Coho Water Resources
Integrated Water Resource Management

Technical Memorandum

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To: Erica Marbet, Squaxin Island Tribe emarbet@squaxin.us
From: Sherry Wilhelm & Chris Pitre sherry@cohowr.com & chris@cohowr.com
Re: **SKOOKUM VALLEY WATER RESOURCE PROGRAMMATIC REVIEW**

This Technical Memorandum (TM) provides a programmatic review of the findings and recommendations of an on-going study of salmon habitat and related water resources management in the Skookum Basin. This work is funded by a four-year grant from the United States Environmental Protection Agency (EPA) passed through the Northwest Indian Fisheries Commission (NWIFC) to the Squaxin Indian Tribe. The goal of this document is to compile and prioritize recommendations from many efforts in order to productively focus efforts in the remaining years of the grant and in the tribe's protection of the basin. As such this is a working document that requires significant input and review by Tribal staff.

The report is structured as follows:

1. **Introduction:** Provides context for this report and immediate recommendations with which to proceed (Section 1.3).
2. **Impacts:** Describes the impacts that are occurring to salmon habitat in the Skookum Basin so the reader has an appreciation of the need to take action.
3. **Actions:** Expands on the immediate recommendations to protect and enhance salmon habitat presented in Section 1.3. The effort required from multiple Tribal departments and enterprises/casino operators is addressed.
4. **Drinking Water System Management:** Presents suggestions for protecting and providing the Tribal drinking water system for consideration by Planning and Community Development.
5. **Next Steps:** Presents gaps in the current understanding and tasks to consider undertaking in the next two years of the second half of the EPA grant.

Contents

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1. INTRODUCTION

We are now approaching the end of the second year of the four-year grant. Much more is known now than when the scope of work was initially developed for this four-year grant. The main findings thus far include:

- The geology of the basin provides relatively few productive groundwater zones. This limits future development of additional water supply for the Tribe and others. It also results in limited storage capacity of the basin with which to provide stream baseflow during times of little precipitation, namely the summer months.
- Existing major water rights in the basin are mostly held by agricultural entities in the central valley. The magnitude of these water rights (the six largest water rights [five surface water and one groundwater] total 3.5 cfs) is much higher than summertime low stream flows (e.g., 1 cfs).
- The Tribe's groundwater supply appears to be connected to Skookum Creek. Therefore, Tribal pumping of groundwater likely has the impact of reducing Skookum Creek flows, and thereby negatively affecting salmon habitat
- The Tribe's water supply is vulnerable to contamination and other disruptions.

A suite of recommendations has been developed based on these findings and our review of previous studies. In addition to improving the habitat for culturally important salmon (Section 3), these recommendations address the Tribe's best interests in providing drinking water for its members and maintaining the economic viability of its enterprises (Section 4).

Following up on many of the recommendations are outside of the scope of the EPA grant, but should be pursued by appropriate Tribal entities. These recommendations and findings are summarized in this TM for presentation to and consideration by Tribal agencies such as Natural Resources, Planning and Community Development, casino operations, golf course operation, and others, as appropriate. Suggestions for work to be completed in the second half of the four-year EPA grant are provided (Section 5).

1.1 Grant Objective

The primary objective of the EPA grant is to protect and improve the habitat and runs of coho, chum, steelhead and other salmonids in the Skookum Basin. Skookum Creek is the most significant salmon-bearing stream crossing Tribal lands and the health of the salmon runs is vital to Tribal culture. Lesser runs occur in tributaries to Skookum Creek, of which the most significant is Little Creek.

1.2 Basis of the Programmatic Review

This programmatic review synthesizes and integrates numerous studies (Attachment A). Most of these studies were conducted to address narrow scopes. The work conducted in the first two years of the EPA grant considered all of these studies and a broad spectrum of influences including:

- Geology and hydrogeology: aerial, regional and detailed local surveys and site-specific field reconnaissance and data collection.
- Natural water balance: seasonal precipitation and streamflow patterns, predicted impacts of climate change.
- Stream and basin characteristics: stream gage data, an aerial Thermal Infrared Radar survey (also referred to as Forward-Looking Infra-Red (FLIR), seepage studies, habitat surveys, and land cover.
- Human water use: surface water diversions and groundwater withdrawals, consumptive uses by both Tribal and non-tribal entities, and reclaimed water production/use.

The Tribe's Natural Resources Department has coordinated this work with other parts of the Tribal community, including Planning and Community Development (public works/utilities) and Enterprises, and other agencies such as Indian Health Services (IHS).

We synthesize these perspectives and information sources into recommendations to provide an integrated approach to water resource management of the Skookum Basin.

1.3 Immediate Recommended Actions

Actions that may best benefit salmon habitat in Skookum Creek, listed with the most beneficial actions listed first, are:

- **Restoration of shade canopy over Skookum Creek [1].** This is the most effective means of maintaining low temperatures in Skookum Creek within a livable range for salmon, particularly for juvenile rearing of coho.
- **Acquisition of the six largest surface water rights.** Current summer low flows of 1 cfs could hypothetically increase Skookum Creek to >3 cfs.
- **Reduction or elimination of Tribal groundwater pumping in the Skookum Valley [2].** This could hypothetically increase Skookum Creek streamflows by 0.6 cfs.

Section 3 expands upon these recommended actions and provides additional recommendations.

[1] The Tribe has submitted grant applications to the Washington Recreation and Conservation Office's (RCO) Riparian Protection Program and to the National Wetland Program riparian restoration and wetland reconnection programs for property acquisition as a first step (Marbet, 2018).

[2] The Tribe has already acquired one of these water rights and will acquire a second water right if the RCO grant application is successful.

2. IMPACTS

Protecting and improving the habitat and runs of salmonids in the Skookum Basin involve identifying current impacts and either removing or mitigating those impacts. The limiting factors of viable salmon habitat in the Skookum Basin are (Caldwell, 2014):

- Streamflows are too low during late summer.
- Stream temperatures are too high during late summer and cause salmon to suffocate.
- Peak stormwater flows during the winter introduce suspended sediment that hurts fish gills and wipe out redds (fish egg nests).

The basin has experienced human impacts since the late 1800s when logging and agricultural use began. The Tribe's activities are a dominant influence in the lower basin. (See Attachment B for a timeline of key Tribal developments related to water and natural resources in the Skookum Basin.) Significant negative impacts on salmonid habitat in the Skookum Basin derive from the following:

Tribal Actions:

- Present-day:
  - Pumping of groundwater for drinking water purposes to support the Tribal community and Tribal enterprises such as the casino.
  - Pumping of groundwater to irrigate the golf course when insufficient reclaimed water is available.
  - Land development that removes native habitat (riparian and upland), reduces groundwater recharge, and increases stormwater runoff.
- Future:
  - Planned expansion of casino will increase water demand.
  - Development of additional land near casino will increase stormwater runoff.

