

TECHNICAL MEMORANDUM—REVISED DRAFT

Date: May 9, 2025

To: Emy Carpenter, Moffatt & Nichol (M&N)

From: Todd Alsbury, Claudia Browne, CE, Michael Lighthiser, PE, Biohabitats, Inc.

RE: Chehalis LAND Alternatives

Subject: Habitat Evaluation Input

Objective

Biohabitats was subcontracted by M&N to assist with the habitat evaluation of Chehalis Basin LAND Alternatives. The purpose of this memorandum is to summarize the approach and high level evaluation of potential impacts to species identified in the Aquatic Species Restoration Plan (ASRP) for the Chehalis Basin by considering potential impacts to geomorphic processes and habitat for fish and wildlife species (fish/salmonid focus).

Methods

In coordination with M&N, Biohabitats developed the following overall approach to the alternative's evaluation:

1. Select assessment criteria based on references
2. Characterize existing habitat
3. Summarize likelihood of impacts in the evaluation matrix, and
4. Identify restoration/mitigation opportunities.

Each of these steps are described in the subsections below.

Selection of Assessment Criteria

The following reference documents were reviewed to understand federal and state guidance, best management practices, and the current/historic use by fish and wildlife throughout the assessment areas.

- Federal guidances:
 - FEMA floodplain habitat assessment (multiple)
 - Habitat Assessment and Restoration Potential-HARP model (NOAA Fisheries, 2021)
- Chehalis Basin Strategy:
 - ASRP
 - Chehalis Watershed Assessment and Salmon Life-cycle Modeling
 - Washington Integrated Fish Distribution
 - Chehalis Basin Smolt Production (2019)
 - LAND Alternatives/Chehalis Combined Conceptual Atlas
 - Fish-friendly Flood-control: Improving Salmon Habitat at Sacramento Levees (2018)

Based on review of the reference documents, the following criteria were identified as being potentially applicable to the current project.

Table 1: List of relevant evaluation categories and potential impacts.

Category	Potential Impact	Considerations
Site context	Land use adjacent to flood protection feature	Potential loss of connectivity (e.g. for potential habitat) due to changes in undeveloped land or open space. Available space for restoration and mitigation.
Geomorphic	Floodplain and riverine processes	Floodplain function, channelization incision, bank erosion, sediment transport and deposition
Aquatic and Riparian Habitat	Direct alteration of streambank	Distance from river, channel length
Aquatic and Riparian Habitat	Riparian and floodplain habitat condition	Riparian and wetland vegetation, shade, abandoned off-channel habitat (oxbows)
Aquatic and Riparian Habitat	Existing/historic refugia conducive for fish rearing	Existing off-channel habitat, pools, substrate
Fish & Wildlife Species	Fish life history characteristics	Migration, spawning, rearing

Fish & Wildlife Species	Wildlife species that occupy floodplain habitats	Amphibians, migratory birds, wetlands, aquatic insects, open water
Restoration/Mitigation Opportunities	Uplift potential of associated restoration actions	Presence of opportunities to restore habitat within assessment areas

Characterization of Existing Habitat

To characterize existing habitat, Biohabitats staff set up a basemap of GIS layers, reviewed aerial imagery, and drew boundaries around LAND alternative features to define evaluation areas. The boundaries were generally broad to encompass adjacent and nearby tributary confluences, side channels, remnant oxbows, wetlands, and floodplain habitats in the vicinity of the LAND alternative. This broadly defined area allowed for initial observations of potential restoration and mitigation opportunities to be included in the evaluation. Strategies to minimize impacts and avoid mitigation is a major focus and they will be incorporated into design development including: 1) setting back levees and floodwalls to avoid sensitive habitats including riparian and wetland areas, 2) conducting work at times of the year when direct impacts can be avoided, 3) incorporation of innovative design techniques (natural channel design, engineering with nature), and 4) consideration of long term impacts resulting from potential geomorphic and hydraulic changes resulting from levee/floodwall development.

In cases where multiple features occurred in an area, we evaluated them separately based on the amount of habitat impacted or potential uplift created by proposed restoration/mitigation actions. Descriptions of existing habitat in the assessment area are included below.

Evaluation Approach

Biohabitats compiled GIS files of the proposed alternatives (provided by M&N) along with available geospatial data on Chehalis flood mapping, habitat features, and fish and wildlife distribution from Washington's Ecological Integrity Assessment and natural heritage ecological systems. In areas potentially impacted by the construction and operation of the alternatives. For each alternative, assessment areas (AA's) were sketched by Biohabitats to include nearby, relevant features including habitats potentially impacted by the LAND alternative as well as restoration/mitigation areas in proximity to the alternative. Each area was then evaluated for the presence and extent of features listed in the criteria table and summarized in location-specific summaries as well as a summary table.

We used similar impact designations of minor, moderate and major as those described in the Chehalis Basin Strategy, as shown below. Note, while the prior study assessed similar impacts, it

looked at combined LAND Alternatives at a basin-wide scale, rather than individual treatments at a local scale.

Degree of Potential Impact

- Minor = minimal and/or easily mitigated
- Moderate= Limited local extent and effect; mitigation expected to be relatively straightforward
- Major= Adverse and larger in scope and extent; mitigation requirements likely significant

Identification of Restoration/Mitigation Opportunities

Restoration and mitigation opportunities were identified by land use type, evidence of historical channels and floodplain connections, available space to conduct restoration and mitigation actions, and opportunity to enhance for species that could be impacted by construction and continued existence of levee and floodwall features. Opportunities identified align with guiding principles and restoration/enhancement concepts found for the Middle Chehalis Basin in the ASRP.

Evaluation Results

Evaluation results for each alternative are described in the following site-specific evaluations and summarized in Table 2.

PJ 2.1 Adna Levee/Floodwall

Site Context

Land use is a mix of rural residential and agricultural land use. Agricultural land with historical side channels may provide major opportunities for restoration/mitigation.

Geomorphic Process Impacts

Moderate overall impact due to the following considerations:

- Altered flow conveyance because of confined river channel between proposed levee/floodwall and opposite bank (southwest of levee) of the Chehalis River.
- Impact to existing floodplain side channels and tributaries downstream of the LAND feature.
- Potential increased rates of channel incision, bank erosion, and sedimentation of downstream habitat. Channel incision could result in further abandonment of floodplain habitats downstream of the LAND feature.

