase. The ability of the riparian zone to serve as a wildlife travel corridor would improve. The riparian area would also serve as a visual buffer for boaters and anglers on the river.
5 SUMMARY

Alternative A would not change the current condition. Ackerman Creek and the Russian River would continue to overtop their banks with the same frequency. The terrace would be inundated for about 10 hours during a 100-year recurrence interval flood event. Fish would continue to become stranded on the floodplain during these events. The abandoned vineyard would likely be replanted with grapevines and be subject to sulfur, herbicide, and pesticide treatments. Riparian vegetation coverage would continue to be restricted to the area below the terrace elevation.

Alternative B poses the greatest risk of entrapment for adult and juvenile salmonids from overtopping events. The 608.5-foot weir floor elevation would allow spilling into the pit during flood events with discharges greater than 12,100 cfs. This would result in about 18 hours of river/pit connection during a 100-year flood event and a 9.5-hour connection during a 10-year flood event. A 5-hour attraction flow could become established during the receding limb of the hydrograph of an event that is capable of filling the pit. Riparian vegetation coverage would continue to be restricted to within the area below the floodplain elevation.

Alternative C poses a greater risk of entrapment over the current condition, but less than Alternative B. The flood control weir with its associated fuse plug would begin to spill when the water surface is above the 19,700 cfs elevation. The potential river/pit connection may increase by about 5 hours during a 100-year flood event compared to the current condition. A 5-hour attraction flow could become established through the weir during the receding limb of the hydrograph of an event that is capable of filling the pit. The culvert would further reduce entrapment potential by allowing fish an escape route as the pit drains below the weir invert elevation. The riparian planting program in the buffer area between the constructed floodplain and the pit would significantly increase high velocity refugia and winter floodplain habitat for salmonids during runoff events exceeding the 2-year recurrence interval. The improved winter habitat quality would likely increase over-winter salmonid survival rates for salmonids compared to current conditions. The improved survival during relatively frequent floods could help offset the loss of fish during the very infrequent floods that may result in entrapment in the pit. The planting program in the buffer area would significantly improve avian and terrestrial wildlife habitat compared to that which currently exists.

Alternative D would result in improved survival of salmonids during the winter period, similarly to Alternative C. However, the buffer between the watercourses and pit could be subject to erosion under Alternative D as floodwaters pour into and drain out of the pit. Depending on the characteristics of the overtopping event, the buffers may suffer significant erosion and possibly breach during the ascending and receding legs of the hydrograph. This would result in a river/pit connection lasting an unknown duration.
6 REFERENCES


PERSONAL COMMUNICATION

Mark Fortner (MBK Engineers), via email, December 12, 2006

APPENDIX

Figures
Figure 1: Project location map. (From the Kunzler Terrace Pit Mining and Reclamation Plan (2007).
Figure 2: Proposed Vegetation Plan. Taken from the Kunzler Terrace Pit Mining and Reclamation Plan (2007).
Figure 3

Modeled 100-year Flood Hydrograph with Current and Proposed Condition Overtopping Durations

--- Russian River downstream of Ackerman Creek (Combined)

- Fuse plug and terrace overtopping are nearly the same discharge. The lines are offset for descriptive purposes.
- Duration of current condition terrace overtopping
- Duration of fuse plug overtopping
- Duration of 608.5 foot weir invert elevation overtopping
Modeled 10-year Flood Hydrograph (SH&G pers. comm.) with Proposed Condition

Overtopping Duration

Russian River downstream of Ackerman Creek (Combined)

Duration of 608.5-foot weir invert elevation

Discharge (cfs)

Date/Time