Non-Tribal Actions:

- Forestry road networks that reduce groundwater recharge and increase stormwater runoff.
- Pumping of water (surface and/or groundwater), particularly direct surface water diversions for agricultural irrigation.
- Maintenance of an artificial duck pond in the main Skookum Creek valley immediately downstream of the Hurley Creek confluence that heats the water before it discharges to Skookum Creek.
- Construction of roads and railroad beds that alters natural drainage pattern and forces streams through culverts.
- Land development that may remove native habitat (riparian and upland), reduce groundwater recharge, and increase stormwater runoff.

3. ACTIONS TO IMPROVE SALMON HABITAT

Critical salmon life cycles in Skookum Creek include the year-round juvenile rearing of coho, steelhead and cutthroat. Because juvenile rearing is year-round, maintaining cold-water thermal refugia is critical to these life stages. Recommended actions to improve salmon habitat include:

1. Restoration of riparian habitat, particularly shade canopy.
2. Acquisition and retirement of water rights, particularly agricultural surface water diversions, and placing them into the State Trust Water Program.
3. Reduction of groundwater pumping by the Tribe.
4. Effective stormwater management.

3.1 Riparian Habitat Restoration

Skookum Creek is listed as water quality impaired under Section 303(d) of the Clean Water Act for temperature and fecal coliform (Ecology, 2006). Sediment remobilization exacerbated by unnaturally high peak stormwater runoff is also an aggravating factor. Restoration of riparian habitat can improve all of these conditions by:

1. Shading the stream from the sun, to slow warming and reduce temperature.
2. Filtering fecal coliform entering the creek from stormwater runoff.
3. Stabilizing creek banks and reducing erosion.

Restoration of tree canopy over the Skookum Creek and tributaries is the most effective means of reducing stream temperatures. The Tribe has several on-going and planned programs to plant riparian vegetation along Skookum Creek.

A Forward-Looking Infra-Red (FLIR) flight was conducted in 2004 from the confluence of the north and south forks of Skookum Creek at River Mile (RM) 8.2 to its mouth. At that time there were three distinct reaches with respect to temperature gradients (Figures 1 and 2):

1. RM 8.2- 4.7: A moderate temperature gradient (~1 ^{o}C/mile).
2. RM 4.7-1: A flat gradient (~0 ^{o}C/mile).
3. RM 1-0: A step gradient (~6 ^{o}C/mile).

It is important to maintain the existing canopy and restore new canopy to shade the creek from the sun and keep the water temperature cool. This will allow higher concentrations of oxygen in the water and allow the salmon to breath more easily. Examples of poor riparian canopy are shown in Figure 3.

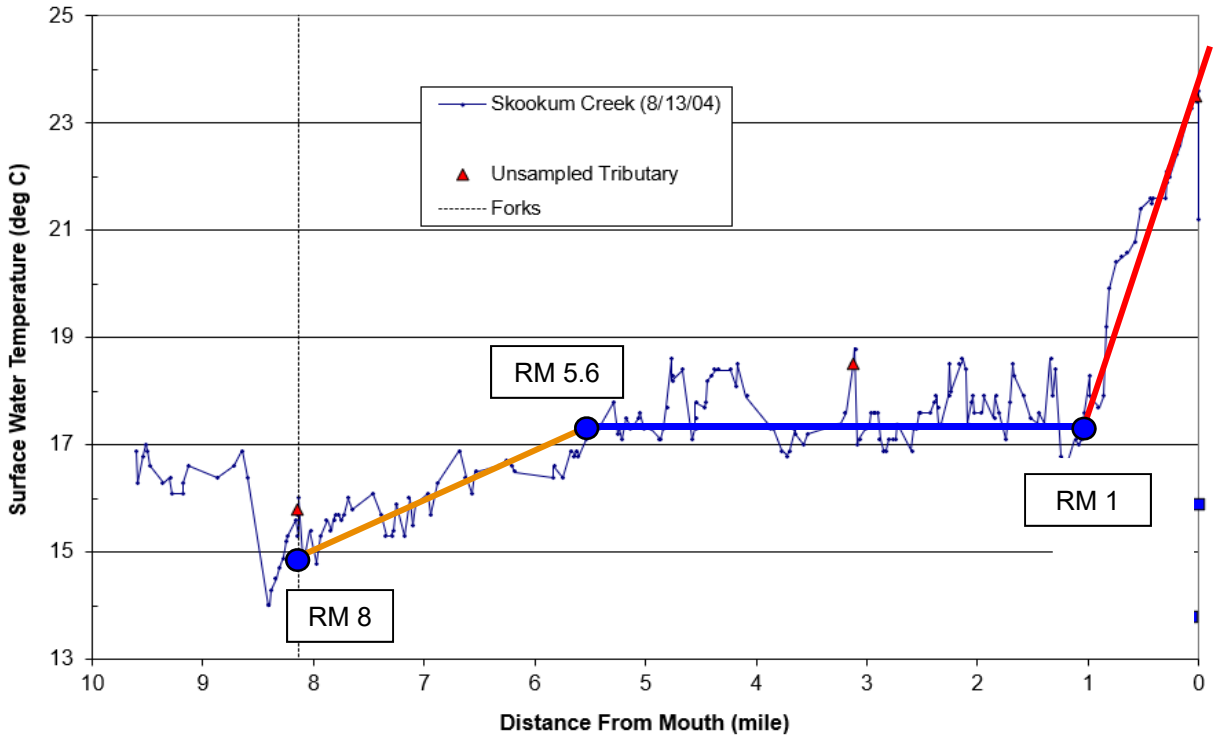

Figure 1. Skookum Creek water temperature longitudinal profile. Forward-Looking Infra-Red (FLIR) flight on August 13, 2004 (Watershed Sciences 2004).