Aquatic and Riparian Habitat

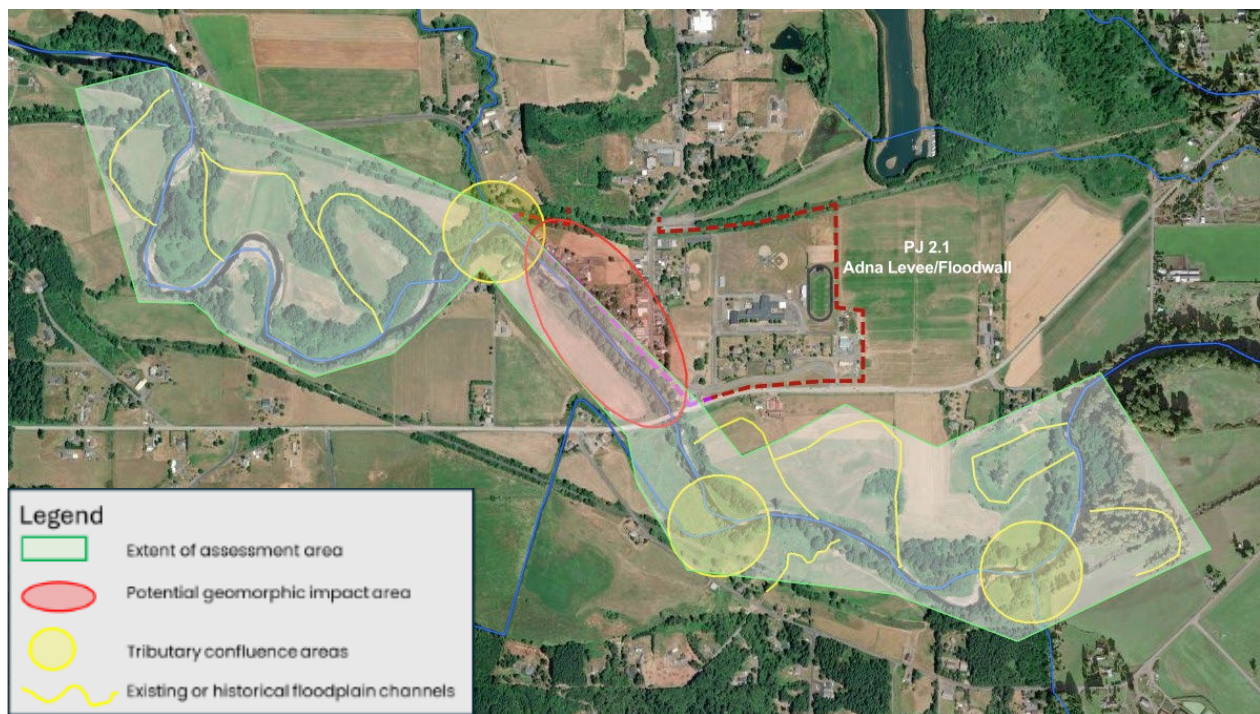
- **Direct alteration of streambank:** Portions of the levee are directly adjacent to the channel upstream of the Hwy 6 Bridge crossing of the Chehalis River, where major impacts to the streambank would be expected. . The proposed levee/floodwall is directly adjacent to the riparian buffer along the river and is likely to alter the streambank resulting from construction related impacts and footprint of the levee/floodwall.
- **Riparian and floodplain habitat condition:** Moderate direct impact is likely to a continuous but narrow strip of good condition riparian vegetation between the levee and the river. Approximately 76 acres of wetlands are in the assessment area with high ecological integrity, which may be potentially impacted by loss of floodplain connectivity.
- **Existing/historic refugia conducive for fish rearing:** High quality rearing habitat appears to be present in the form of side channels and tributary confluences within the AA that is at moderate risk of being impacted by the proposed levee/floodwall. It is unclear to what extent these side channels are connected to the river and currently providing opportunities for juvenile fish rearing. There is minor risk of floodplain habitat being impacted by the proposed levee/floodwall.

Fish & Wildlife Species

- **Fish life history characteristics:**
 - Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.
 - Native fish species could be impacted because of loss of access to off-channel rearing habitats that are critical for juvenile fish productivity and survival. Potential risk to adult fish habitat is unknown but could be impacted by channel incision associated with floodplain narrowing, which may result in loss of access to tributaries or direct impacts on adults if spawning activity occurs in this reach of the river prior to extreme high flow events.

- **Wildlife species that occupy/use floodplain habitats:** Minor wildlife impacts likely due to some loss of riparian vegetation habitat and potentially reduced connectivity.

Figure 1: PJ 2.1 Adna Levee (red dashed line) and Floodwall (purple dashed line). Potential geomorphic impact area is based on anticipated changes related to conveyance and channel capacity at higher range of flood levels.



PJ 2.2 East Bank of the Newaukum and Chehalis Rivers

Site Context

Mix of urban and agricultural land use. Half of AA consists of pasture/hay with some low-intensity development. Temperate freshwater emergent marsh and lowland riparian forest and shrubland take up half of the AA. Pasture may provide opportunities for restoration/mitigation.

Geomorphic Process Impacts

Minor impact due to confinement of flows in Dillenbaugh Creek and minor risk of reduction in floodplain capacity and storage.

Aquatic and Riparian Habitat

- **Direct alteration of streambank:** Minor impact to streambank where small section of levee is directly adjacent to channel at north end, but levee is setback at greater distances to south (up to approximately 1,000 ft at the south end). Dillenbaugh Creek
- **Riparian & floodplain habitat condition:** Riparian vegetation is moderately intact mix of marsh and meadows in good quality west of Interstate 5. Approximately 175 acres of wetlands in the assessment area have moderate ecological integrity and some poor quality emergent marsh is on east side of Interstate 5.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** Complex habitat in the form of large wood and pools that provide juvenile fish rearing opportunities is lacking in the AA. Riparian habitat is fragmented along the Chehalis and Newaukum Rivers to non-existent in Dillenbaugh Creek. There is minor risk of impacts associated with the proposed levee/floodwall, but opportunities exist to create uplift for native fish species by establishing a riparian buffer and increasing the amount of complex habitat available for juvenile fish rearing at tributary confluences where cooler summer flows provide potential refuge from high temperatures in the mainstem Chehalis River.

Fish & Wildlife Species

- **Fish life history characteristics:**

- Chehalis/Newaukum: Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.
- Dillenbaugh Creek: Coho salmon, rainbow trout, and coastal cutthroat trout
- Native fish in the AA likely migrate through as they seek higher quality habitat upstream but also rear as juveniles provided complex habitat is available and water quality conditions allow.
- **Wildlife species that occupy/use floodplain habitats:** Minor impacts expected since levee is set back and adjacent to developed area on one side, so little change in habitat connectivity is expected.

Figure 2: PJ 2.2 East bank of the Newaukum and Chehalis Rivers. Red dashed line is levee; purple dashed line is floodwall. Historical floodplain side channels and riparian corridor offer potential restoration/mitigation opportunities.



PJ 2.3 Skookumchuck Levee

Site Context

Land use is mix of urban, residential, agricultural, and industrial (rock quarry immediately upstream of levee). Mostly low-intensity urban development with some areas of high intensity.

Geomorphic Process Impacts

Moderate overall impact due to the following considerations:

- High potential for impact to high flow regime associated with development of levees on both sides of the river.
- Moderate potential to impact existing floodplain side channels and tributaries downstream of the LAND feature.
- Potential increased rates of channel incision, bank erosion, and sedimentation of downstream habitat. Channel incision could result in further abandonment of floodplain habitats downstream of the LAND feature.

Aquatic and Riparian Habitat

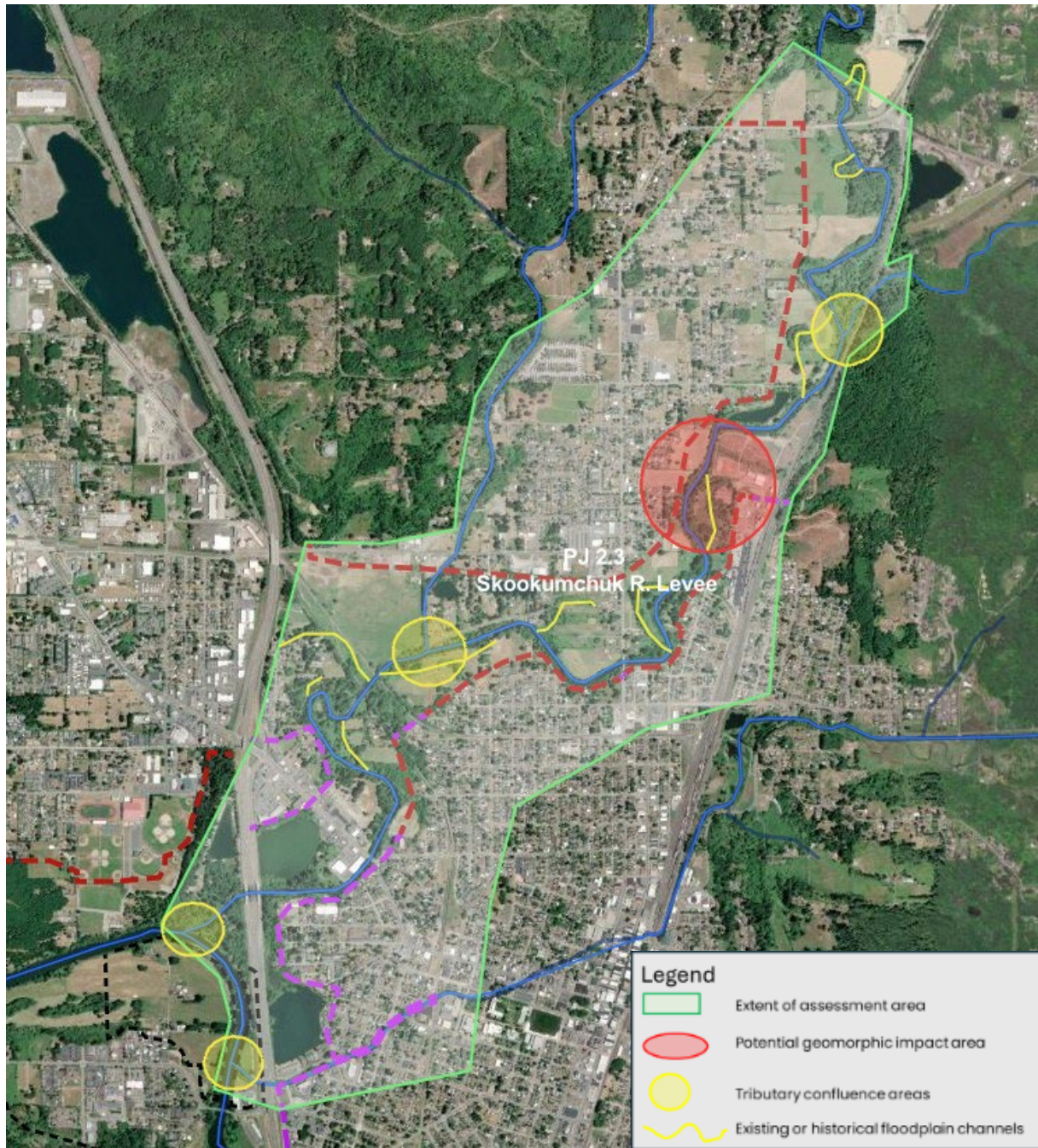
- **Direct alteration of streambank:** Significant portions of the proposed levees are directly adjacent to bound the lower Skookumchuck River between a confining hillslope on the channel where major impacts north end near Hwy 507 and between levees on the north and south side of the river downstream of the intersection of the proposed levee and Central Blvd. Impacts to the streambank would be expected.
- **Riparian and floodplain habitat condition:** Moderate impact because riparian vegetation is already characterized as highly degraded, with some “fair” to “good” quality lowland riparian forest and shrubland along the river channel. Nevertheless, roughly 186 acres of wetlands are within the overall assessment area and characterized as moderately high ecological integrity.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** The Skookumchuck River provides core habitat for spring Chinook salmon and coho salmon (ASRP, 2019). The lower river provides an opportunity for spawning by fall Chinook salmon within the AA. Rearing habitat for juveniles for all native fish species is limited due to lack of large