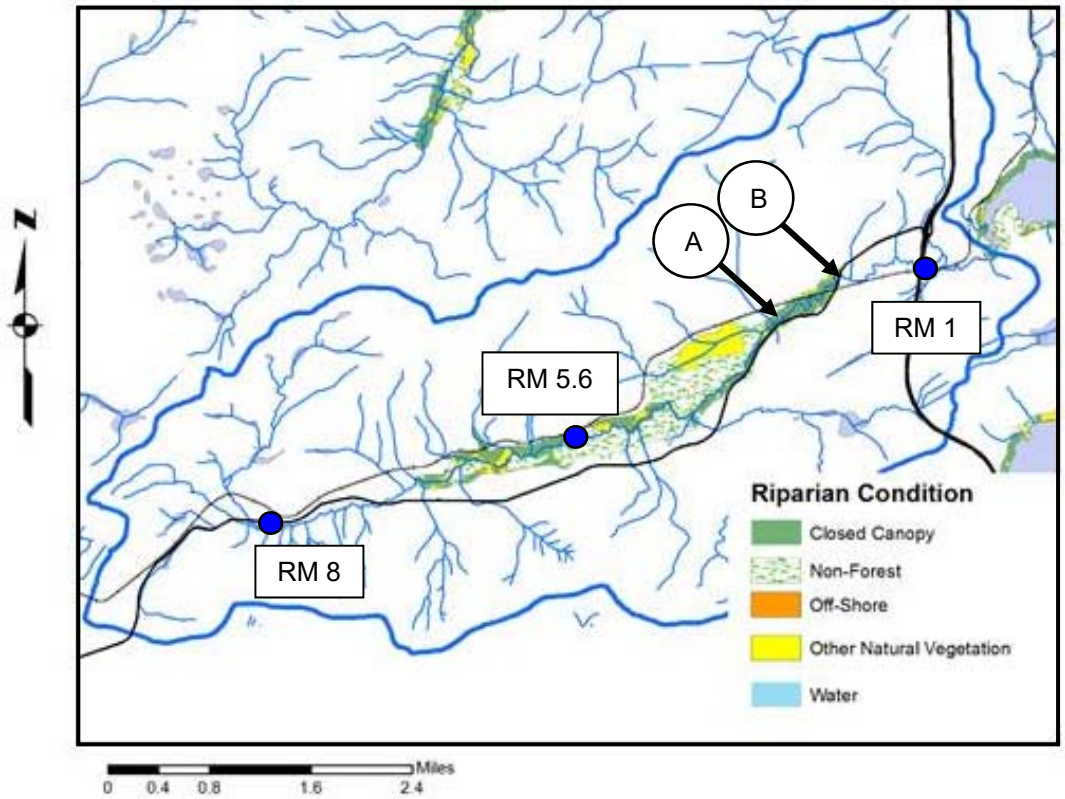

Figure 2: Riparian conditions (2009) in the Skookum Basin (from Caldwell, 2014)**. Letters indicate locations of photos in Figure 3.**

A) Looking west from W State Route (SR) 108 along Skookum Creek at River Mile 2.9.

B) Looking southeast along Skookum Creek from SR 108 next to the Tribal community garden (River Mile 1.9).

Figure 3: Examples of poor riparian shade canopy.

The effect of riparian canopy is to provide shade and prevent temperature increase – it does not effectively reduce temperature. Assuming a direct correlation between riparian canopy and avoiding increase of stream temperature, the most effective reach to improve may be below RM 1. This would best benefit salmonid migration. However, if a reach already exceeds critical or lethal levels with respect to salmon (e.g., the temperature is above 20 ^{o}C, which is most common below River Mile 1), avoiding further temperature increase that is already in the lethal range may be of limited benefit. Also, improving riparian canopy upstream above RM 5 will benefit more of the stream.

Juvenile rearing of salmonids is considered the critical life stage to protect and encourage to maintain their viability – more so than assisting the migration stage of life, though all life stages need support. Juvenile salmonids need cold water with lots of oxygen.

Though closed canopy is an important variable, and possibly the most important at the moment for Skookum Creek, other variables also influence stream temperature including interaction with groundwater (Coho, 2017f), inflows of tributaries, sediment load, and channel morphology (width/depth ratio). Variables of wood debris, channel migration, flooding, connection to wetlands and other factors are not addressed in this technical memorandum, though they are important.

Buffers around wetlands and streams are a standard tool to protect aquatic habitat. Buffer zones consisting of natural vegetation slow the rate of stormwater runoff from uplands, which may be developed or logged, to the stream. This will dampen peak stormwater-driven streamflows and improve salmon habitat. Wetlands and areas of slower water velocity also provide refugia when the water velocity in the mainstream channel is so high that it will flush young salmon out to the sea before they are ready.

A wealth of science and standard accepted practices exists for establishing the size of the buffers. Commonly, the buffer size increases proportionally to the value of the resource being protected. There is a degree of subjectivity that factors into selecting the appropriate buffer setback that involves the values of the community. Mason County's Critical Areas Ordinance is consistent with standard practices in Puget Sound and may be considered as a starting point, with buffers which vary between 25 feet and 250 feet for wetlands and which is 150 feet for streams with fish habitat (Mason County Code 8.52.110 and 8.52.170, respectively).

Policy may accommodate variances in the form of mitigation ratios (e.g., an acre of wetland may be allowed to be degraded if 3 acres of wetlands is restored – this is only an illustrative example to explain the concept of mitigation ratios – ratios are typically higher) or averaging (e.g., a buffer may be narrowed by 50% over 100 feet if adjacent reaches are expanded by 100%). While buffers (100-foot) in forestry lands provide benefit, expansion of those buffers through acquisition of conservation easements may provide further improvement to aquatic and salmonid habitat.

3.2 Acquisition of Water Rights

Surface water right diversions for agricultural irrigation have an impact on streamflows. They occur at the worst time for salmonid habitat, when streamflows are at their seasonal lowest levels, and their impacts are immediate and direct. Unlike surface water diversions, impacts from groundwater withdrawals on streamflows may have a lag time and may be muted in magnitude. Recommendations for acquiring water rights were provided in the recent technical memorandum "Skookum Basin Instream Flow Regulations and Water Rights" (Coho, 2017d).

The five largest surface water certificates in the basin are for agricultural irrigation. These certificates total 3 cfs and represent approximately 80% of the volume of all surface water rights in the Skookum Basin, on both an instantaneous and annual basis (Table 2; Figure 4). The largest groundwater right (0.6 cfs) represents 50% of all administratively issued groundwater rights. This compares to low streamflows in Skookum Creek dropping below 1 cfs in some years. Acquiring these five water rights could hypothetically increase streamflows by a factor of greater than three. The Tribe has already acquired one of these large water rights (S2-3821C for 0.33 cfs) as well as a smaller one (S2-1077C for 0.12 cfs).

As the Tribe acquires properties and associated water rights, they should consider forming a deliberate policy on managing these water rights. If the Tribe does not intend to continue using these water rights to their maximum capacity as permitted, they should be placed into the State's Trust Water Program (https://ecology.wa.gov/Water-Shorelines/Water-supply/Water-rights/Trust-water-rights). Water rights may be placed in trust temporarily and may be withdrawn from the trust program when needed, or they may be permanently deeded to instream flows.

Table 2: Water Right Certificates in the Skookum Basin Each with a Q_i >0.3 cfs.
(All for irrigation use.)

Document Number	Original Owner (Current Owner*)	Priority Date	Qi (cfs)	Qa (afy)	Acres Irr	Section (all in T19N/R04W)	¼-¼	SOURCE
Surface Water Right Certificates								
S2-*11207ALC	Stoehr (Skookum Ranch)	01-Apr-52	0.6	160‡	80	24	SE/SW	Skookum Creek
S2-*14810ALC	Stoehr (Stoehr)	19-May-58	0.73	146	73	24	S2/NE	
S2-*17989C	Swantak (Reller)	21-Jun-63	0.9	180	90	26	NE/NE	
S2-00348C	Lovgreen (unknown)	04-Mar-68	0.4	80	40	25	SE/NE	Unnamed Spring
S2-23831C	Cunningham (Squaxin)	22-May-75	0.33	30	15	28	SW/SE	Skookum Creek
Groundwater Right Certificate								
G2-25233C	Cunningham (Squaxin)	29-May-79	0.5	100	50	28	SW/SW	
TOTAL:			**3.5**	**436**	**298**			

* Current owner tentatively identified using Mason County online tax parcel assessor's site and Ecology's state-wide water rights database. More accurate information may be obtained from water right documents and site visits.

‡ Qa estimated using a 2-foot irrigation duty.

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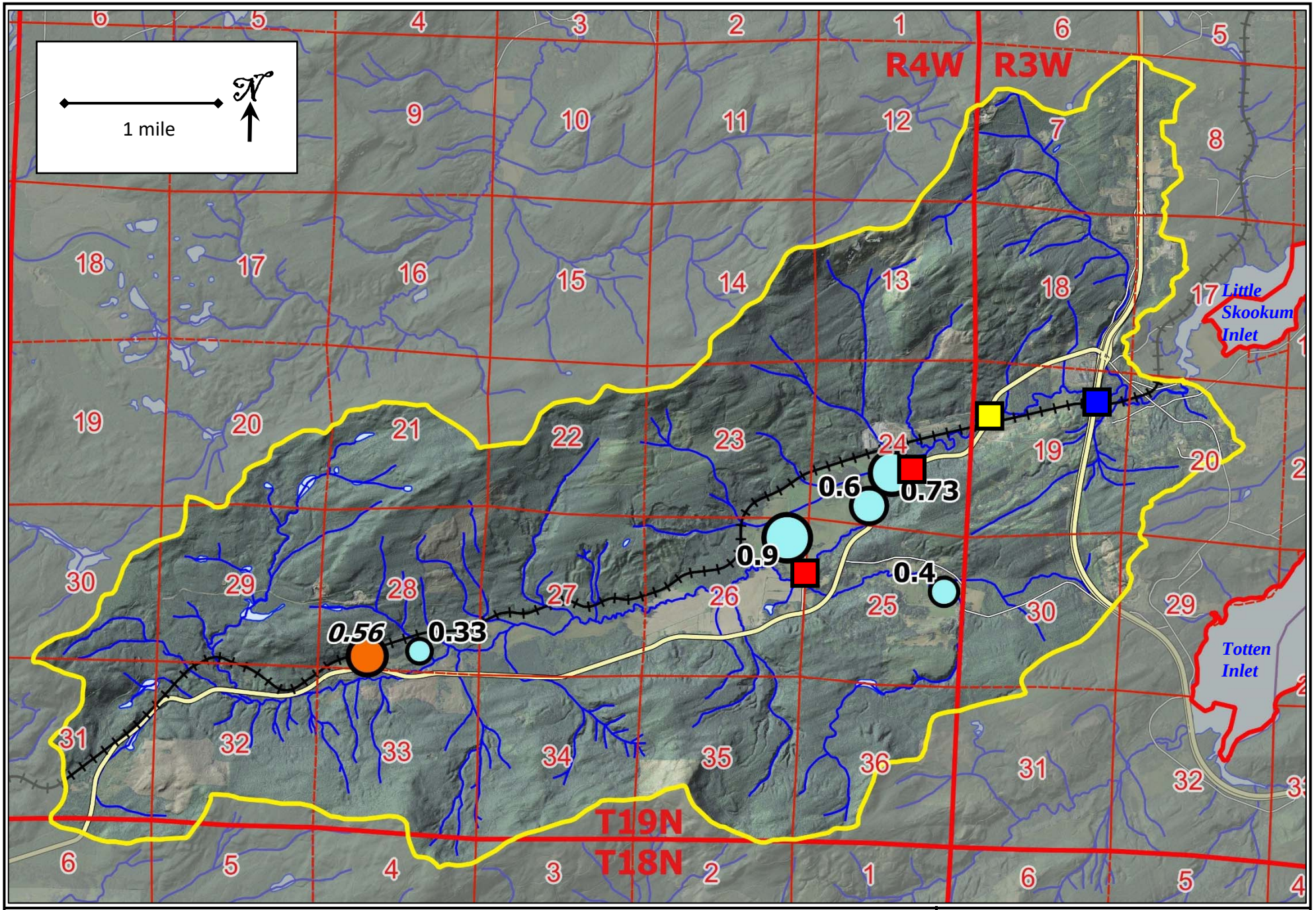

Water rights
- Surface water
- *Groundwater*

Labelled in cfs.

Stream gages/monitoring points
- Current Tribal gage
- Historical USGS gage (recommended to be re-established)
- Candidate new temperature monitoring points

Figure 4
Water Right Certificates >0.3 cfs
& Stream Monitoring Points
Skookum Valley Water Assessment

If valid water rights are placed into trust within five years of their last beneficial use, they will remain available to the Tribe for future use and/or are dedicated to instream flows without the risk of being reallocated in the future to out-of-stream consumptive uses. A fact sheet for placing the rights into trust are included in Attachment C of Coho (2017d).

Additional recommendations related to water rights and instream flow regulations are contained in Coho (2017d).

3.3 Reduction of Groundwater Pumping

Reduction of groundwater pumping in the Skookum Valley will reduce impacts to streamflows because groundwater and surface water are hydraulically connected. The following options should be considered:

- Water conservation.
- More complete use of reclaimed water for golf course irrigation.
- Possible relocation of groundwater pumping away from Skookum Creek.

The related issue of stormwater management is also considered.

This section is closely related to Section 4 (Drinking Water System Management).