wood and off-channel habitat. There is moderate potential for impacts related to degradation of spawning and rearing habitat in the AA.

Fish & Wildlife Species

- **Fish life history characteristics:**
 - Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.
 - Spring Chinook, coho salmon, and winter steelhead adults migrate through the AA on their way to higher quality spawning habitat upstream. A significant portion of the available spring Chinook spawning habitat in the basin is not accessible due to lack of passage upstream of the Skookumchuck Reservoir. The lack of access to primary spawning habitats puts additional pressure on the lower river to support spawning and rearing needs for this population that is at risk of being listed under the Endangered Species Act.
- **Wildlife species that occupy/use floodplain habitats:** Species using the streambanks will be moderately impacted by proximate levees; however, the area is already predominantly urban and industrial land use, so presence and abundance of wildlife is expected to already be degraded.

Figure 3: PJ 2.3 Skookumchuck Levee/Floodwall. Red dashed line is levee; purple dashed line is floodwall. Historical floodplain side channels are potential locations for restoration/mitigation Potential area of geomorphic risk is related to changes in conveyance



PJ 2.4 Fort Borst Levee

Site Context

Primarily agricultural and undeveloped land use.

Geomorphic Process Impacts

Moderate impact due to significant narrowing of floodplain in localized areas (between proposed levee and opposite bank of the Chehalis River).

Aquatic and Riparian Habitat

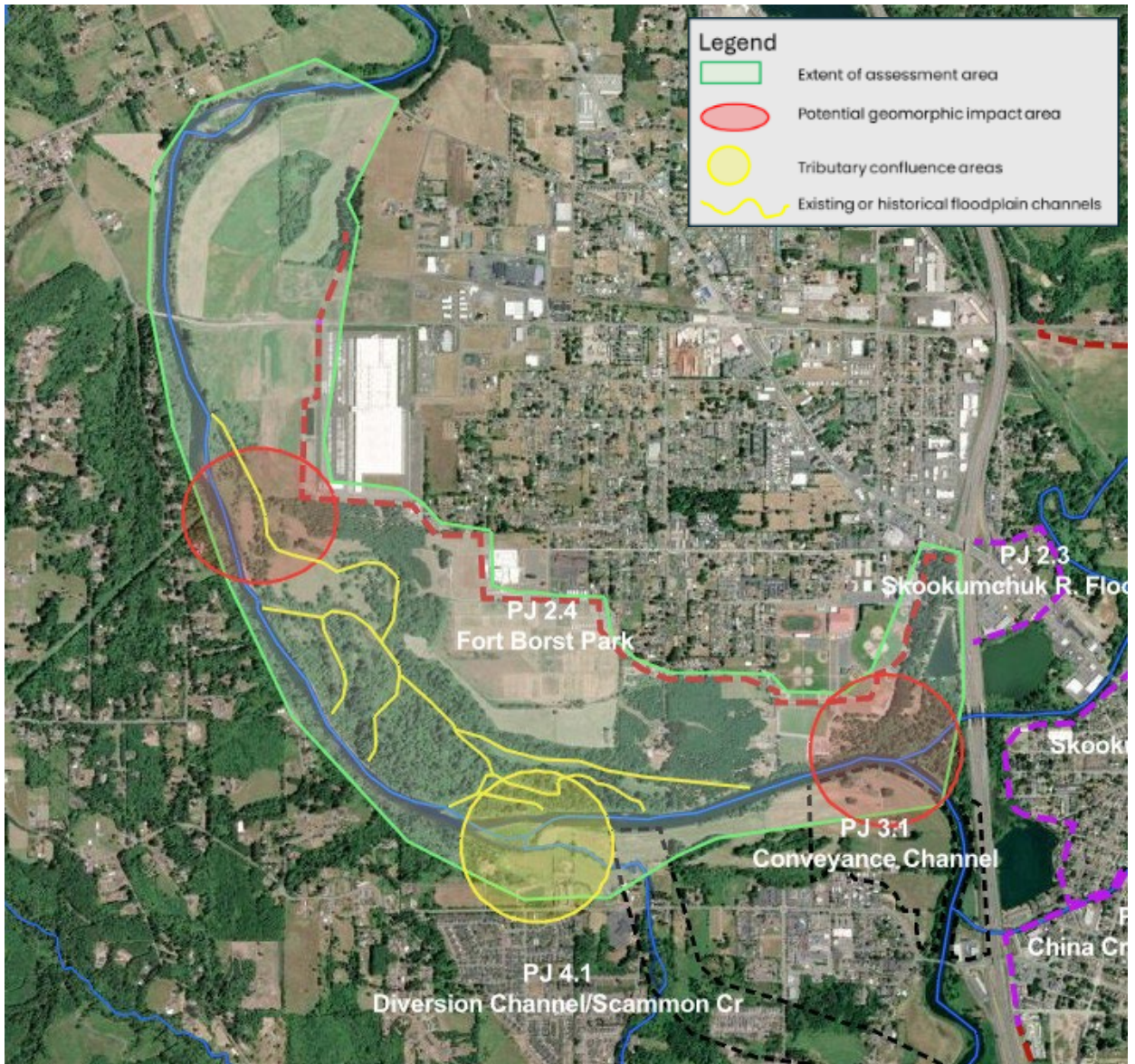
- **Direct alteration of streambank:** Minor impact due to the levee location setback from the river. The Fort Borst levee varies from 700 feet to 0.5 miles away from the Chehalis River. There is minor impact to the streambank associated with the proposed levee
- **Riparian & floodplain habitat condition:** Riparian vegetation is extensive and in excellent condition. Large areas of excellent-quality forest vegetation function as a key ecological corridor. Approximately 123 acres of wetlands in the assessment area are identified as having high ecological integrity.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** A relatively intact riparian forest with off-channel habitat is present within the AA that provides moderate opportunities for uplift. Enhancing off-channel habitat in this area can provide benefit to all rearing fish from upstream areas of the Chehalis Basin

Fish & Wildlife Species

- **Fish life history characteristics:**
 - Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.
 - All species of adult fish migrate through the AA on their way to primary spawning habitats upstream. Juvenile fish of all species likely use habitats like what is found in the AA to rear as they prepare for ocean migration.