3.3.1 Water Conservation

Groundwater pumping can be reduced by reducing water use. Water use can be reduced by a public outreach program, incentives, and better control of the pumped water (unaccounted-for-water). Alex Wohlgemuth of IHS analyzed meter data of the Tribe's total water production and metered connections in the Casino-Kamilche zone. Monthly unaccounted-for-water varied from 16% (400,000 gallons) in January to 40% in the summer. This could be explained by:

- Leaks in the distribution system (a maximum of 400,000 gallons per month, 13,000 gpd, 4.8 MG/year, from the Casino-Kamilche zone alone). Plugging any leaks will result in a direct reduction of groundwater pumped.
- Unmetered use.

Further analysis is being conducted by IHS of meter data in the Housing District and Government zones. A leakage and meter study has been recommended. An assessment of meters, particularly the principal meters measuring flow between zones (including their locations), is recommended to understand the appropriate level of confidence in the meter data and leakage studies.

For example, the meter to the Government Campus measured 17,000 gpd in 2011 and now only records 3,000 gpd (2016). This indicates a failing meter and erroneous

measurement because there is no known reason for such a dramatic a change in water use. The meter should be replaced. Because Housing District water use is calculated by subtracting Government Campus water use from the combined water metered for the two zones, Housing District water use is probably relatively constant over the past decade when the artefact of the Government Campus meter is taken into account.

The Casino Zone accounts for 65% of the total Tribal water use. It is recommended that the casino commission a water use audit of their facilities to understand water use patterns and to identify possible options for conserving water.

Educating the community of the impacts of water use, groundwater pumping and resulting reduction of streamflows may encourage water conservation. A public education program is recommended. It is suggested that the Tribe's Planning and Community Development Department undertake this task. This public outreach can be coordinated with recommendations in Section 5.

3.3.2 Full Use of Reclaimed Water

Reclaimed water is produced at the Tribe's Membrane BioReactor (MBR) Water Reclamation Facility and is used for golf course irrigation. While reclaimed water production is relatively constant year-round at almost 100,000 gallons per day (gpd), irrigation demand is seasonal and peaks in late summer. Therefore, reclaimed water is stored in a 23-million gallon (MG) constructed reservoir at the east end of the golf course to store reclaimed water produced in the winter for use in late summer.

However:

- The constructed storage is full by late winter and overflowing reclaimed water is discharged to wetlands on the golf course.
- Storage is commonly depleted by August and auxiliary groundwater wells and stormwater ponds are pumped to meet irrigation demand (estimated at 173,000 gpd; Coho, 2017h).

Additional storage of reclaimed water during the winter is needed to meet late summer irrigation demand of the golf course to preclude the need to pump auxiliary groundwater wells. The potential to store reclaimed water in groundwater aquifers was investigated by hydrogeological studies and geophysical surveys and is considered unlikely to be feasible. The only means to use reclaimed water to fully meet the golf course irrigation demand is to construct additional storage by:

- Expanding the existing reservoir.

- Constructing a new reservoir at an alternate location. An alternate reservoir location may be at the west end of the golf course and may provide operational benefits.

The cost of developing additional storage will be proportional to the storage capacity. The size will be driven by the irrigation demand schedule and reclaimed water production including any anticipated changes such as increased reclaimed water production from a third hotel tower. A rigorous water use schedule should be developed to budget and finance construction of additional storage. It is recommended that Salish Cliffs Golf Club develop this water use schedule and associated budget and cost estimate.

3.3.3 Relocating Water Supply to Outside of Skookum Valley

The Tribe's principal water supply is obtained from two production wells in the Lower Skookum Valley that pump at a peak rate of approximately 0.4 cfs in the late summer. The magnitude of the impact of this groundwater withdrawal on Skookum Creek is the subject of current analysis but could be as high as 0.4 cfs. Relocating water supply to outside of the Skookum Basin could increase late summer minimum instream flows of 1 cfs by up to 40%.

Additionally, the Enterprises arm of the Tribe is interested in building a third tower of the hotel, which is estimated to require a 35% increase in the current water supply. There may also be interest in developing other undefined economic operations, of unknown potential water demand (e.g., a shopping complex would be expected to have low water demand). Two variables factor into water supply for Tribal Enterprises that also encourage the development of water supply outside of the Skookum Basin:

- **Quantity:** Finding the productive portion of the aquifer in which the current production wells are installed required multiple test wells. Prospects for identifying additional productive zones are not considered favorable. Installing a third well within the same production zone as the existing wells may interfere with the existing wells thereby reducing their yield. Additional pumping will likely also increase impacts on and reduce stream flows.
- **Reliability:** There is no redundancy in the Tribe's water supply. Serious water use restrictions will be needed if one well fails. Failure may be due pump failure or aquifer formation/well collapse. If one of the existing production wells is impacted by contamination, it is likely both wells will be impacted because they are located so close to each other.

Developing a water supply outside of the Skookum Basin will supplement the existing supply and provide diversity of sources so that not "all eggs are in one basket". Two options are recognized:

- Develop groundwater supply from Taylor Shellfish's wellfield.
- Investigate the potential of developing groundwater supply on the Kamilche Peninsula east of the Housing District.

If a new supply is developed, it is recommended that the current production wells be maintained. The existing wells could be operated during the winter when impacts to Skookum Creek flows are not a concern, and other sources could be pumped during the summer depending on optimization of pumping and operational cost and balancing the distribution of environmental impacts. In either case, maintenance of alternative and diverse sources improves the redundancy and reliability of the water system.

New supply options are presented in the following subsections.

3.3.3.1 Taylors New Supply

A productive aquifer exists approximately one mile northeast of the US HWY 101 and SR 108 interchange. The Tribe is currently working jointly with Taylors to evaluate the technical, permitting and financial feasibility of developing additional groundwater supply. Some relevant factors are:

- It is expected most of the impacts of pumping groundwater will accrue to seeps and springs discharging to bluffs overlooking Little Skookum Inlet. No mitigation of these impacts is considered necessary.
- Some impacts may accrue to Elson Creek. These impacts will be mitigated by infiltrating process water from Taylor Shellfish operations wash water in strategic locations to benefit Elson Creek.
- A 1-mile transmission pipeline will need to be constructed. The pipeline may be directed under US HWY 101 or it may tie into the Tribal water system near the US HWY 101 and SR 108 interchange. An engineering feasibility study is needed to evaluate these options.
- The timeline to bring new water supply online may be several years.
- The relatively high confidence in the viability of this water supply balances its drawbacks of cost and timeline.

3.3.3.2 Kamilche Peninsula New Supply

The Tribal reservation used to obtain its water supply from three wells located in the Tribal Housing District (IHS, 2008). Production from each well was 20-30 gpm but declined considerably during dry summer months and had to be turned off occasionally to allow water levels to recover. One of these wells is maintained to provide water to the

"Chairman's Pond". Another well, located between the water storage tanks in the Housing District, remains unused.

Tri9bal staff has asked about the feasibility of re-establishing a water supply in the Housing District or further east on the Kamilche Peninsula. Initial impressions are not favorable for water supply in these locations because:

- The original wells were determined to be insufficient.
- Bedrock is reported at about 100 feet below ground surface in the original wells (Coho, 2017e). A search for water supply may be better focused further to the east where the depth to bedrock may be deeper and there may be a greater thickness of overlying sediments.
- The recharge area of the Kamilche peninsula is limited (i.e., the width of the peninsula) and is mantled with glacial till, which restricts the recharge of precipitation.
- The Kamilche Peninsula is flanked by salt water (Little Skookum and Totten Inlets).
- Small salmon-bearing streams run off of the Kamilche Peninsula that may be impacted by new wells.

However, the potential for developing a water supply on the peninsula has not been rigorously evaluated. Such an evaluation may consist of the following:

- Detailed compilation and review of well logs.
- Field reconnaissance.

Also, if a new supply is found close to the Housing District, the cost of constructing a 1-mile transmission line as needed for the Taylors option may be avoided. One area that may warrant attention is the area of the swale immediately east of the Housing District that discharges to Little Skookum Inlet. This location is on an alignment extending southeast from Taylors' productive aquifer zone on the north side of Little Skookum Inlet. This alignment may represent the orientation of the Vashon ice front along which clean gravel aquifer material was deposited.

3.4 Stormwater Management

The Stormwater Management Manual for Western Washington (SMMWW; Ecology, 2014) provides comprehensive guidance for stormwater management. The environmental review document for the Little Creek Golf Course stated that stormwater management would be consistent with the SMMWW (the 2001 precursor version of the current 2014 version). No improvements are recommended to practices if the Tribe constructs and operates projects consistent with the SMMWW.

The SMMWW addresses water quality and flooding concerns. Stormwater management in the Skookum Basin should focus on ensuring runoff does not increase and exacerbate high stream flows that occur seasonally or immediately after a precipitation event. High flows harm aquatic habitat by:

- Wiping out redds.
- Eroding and incising the stream channel.
- Creating turbidity that abrade fish gills.
- Remobilizing sediments that may contain settled fecal coliform bacteria.

Stormwater retention/detention ponds are recommended as the first option if additional stormwater management is needed. One large pond may be attractive from a management perspective but might not be able to achieve the needed infiltration rates, depending on the soil types. Smaller dispersed ponds may be more aesthetic, minimize larger scale infrastructure (e.g., stormwater mains) and achieve the needed infiltration rate to dissipate the collected stormwater.

Roads and parking lots produce runoff that may contain petroleum products and metals. Much of the stormwater in Skookum Valley and around Tribal enterprises is directed to stormwater ponds and. These contaminants, which are harmful to salmon, may not be removed by the stormwater ponds, particularly if the stormwater ponds overflow. The constructed retention/detention ponds will achieve most of their water quality treatment function if they fully contain collected stormwater and no overland runoff occurs.

4. DRINKING WATER SYSTEM MANAGEMENT

Assessment of the basin hydrogeology and basin-wide water availability for Skookum Creek necessitated understanding the Tribe's water supply. This work led to the following reports aimed at protecting the Tribe's water supply:

- Emergency Water Supply Plan.
- A Contaminant Source Inventory.
- Wellhead Protection Plan.
- Critical Aquifer Recharge Areas (CARAs).

The recommendations which resulted from these reports are summarized in the following sections, in decreasing order of priority.

Section 3.3 (Reduction of Groundwater Pumping) discusses the related issues of conservation and relocation or supplementation of the current groundwater drinking water source, which are typical components of drinking water system management.

4.1 Emergency Water Supply Plan

The Tribe's drinking water supply is considered to be significantly at risk because of its vulnerability and lack of redundancy. The following recommendations for initial actions were provided in the Emergency Water Supply Plan prepared by Coho (2017c):

- Review and update the Emergency Water Supply Plan every six months (water system manager and staff).
- Join the WA-WARN mutual aid association.
- Obtain plastic tanks for transporting water in Tribally-owned trucks to meet smaller water demand, such as critical drinking water needs on the reservation.
- Contact Taylor Shellfish regarding access to their water supply in an emergency (to be delivered by large rented tanker trucks to meet larger demand, such as casino operations).
- Prioritize recipients of water (i.e., who will/will not get water) under certain conditions.
- Obtain emergency backup generators to operate the production wells and booster stations in case of power failures.
- Evaluate outfitting inactive Tribal wells, such as the old reservation wells, for emergency supply and hooking up active auxiliary wells, such as the Valet, Cedar Box, and Clary wells, to the drinking water system.
- Share the Emergency Water Supply Plan with the rest of the Tribal Community to get feedback, to improve it and to better ensure the community is familiar with the plan if/when it may be implemented (e.g., Tribal Council and emergency responders).

4.2 Contaminant Source Inventory

To protect the Tribe's drinking water supply, we recommend the following steps, in order of decreasing importance (please refer to Coho, 2017a for details). This is a low-cost, high-value outcome of the wellhead protection effort.

- **Alta Forest Products:** Meet with Alta Forest Products to discuss concerns of their location within the 5-10 year capture zone of the Tribe's primary drinking water source.
- **Squaxin WWTP:** Have discussions with the WWTP management to ensure awareness that the WWTP is located with the 1- to 5-year capture zone of the Tribe's primary drinking water source.
- **Petrosol / Keyera Railroad Terminal:** Research environmental site assessment reports conducted for that site as part of real estate transactions.
- **Gas Pipeline:** Contact the Cascade Natural Gas Corporation to understand the types and practices of herbicide application along the natural gas pipeline and request that no herbicides be used within the wellhead protection areas (WHPAs).
- **Golf Course:** Contact the Salish Cliffs Golf Course managers to understand pesticide/herbicide management, use, and storage practices, particularly at their maintenance facility, which is within the 5-year capture zone of the Tribe's primary drinking water source.

4.3 Wellhead Protection Plan Recommendations

The following recommendations will help to keep the groundwater which supplies the Tribe safe and free from contamination (details are contained within Coho, 2017b).