- **Wildlife species that occupy/use floodplain habitats:** Areas of moderate impact from floodplain narrowing could reduce habitat connectivity.

Figure 4: PJ 2.4 Fort Borst Park Levee. Red dashed line is levee. Tributary confluences historical floodplain side channels offer potential restoration/mitigation areas. Potential geomorphic risk is related to conveyance and channel capacity at higher range of f



PJ 2.5 China Creek Floodwall

Site Context

Urban land use.

Geomorphic Process Impacts

- Floodwalls on either side of river represent intensive treatments: but due to existing urbanized conditions, the additional impacts appear to be only moderate.

Aquatic and Riparian Habitat

- **Direct alteration of streambank:** Impacts are expected to be minor based on existing urbanized conditions. Directly adjacent to river. Floodwalls confine the creek on both sides, limiting opportunity for restoration of riparian and instream habitat.
- **Riparian & floodplain habitat condition:** Potential impacts are minor because riparian vegetation in this area is limited, low quality, and ecological functions are minimal, except for the downstream end (western edge) which has “good” forest and shrubland. Only about 1.6 acres of wetlands are mapped in the assessment area with very low ecological integrity.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** Rearing habitat is limited in the AA due to impacts from urban development adjacent to the creek. The riparian condition is poor leading to limited overhead cover and a lack of a source of woody material that provides complex rearing habitat for juvenile fish. The confluence of China Creek with the Chehalis River provides an opportunity for creation of rearing habitat in a location where cooler water can provide rearing opportunities for fish from outside of the China Creek watershed.

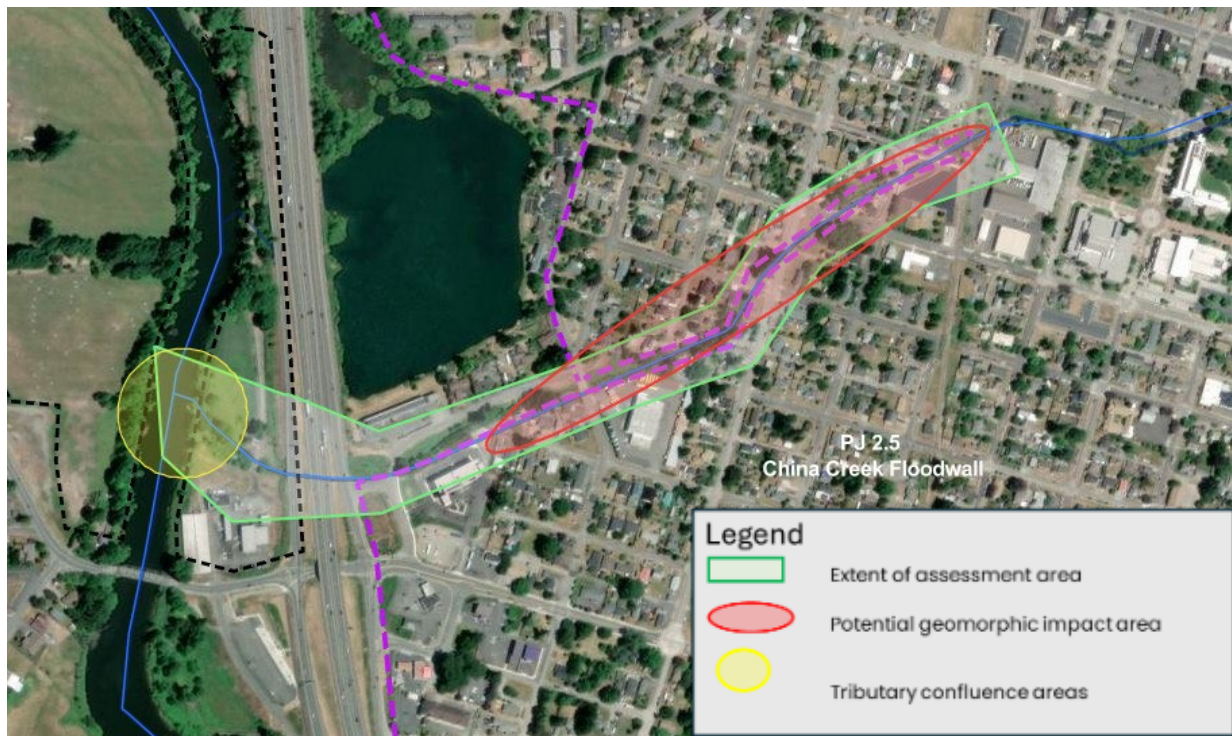
Fish & Wildlife Species

- **Fish life history characteristics:**
 - Native fish species include coho salmon and rainbow trout.
 - The current condition of lower China Creek does not allow for spawning by adult coho salmon or rainbow trout due to instream and riparian habitat conditions that lead to lack of overhead cover and fine sediments that cover or embed spawning

sized gravel. It is likely that adult fish migrate through this reach on their way to more suitable spawning habitat upstream and juveniles are not able to find rearing habitat and are required to move into the Chehalis mainstem to rear.

- **Wildlife species that occupy/use floodplain habitats:** Minor impacts due to low existing habitat quality and constraints.

Figure 5: PJ 2.5 China Creek Floodwall. Purple dashed line is floodwall. Potential geomorphic risk is related to change in channel capacity and conveyance. Potential restoration/mitigation opportunity is at confluence with the Chehalis River.



PJ 2.6 China Creek to Salzer Levee

Site Context

Agricultural, rural residential, urban residential land uses.

Geomorphic Process Impacts

- Localized areas of moderate impact due to proximity of levee near 1298 Pacific Avenue to Salzer Creek and constraining hillslope to the south/southeast. Overall, the remainder of the area has fewer impacts.

Aquatic and Riparian Habitat

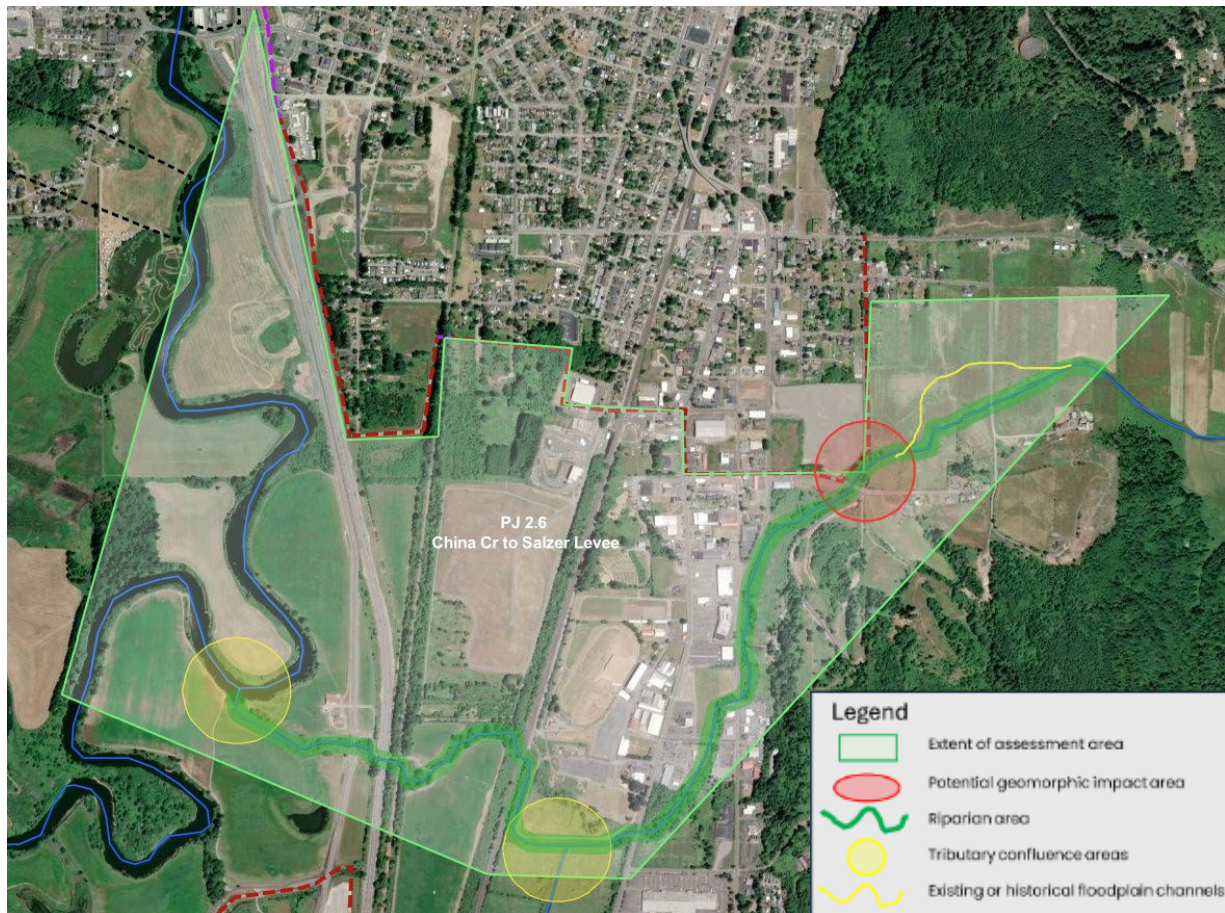
- **Direct alteration of streambank:** Minor impacts expected because only a small section of the levee is along the streambank (within 80 feet of Salzer Creek and 300 feet of the Chehalis River). Construction of the proposed levee near Salzer Creek could lead to minor impacts to the streambank in the AA due to the short length of the levee that will interact with the creek in the area.
- **Riparian habitat condition:** Riparian vegetation in the assessment area is generally good condition, and the area includes lowland forest and shrubland on the west side of the river in good to excellent condition. Approximately 441 acres of marsh and meadow wetland communities in the assessment area have moderate ecological integrity.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** Complex habitat in the form of large wood and pools that provide juvenile fish rearing opportunities is lacking in the AA. Riparian habitat is fragmented to non-existent leading to limitations on spawning and rearing habitat. There is minor risk of impacts associated with the proposed levee/floodwall, but opportunities exist to create uplift for native fish species by establishing a riparian buffer and increasing the amount of complex habitat available for juvenile fish rearing at the confluence of Salzer Creek and the Chehalis River where cooler summer flows provide potential refuge from high temperatures in the mainstem Chehalis River.