- Complete or update the following standard components of a Wellhead Protection Plan:
  - Update the Contaminated Site Inventory every two years, per DOH guidelines. The next update is due in June 2019.
  - Conduct a "windshield survey' of the WHPAs (field survey).
  - Identify emergency water supply in case the wells are contaminated.
  - Conduct public outreach to Tribal enterprises and Alta Resources.
- Install two monitoring wells upgradient of the production wells (Figure 4 of Coho, 2017b). Monitor water quality and water levels in the new monitoring wells, the production wells and the Knight Well (Tables 4, 5 and 6 of Coho [2017b]).
- Manage activities within the WHPAs to ensure that water quality in the wells providing drinking water to the Tribe remains healthy. Protective measures and best management practices to consider include:

- Construct stormwater bio-retention ponds that provide treatment to water that recharges groundwater.
- Develop an emergency response plan for accidents that may occur along transportation corridors within the WHPAs. Share these plans with local emergency agencies (e.g., fire and police departments).
- Monitor/track the storage and use of hazardous materials within the WHPAs.
- Provide signage at entry points into WHPAs and at critical points within WHPAs (e.g., at facilities where hazardous materials may be introduced or handled, such as at Alta Resources and the storage facility in the over-flow parking lot).

4.4 Critical Aquifer Recharge Areas

Critical Aquifer Recharge Areas (CARAs) is one of five critical areas covered by the Washington State Growth Management Act (GMA; other critical areas are wetlands, flood plains, geologic hazards and fish and wildlife conservation areas). While the GMA may not apply to Tribal lands, it does provide a model for the Tribe to consider in managing and protecting resources in its stewardship. CARAs are meant to protect groundwater quality for drinking water and the natural environment. Well capture zones are often used as a surrogate to delineate Critical Aquifer Recharge Areas (CARAs). The following zones were delineated by Coho (Figure 2 in 2017f):

- 100-foot radius Sanitary Control Area (SCA) [3].
- 6-month, 1-, 5-, and 10-year capture zones (or time-of-travel).
- Buffer zones.

The 100-foot SCA and probably the 6-month and 1-year capture zones are located over the fine sand aquifer and are therefore more vulnerable to contamination. The Tribe may consider developing stricter land use policy/restrictions for these zones. Most of the 10-year capture zone and possibly a portion of the 5-year capture zones may be located over clay/silt and are not as vulnerable to contamination entering the Tribe's drinking water over these areas.

Restrictions are commonly placed on land use and activities commensurate with each zone, such as double containment of petroleum storage and exclusion of specific activities (e.g., handling of certain classes of solvents). This is usually closely tied to the Wellhead Protection Plan.

[3] Tribal Council has directed staff to develop an ordinance on allowed land uses within SCAs.

5. NEXT STEPS IN THE SKOOKUM HYDROGEOLOGY PROJECT

This section presents:

1. Actions that are recommended based on current knowledge.
2. Data gaps.
3. Options for additional investigation.

5.1 Follow-Up on Currently Identified Tasks

Among the tasks outlined throughout this programmatic review, the following responsibilities are suggested for relevant Tribal entities:

- Natural Resources:
  - Develop a riparian restoration program, including prioritization of reaches, funding sources and schedule. [4]
  - Propose a land use policy to guide development, similar to a Critical Areas Ordinance under the Washington State Growth Management Act.
- Planning and Community Development: Follow through on recommendations in Section 4 (Drinking Water System Management), especially the Emergency Water Supply Plan.
- Casino Operations: Conduct a water use audit of the casino.
- Golf Course: Develop a water use schedule. Actual use from the available period of record at the available resolution (e.g., daily) should be compiled and juxtaposed with the precipitation record. This would include sources of water supply (e.g., reclaimed water reservoir, reservoir stage, withdrawals from auxiliary wells). Install meters on the auxiliary wells and the lines into and out of the reservoir.
- Joint efforts:
  - Develop alternative water supplies (Taylors wellfield or east of the Reservation).
  - Educate Tribal members and local non-tribal community about the health and value of Skookum Creek and Tribal efforts to protect it. For instance, build interpretative trails to educate and connect Tribal members and the public with the resource.

[4] The Tribe has submitted grant applications to the Washington Recreation and Conservation Office's (RCO) Riparian Protection Program and to the National Wetland Program riparian restoration and wetland reconnection programs for property acquisition as a first step (Marbet, 2018).

5.2 Data Gaps

Data gaps that remain in the understanding of the water resources of the Skookum Basin include:

- The degree of hydraulic continuity between surface water and groundwater along the length of Skookum Creek and its influence on moderating stream temperature.
- The effects of climate change, including:
  - Sea level rise on the inland transgression of the saline interface.
  - The seasonal shift of precipitation toward longer drier summers and wetter winters with peak stormwater flows, floods, and erosion.
  - The increased summer demand for landscape and golf course irrigation.
  - Mapping of the riparian zone (as reported by Caldwell, 2014).
- Water use estimates, including:
  - Salish Cliffs Golf Course
  - Casino/hotel water use and expansion plans.
  - Actual agricultural water use in the valley.
- Stormwater management procedures in the Casino Area.
- Specific options for expanded reclaimed water storage and use.

5.3 Candidate Third-Year Tasks

The focus of the four-year EPA grant is on protecting and improving the habitat of coho and other salmonids in the Skookum Basin. Two years of the grant have been completed and two remain. Candidate water-resource-related tasks to complete in the third year of the EPA grant include:

1. **Develop plans to increase reclaimed water storage and use:** Prepare a feasibility study/preliminary design for additional reclaimed water storage to allow full use of reclaimed water for irrigation of the golf course and other uses. The cost of developing additional storage will be proportional to the storage capacity. The size will be driven by the irrigation demand schedule assuming that there will be enough reclaimed water production to meet the full demand on an annual basis including current production and future production (e.g., from a third hotel tower). A rigorous water use schedule for the golf course should be developed to aid in design of additional storage.

2. **Increase the understanding of temperature regime and controls in Skookum Creek:** Conduct a detailed examination of the 2004 FLIR data set (Ecology, 2006), riparian zone mapping, seepage surveys (Ecology, 2006; Marbet, 2017), and snorkel surveys to identify zones and the degree of groundwater discharge and tributary inflow influences in moderating stream temperature. [5]

3. **Improve long-term monitoring of stream flow and temperature:**
   - Re-establish the stream gage at the SR 108 HWY crossing of Skookum Creek next to the Tribal Community Garden. This is the location that the USGS gaged stream flow in the 1950s and was used to establish Surface Water Source Limitation Letters controlling the exercise of water rights. The existing stream gage at the US HWY 101 crossing of Skookum Creek is periodically affected by high tides. Tidal interference will increase as the sea level rises as a result of global warming. Such interferences will increasingly compromise the quality of data collected.
   - Establish a station mid-basin to monitor stream temperature to evaluate factors affecting stream temperature and the effectiveness of mitigation measures. Candidate locations include Skookum Creek crossings at W. SR 108 or W. Eich Rd.