Fish & Wildlife Species

- **Fish life history characteristics:**

- Native fish species include coho salmon and rainbow trout.
- The current condition of lower Salzer Creek does not allow for spawning by adult coho salmon or rainbow trout in the AA due to instream and riparian habitat conditions that lead to lack of overhead cover and fine sediments that cover or embed spawning sized gravel. It is likely that adult fish migrate through this reach on their way to a more suitable spawning habitat upstream and juveniles are not able to find rearing habitat and are required to move into the Chehalis mainstem to rear.
- **Wildlife species that occupy/use floodplain habitats:** Minor impacts due to little change to existing habitat connectivity.

Figure 6: PJ 2.6 China Creek to Salzer Levee. Red dashed line is levee, and purple dashed line is floodwall. Existing or historical floodplain side channels and riparian area offer potential restoration/mitigation areas.



PJ 2.7 Chehalis Airport

Site Context

Southwest and western boundary consists of cultivated cropland. Area near airport is developed with harvested forest grass regeneration. The remaining area is agricultural .

Geomorphic Process Impacts

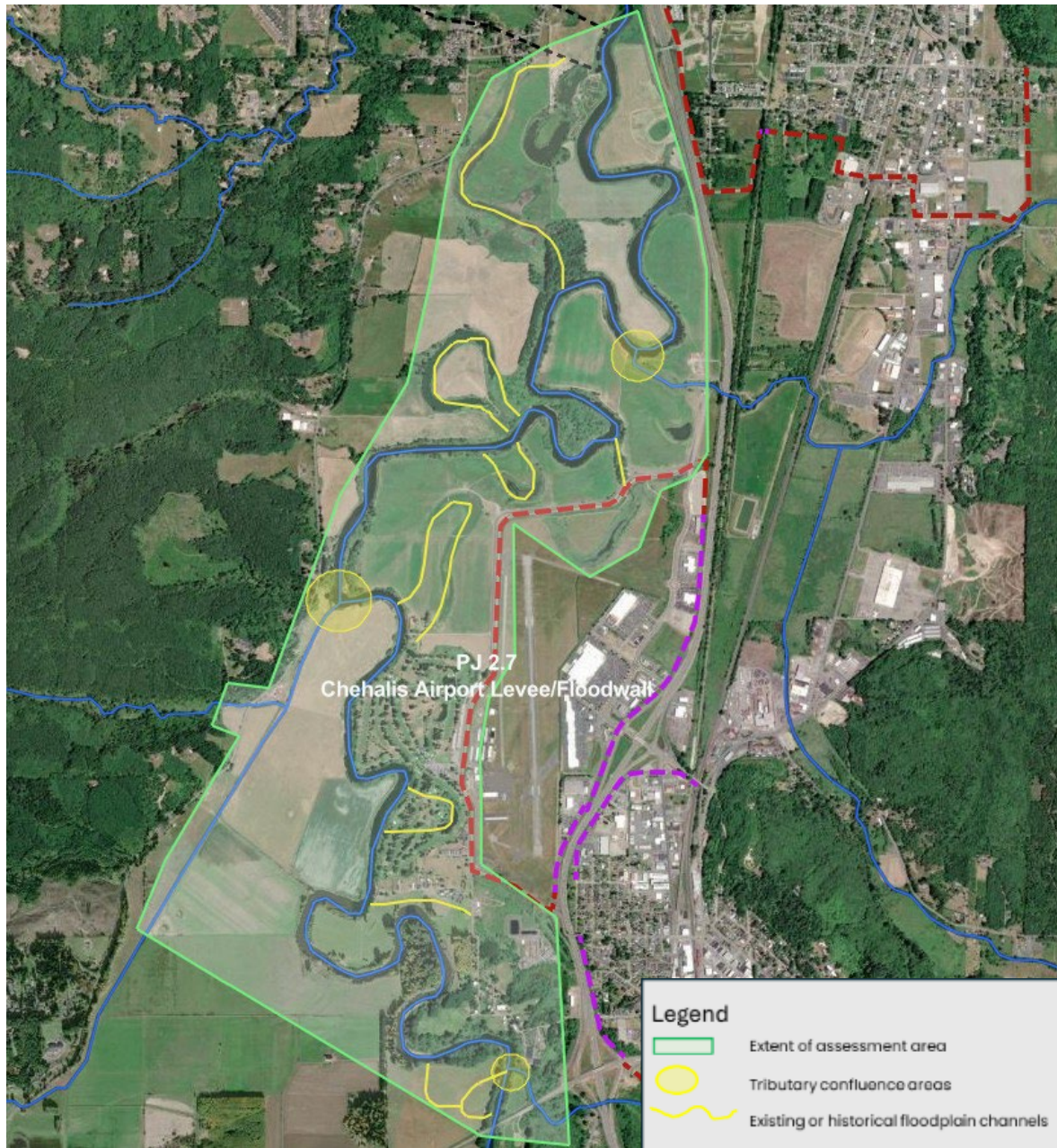
- Localized areas of moderate impact due to narrowing of floodplain and disconnection of side channel. However, because of existing levee, additional impacts are limited.

Aquatic and Riparian Habitat

- **Direct alteration of streambank:** The levee is setback from the river, so streambank impacts are not expected.
- **Riparian & floodplain habitat condition:** Riparian vegetation is limited to a narrow strip of trees that is fragmented throughout the AA. The narrow buffer does not provide adequate shading and likely contributes to degraded water quality. Roughly 380 acres of emergent wetlands in the assessment area have moderate ecological integrity.
- **Existing/historic refugia conducive for spawning and/or fish rearing:** Adult fish of all species migrate through the AA on their way to higher quality spawning habitat upstream. Off-channel habitats that provide juvenile fish rearing opportunities are lacking in the AA. Riparian habitat is fragmented and limited to a narrow strip along a large river system. There is minor risk of impacts associated with the proposed levee/floodwall, but opportunities exist to create uplift for native fish species by establishing an effective riparian buffer and increasing the amount of complex habitat available for juvenile fish rearing in off-channel habitats.
- Fish & **Wildlife** Species
- **Fish life history characteristics:**
 - Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.

- All species of adult fish migrate through the AA on their way to primary spawning habitats upstream. Juvenile fish of all species find little opportunity for rearing in the AA due to extensive channel incision and abandonment of historic side channels that provided critical rearing areas used by juvenile fish from throughout the basin. Opportunities exist to reconnect abandoned meander scars that are evident from aerial views of the AA and improving the riparian condition by sloping incised banks to a more stable angle that allows for effective revegetation of the riparian zone.
- **Wildlife species that occupy/use floodplain habitats:** Moderate impact to wildlife could occur due to fragmentation of portions of floodplain habitat (such as oxbow in north.)

Figure 7: PJ 2.7 Chehalis Airport. Red dashed line is levee, and pink dashed line is floodwall. Tributary confluences and existing or historical floodplain side channels offer potential restoration/mitigation areas.



PJ 3.1 Conveyance Channel (remove pinch points)

Site Context

Agricultural and undeveloped.

Geomorphic Process Impacts

- Despite extensive disturbances to adjacent lands from earthwork to support conveyance, minor adverse impacts to geomorphologic processes are expected. Potential changes in sediment transport processes are uncertain and could increase sediment accumulation. Overall, long-term impact of project would reduce entrenchment and increase floodplain connectivity with beneficial outcomes. (Also, provides opportunity for restoration of riparian buffer near Chehalis/Skookumchuck confluence.)

Aquatic and Riparian Habitat

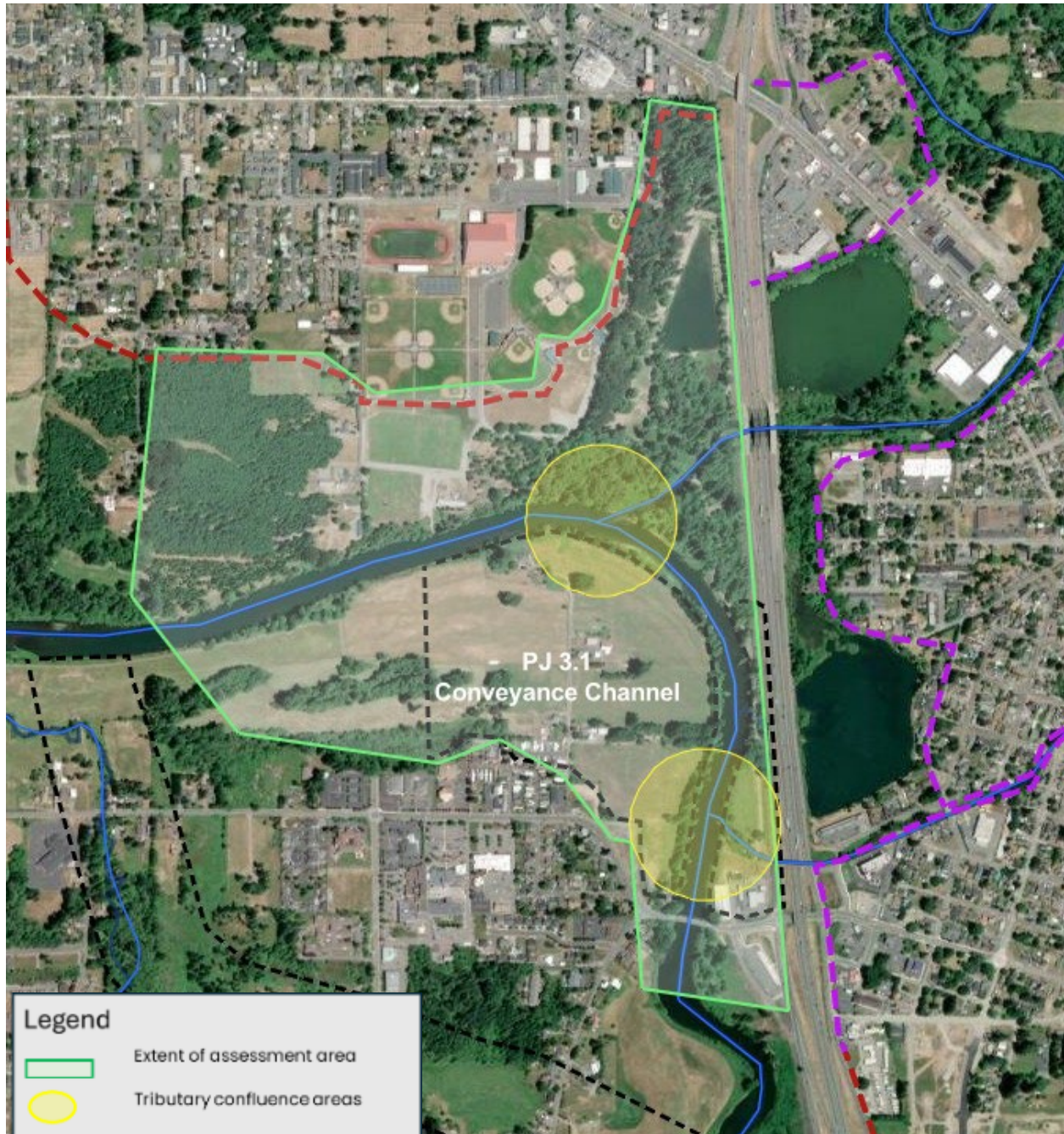
- **Direct alteration of streambank:** Direct alteration of streambanks is expected so as to accommodate lowering of floodplain and conveyance, but impacts will depend on design and extent of any armoring. Assumed minor impacts overall associated with reduced entrenchment.
- **Riparian & floodplain habitat condition:** Riparian vegetation is high quality along the river at the Chehalis/Skookumchuck confluence but relatively limited in extent, composed of intact “good” riparian shrubland and forest. Roughly 47 acres of wetlands in the assessment area provide moderate ecological integrity.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** Adult fish migrate through the AA on their way to spawning habitat upstream in tributaries and upper reaches of the Chehalis River. The confluence of the Skookumchuck River and China Creek are within the AA and provide significant opportunities for rearing by juvenile fish from all areas of the watershed upstream. Improving conditions by supplementing large wood at the confluences within the AA could provide significant uplift to native fish species in the basin.

Fish & Wildlife Species

- **Fish life history characteristics:**

- Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.
- All species of adult fish migrate through the AA on their way to primary spawning habitats upstream. Juvenile fish of all species find opportunities for rearing at the confluence of the Skookumchuck River and China Creek. These rearing areas could be improved to provide off-channel rearing opportunities in cooler water of tributaries entering the Chehalis River in the AA.
- **Wildlife species that occupy/use floodplain habitats:** Extensive earthwork will result in moderate impact to wildlife from soil and vegetation removal. Connectivity will be impacted in the near-term but should eventually recover to current levels.

Figure 8: PJ 3.1 Conveyance Channel. Black dashed line is proposed conveyance channel.



PJ 4.1 Diversion Channel/Scammon Creek

Site Context

Agricultural and undeveloped.

Geomorphic Process Impacts

- Moderate adverse impact to existing channel due to diversion of high flows away from the river, resulting in alteration of all existing high flow geomorphic processes. Risk of erosion and the need to protect geomorphic process at the entrance and exit of the new channel.

Aquatic and Riparian Habitat

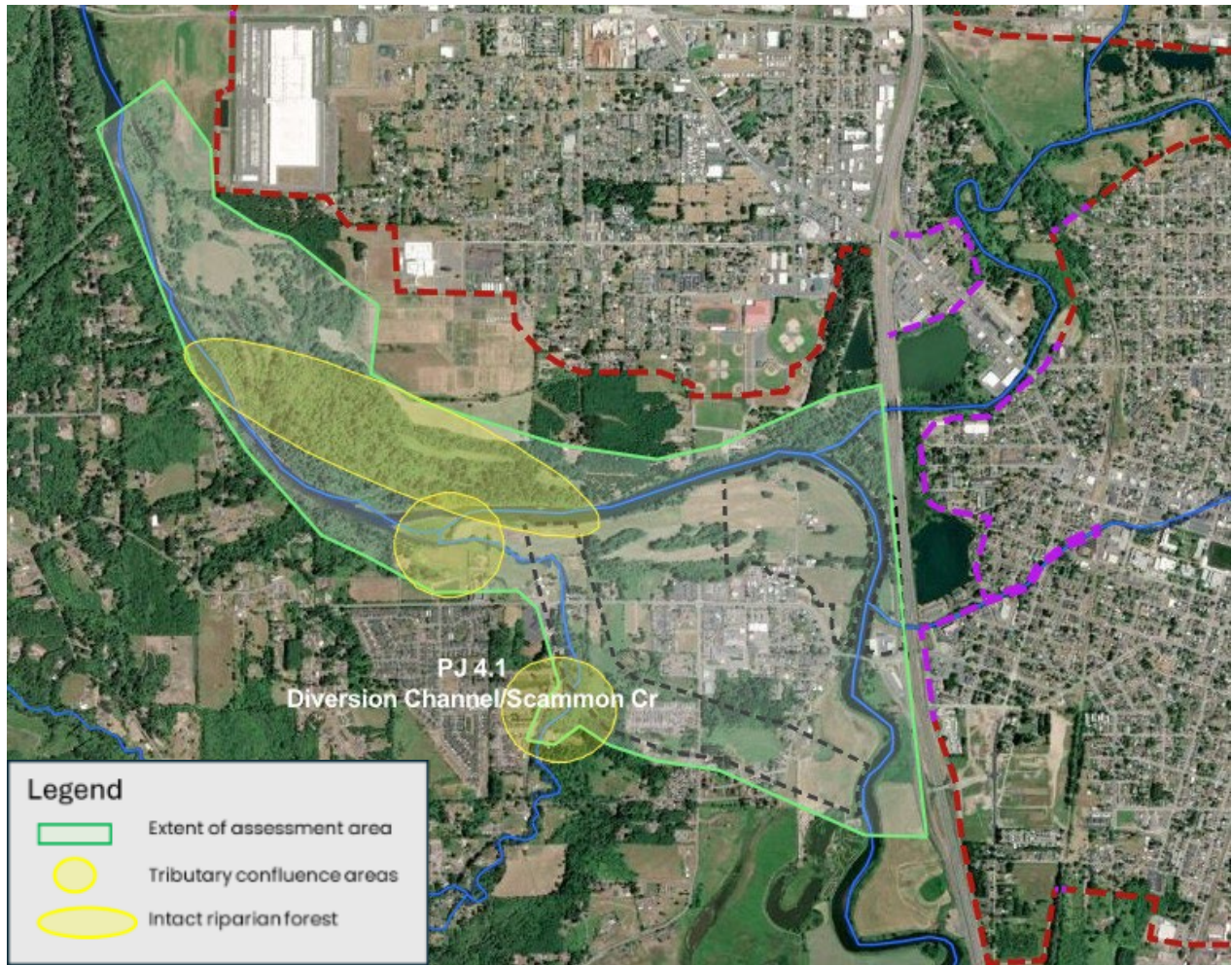
- **Direct alteration of streambank:** Diversion of high flows could have minor impact on streambanks of the main channel related to construction of the entrance and exit of the channel. Potential risk to the north bank of the Chehalis River and off-channel habitat that currently exists on the floodplain to the north of the river should also be considered in development of the proposed diversion channel.
- **Riparian & floodplain habitat condition:** A large, contiguous area of high integrity “excellent, with some “good,” riparian vegetation is present. Approximately 141 acres of emergent marsh wetlands with high ecological integrity are within the assessment area.
- **Existing/historic refugia conducive for fish spawning and/or rearing:** The diversion channel is proposed so there is no existing spawning or rearing habitat present except for Scammon Creek which would be impacted by the diversion channel. The channel length of Scammon Creek will be reduced as it will enter the diversion channel upstream of its current location. It is unclear whether a fully functioning riparian area will be established in the lower reach of the creek as it flows through the diversion channel. It will be critical to determine how the diversion channel will interact with Scammon Creek to identify measures to reduce impacts on a cold-water tributary.

Fish & Wildlife Species

- Fish life history characteristics:

- Native fish species include spring and fall Chinook salmon, coho salmon, winter steelhead, rainbow trout, and coastal cutthroat trout in addition to other non-game fish species.
- All species of adult fish migrate through the AA on their way to primary spawning habitats upstream. Juvenile fish of all species find opportunities for rearing at the confluence of the Skookumchuck River and China Creek. These rearing areas could be improved to provide off-channel rearing opportunities in cooler water of tributaries entering the Chehalis River in the AA.
- Scammon Creek provides spawning and rearing habitat for rainbow trout. It is unclear whether coho salmon are present or there is a lack of data to document presence.
- **Wildlife species that occupy/use floodplain habitats:** Moderate impact from loss of habitat with very high conservation value and high ecological integrity.

Figure 9: PJ 4.1 Diversion Channel/Scammon. Black dashed lines near the southern edge are edges of proposed diversion channel. Tributary confluences and existing, intact riparian forest downstream of outlet of the diversion channel offer potential restoration/mi



PJ 5.1 China Creek Daylight

Site Context

Low to high intensity urban development.

Geomorphic Process Impacts

- Not applicable. No adverse impact due to absence of existing channel. Overall, restoration of channel will result in positive long-term outcomes.

Aquatic and Riparian Habitat

- **Direct alteration of streambank:** Not applicable.
- **Riparian & floodplain habitat condition:** There are 7.5 ac. of riverine wetland features identified in state mapping, but no condition information is available for quality assessment.
- **Existing/historic refugia conducive for fish rearing:** Adult fish migrate through the AA on their way to spawning habitat upstream in tributaries and upper reaches of the Chehalis River. The confluence of the Skookumchuck River and China Creek are within the AA and provide opportunities for rearing by juvenile fish from all areas of the watershed upstream. Improving conditions by supplementing large wood at the confluences within the AA could provide significant uplift to native fish species in the basin.

Fish & Wildlife Species

- **Fish life history characteristics:**
 - Native fish species include coho salmon and rainbow trout.
 - The current condition of lower China Creek does not allow for spawning by adult coho salmon or rainbow trout due to instream and riparian habitat conditions that lead to lack of overhead cover and fine sediments that cover or embed spawning sized gravel. It is likely that adult fish migrate through this reach on their way to more suitable spawning habitat upstream and juveniles are not able to find rearing habitat and are required to move into the Chehalis mainstem to rear.

- **Wildlife species that occupy/use floodplain habitats:** Minor impact is expected due to the absence of habitat.

Figure 10: PJ 5.1 Daylight China Creek. Green boundary shows extent of assessment area. Dark blue line indicates historical presence of coho salmon and rainbow trout.



Restoration and Mitigation Considerations

- High-priority restoration zones and opportunities for mitigation, if necessary, include Fort Borst, Adna, and the Conveyance Channel—due to proximity of confluence, tributary, and off-channel habitat restoration opportunities. Potential presence of rare plant species and high habitat quality/intactness/connectivity was also considered when identifying restoration and mitigation opportunities. Opportunities are consistent with concepts identified in the ASRP for the Middle Chehalis Basin.
 - Fort Borst – The Fort Borst Levee is currently setback a significant distance from the river and there appears to be limited potential to impact riparian or wetland habitats from construction or ongoing operation of the proposed levee.
 - Off channel habitat reconnection and restoration to increase complexity of habitat used by rearing juvenile salmonids in the vicinity of the levee and diversion channel. Substantial side channel length appears to be present between the proposed levee and river, but it is unclear the extent the side channels are connected to the mainstem river and currently providing rearing opportunities.

- Adna – The Adna Levee/Floodwall has the potential to impact the riparian area along the north bank of the Chehalis River resulting from the construction footprint and maintenance needs of the operating levee.
- Floodplain side channels upstream and downstream of the Adna Levee could be improved through the addition of large wood and increase in connectivity to the river at a wider range of flows. Particularly if channel degradation has led to abandonment of side channels and floodplain habitats.
- Conveyance Channel – Similar to the diversion channel, the conveyance channel provides an opportunity to create substantial uplift for native fish species through enhancement of conditions at tributary confluences in the area. Tributary confluences are often cooler than the mainstem river leading to increased use by rearing juvenile salmonids.
- The addition of large complex wood structures at confluence areas provides opportunities for adult fish to hold in cooler waters as they prepare for upstream migration into tributary streams. Juvenile fish, particularly sub-yearling migrant coho and spring Chinook rear in the mainstem Chehalis River and require off-channel rearing areas to escape peak summer water temperature.
- Additional restoration zones: Lower Skookumchuck River, Lower Newaukum River, Salzer Creek, Dillenbaugh Creek, where habitat degradation is high and restoration may provide uplift to native fish and wildlife species.
 - Large scale riparian enhancement to create and maintain cool water refugia needed by migrating adult and rearing juvenile salmonids.
 - Tributary confluence enhancement (large wood for overhead cover and to increase complex habitat.
 - Gravel augmentation to support adult spawning, juvenile rearing, and aquatic macroinvertebrate production.
- Measures to minimize risk and avoid the need for mitigation include: 1) setting back levees and floodwalls to avoid sensitive habitats including riparian and wetland areas, 2) conducting work at times of the year when direct impacts can be avoided, 3) incorporation of innovative design techniques (natural channel design, engineering with nature), and 4) consideration of long term impacts resulting from potential geomorphic and hydraulic changes resulting from levee/floodwall development.

- Alternatives that intersect high-integrity riparian and wetland systems (e.g., Fort Borst, Diversion Channel) may require robust mitigation and design sensitivity but also may be more resilient to change. Low-integrity areas (e.g., China Creek Floodwall, Skookumchuck) may offer restoration potential, including ecological uplift, floodplain reconnection, and native species reintroduction and resilience.

Other Considerations

- The Chehalis Basin Strategy Programmatic EIS includes descriptions of short-term impacts from construction, which are potentially relevant and could be applicable to the individual alternatives. However, discussion of construction impacts is not included here, as that analysis is more appropriate to evaluate once design and implementation plans are available to assess differences between the alternatives.
- Additional site-specific assessments will be included as part of future environmental review as the project alternatives go through additional refinement of design features.
- This evaluation does not include detailed review or assessment of potential impacts associated with altered flow regimes, e.g., where channel alterations occur such as in Alternative PJ 4.1.
- This evaluation does not include a detailed geomorphic analysis due to channel and floodplain narrowing and diversions.

Table 2: High-Level Summary of Potential Impacts by LAND Alternative

Summary of Potential Adverse Impacts			Flood Reduction Measure									
			PJ 2.1 Adna	PJ 2.2 East bank of the Newaukum and Chehalis	PJ 2.3 Skookumchuck River	PJ 2.4 Fort Borst Park	PJ 2.5 China Creek	PJ 2.6 I-5 from China Creek to Salzer Creek	PJ 2.7 Chehalis-Centralia Airport	PJ 3.1 Conveyance-Remove Pinch points along the Chehalis River in the Chehalis/	PJ 4.1 Construct a new diversion to increase water flow	PJ 5.1 Daylight China Creek
Category	Potential Impact	Considerations	Construct new ring levee in Adna around the new high school and commercial area (1.7 miles)	Construct new levee on the east bank of the Newaukum and Chehalis Rivers east of I-5 near (1.2 miles)	Construct new and expand levees on the north and south sides of the Skookumchuck River (6.6 miles)	Construct new levee on the north bank of the Chehalis River from north of Fort Borst Park downstream to Galvin Road (2.7 miles)	Construct new levees on the north and south sides of China Creek from I-5 to the railroad tracks (2.3 miles)	Construct new levee on the east side of I-5 from China Creek to Salzer Creek (3.3 miles)	Expand levee around the Chehalis-Centralia Airport (4.3 miles)	Increase conveyance near the existing Mellen Street Bridge by removing approximately 1.3 million cubic yards of soil immediately upstream and for approximately 3,000 feet downstream of the existing Mellen Street Bridge.	Construct a new 700-foot-wide, one mile long, waterflow diversion by excavating approximately 1.3 million cubic yards of soil west of the existing Mellen Street.	Day light China Creek to create additional conveyance and amenity to encourage redevelopment of adjacent parcels for higher density, mixed uses.
Site context	Land use adjacent to flood protection feature	% developed and undeveloped areas; potential loss of connectivity	Rural residential	Urban/agricultural	Urban, residential, agricultural, industrial	Urban/ag	Urban	Urban	Urban	Urban/rural residential	Urban/rural residential	Urban
Geomorphic	Riverine and floodplain processes	Floodplain function, channelization incision, bank erosion, sediment transport, deposition	Moderate	Minor	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Not applicable (no existing channel)
Aquatic and Riparian Habitat	Direct alteration of streambank	Distance from river, channel length,	Major	Minor	Major	Minor	Minor	Minor	Minor	Minor ¹	Minor ¹	Minor
	Riparian & floodplain habitat	Extent and condition of riparian and wetland vegetation, shade provided	Moderate	Minor	Moderate	Minor	Minor	Moderate	Minor	Moderate ¹	Minor ¹	Minor
	Existing/historic refugia conducive for fish spawning and/or rearing	Existing off-channel habitat, pools, substrate condition	Moderate	Minor	Moderate	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor
Fish & Wildlife Species	Fish life history characteristics	Migration, spawning, rearing of target fish species (salmonids, lampreys)	Minor	Minor	Moderate	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor
	Wildlife species that occupy floodplain habitats	Amphibians, migratory birds, wetlands, open water	Minor	Minor	Moderate	Moderate	Minor	Minor	Moderate	Moderate	Moderate	Minor

¹ Short term impacts to streambank may be major but long term benefit of ecological uplift is significant and likely mitigates for short term impacts related to construction

Degree of Potential Impacts: Minor = minimal and/or easily mitigated; Moderate= Limited local extent and effect; mitigation expected to be relatively straightforward; Major= Adverse and larger in scope and extent; mitigation requirements are likely significant.

Table 3: Restoration and Mitigation Opportunities

Summary of Mitigation Opportunities												
			PJ 2.1 Adna	PJ 2.2 East bank of the Newaukum and Chehalis	PJ 2.3 Skookumchuck River	PJ 2.4 Fort Borst Park	PJ 2.5 China Creek	PJ 2.6 1-5 from China Creek to Salzer Creek	PJ 2.7 Chehalis-Centralia Airport	PJ 3.1 Conveyance- Remove Pinch points along the Chehalis River in the Chehalis/	PJ 4.1 Construct a new diversion to increase water flow	PJ 5.1 Daylight China Creek
Mitigation Opportunities	Uplift potential of associated restoration actions	Direct/Indirect benefits to fish and wildlife	Major	Moderate	Minor	Major	Minor	Moderate	Moderate	Moderate	Major	Moderate
		Types of Opportunities	Off-channel habitat enhancement including large wood placement and riparian restoration, reconnection of side channels at wider range of flows due to channel incision resulting in floodplain abandonment.	Lower Newaukum riparian enhancement, maintenance of cool water refugia, Newaukum, Dillenbaugh tributary confluence enhancement. Dillenbaugh Creek riparian enhancement & floodplain reconnection	Limited opportunity for off-channel habitat enhancement including large wood placement and riparian restoration, reconnection of side channels. Levee confinement may risk restoration actions implemented.	Off-channel habitat enhancement including large wood placement and riparian restoration, reconnection of side channels. Large area of existing off-channel habitat between the Chehalis and proposed levee.	Large wood placement for creation of complex habitat. Creation of pools needed for migrating adults and rearing juvenile fish in highly confined reach of stream	Salzer Creek riparian enhancement, maintenance of cool water refugia, Chehalis/Salzer confluence enhancement. Salzer Creek gravel augmentation.	Mainstem Chehalis River restoration of floodplain connectivity through reduction/restoration of channel incision. Mainstem Chehalis R. riparian enhancement	Skookumchuck/China Creek confluence enhancement. Project creates short term risk related to removal of mature riparian buffer. Riparian enhancement/mitigation may be required for short term impacts related to temperature.	Riparian enhancement, maintenance of cool water refugia, increasing channel length allows for creation of habitat that currently does not exist. Confluence habitat and restoration of lower Scammon Creek	Restoration in an urban setting. Provide opportunity for public to see restoration in action. Gravel augmentation to support spawning and macroinvertebrate production

Degree of Potential Opportunities: Minor= little opportunity; Moderate= Some limited local opportunity in floodplain; Major= Significant area and historical floodplain features available for potential mitigation.