4. **Install monitoring wells**: The Wellhead Protection Plan recommends installation of two monitoring wells upgradient of the production wells. These wells can also provide additional geological characterization in an important part of the valley, and nested piezometers will provide information on vertical

[5] Tribal staff (Sarah Zaniewski) has started this task (Marbet, 2018).

gradients and associated hydraulic continuity between surface water and groundwater. A monitoring program could be developed.

5. **Refine the conceptual model of groundwater-surface water interactions:**
   - Conduct a topographic survey of locations and elevations of stream stage gaging stations and monitoring wells. Include key physical structures along the stream.
   - Integrate monitoring well elevations into interpretation of seasonal patterns of groundwater levels, seasonal vertical hydraulic gradient dynamics, and the influence of tribal groundwater withdrawals.
   - Install stand pipes on artesian wells and instrument them with pressure transducers to better understand seasonal variations and influences of pumping on the discharge of groundwater to and baseflow of Skookum Creek.
   - Conduct detailed logging of monitoring wells installed for wellhead protection (item 4 above). These wells will be drilled near the transition in Skookum Creek Valley from fine to coarser sediments.
   - Determine the extents of alluvium in the lower Skookum Basin and the location and nature of the transition to finer-grained up-valley sediments.

6. **Continue organization and documentation of data sources:** Builds upon effort initiated at the beginning of this grant and includes maintenance of the well log database (Coho, 2017) and Skookum-related documents library, as presented in Attachment A.

7. **Manage acquired water rights:** Place acquired, and unused, administratively-issued water rights into Ecology's Trust Water Right Program (Coho, 2017b). Start this process with water rights associated with recently acquired Cunningham property. A determination of the tentative validity of the water rights could be conducted at the same time to provide a level of reliance by the Tribe on potential uses of those water rights should the Tribe wish to retrieve them from the trust program in the future.

8. **Improve estimate of water demand in the Skookum Basin:** Develop a plan for a metering program, including objectives, equipment specifications, and guidelines for installation, monitoring, data collection and archiving, analysis and reporting. A comprehensive metering program will provide better estimates of water use and needs, and could include the following sources:

- Tribal Production Wells 1 and 2. These are currently metered for daily pumped volumes but should be upgraded to record pumping rates at finer temporal resolution (e.g., 15-minute).[6]
- Unmetered Tribal sources:
  - Golf course irrigation water, mostly reclaimed water use (can be monitored as water removed from reservoir).
  - Reclaimed water production.
  - Auxiliary wells (Valet, Cedar, Clary, Hole 11).
  - Tobacco Factory Well.
  - Reservation Well 3 (delivering to Chairman's Pond).
  - Grow Operation Well.
- Non-tribal sources: Offer subsidized meters and installation to domestic residences, with voluntary reporting of water use to Ecology through their web site portal.

9. **Communicate findings and options regarding water resource management in the Skookum Basin:** Presentations and preparation of educational materials for: Tribal council, staff and community; grant funding agencies; the broader non-tribal community; and/or, others.

10. **Optimize pumping of groundwater by the Tribe:**
    - Evaluate the efficiency of the main production wells and consider options for re-development and efficient energy use.
    - Design a schedule for pumping golf course auxiliary wells to spread pumping over more time or earlier in the summer, thus decreasing intensity of pumping in late summer and minimize impacts on Skookum Creek flows.

11. **Characterize sub-basins in Skookum Basin:** Summarize the physical and cultural qualities of sub-basins including Little Creek, Hurley Creek, North Fork of Skookum Creek, and Reitdorf Creek. This characterization can identify areas most suitable for focused effort to preserve or restore high value habitats or for testing restoration approaches.

Tasks from the candidate list should be judiciously selected within the budget limitations for this coming third year of the grant to ensure the ultimate objectives, which are to protect and improve habitat conditions and runs of coho, chum, steelhead and other salmonids in the Skookum Basin.

[6] The Tribe is actively evaluating vendor proposals to upgrade the SCADA system with this capability (Marbet, 2018).

6. SUPPLEMENTAL FUNDING

Funding supplemental to the EPA grant may be applied for through Ecology's Streamflow Enhancement Program. The following information was obtained from Ecology's website (accessed 2018-06-01):

> The Washington State Legislature authorized $300 million over 15 years to be used for restoring and enhancing streamflows statewide. Funds are prioritized for 15 basins (which includes Water Resources Inventory Area (WRIA) 14 – the Kennedy-Goldsborough Watershed, which contains the Skookum Basin). Ecology is developing a system for the prioritization and evaluation of proposed projects, with the following schedule:
>
> **Spring 2018:** Provide detailed information about accessing funding for projects under the current legislative appropriation.
>
> **Summer 2018:** Begin accepting funding proposals.
>
> **Fall 2018:** Decisions on project proposals are anticipated.
>
> Ecology has yet to determine the process for subsequent funding rounds.

7. CLOSING

We appreciate the opportunity to conduct this work for you and hope the information presented in this Technical Memorandum is helpful to the Tribe.

Sincerely,

Coho Water Resources

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ATTACHMENT A

WATER RESOURCES BIBLIOGRAPHY OF THE SKOOKUM BASIN

This bibliography will continue to be expanded as work continues.

WATER RESOURCES BIBLIOGRAPHY OF THE SKOOKUM BASIN

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
May 2018	Marbet, E., 2018. **E-mail communication.** With Sherry Wilhelm and Chris Pitre of Coho Water Resources. May 21, 2018.		Y
May 2018	Coho Water Resources, 2018b. **Water Demand and Supply Analysis in the Skookum Basin.** Technical memorandum prepared for Squaxin Island Tribe. Dated May 25, 2018.	Includes Tribal and non-tribal, current and future.	Y
March 2018	Coho Water Resources, 2018a. **Salish Hill Geophysical Survey Review.** Technical memorandum prepared for Squaxin Island Tribe. Dated March 22, 2018.	Recommends expansion of above-ground conventional reservoir to store winter reclaimed water for full beneficial use for golf course irrigation and other uses.	Y
March 2018	Golder Associates Inc., 2018. **Seismic Refraction Investigation Results, Skookum Creek Water Assessment, Kamilche, Washington.** Prepared for Coho Water Resources.	Detected hard till and bedrock. Did not detect aquifer material, but uncertainty remains on this point.	Y
March 2018	Marbet, E., 2018. **Skookum Watershed Action Plan** (updated from Konovski, 2006)**.** Prepared for Squaxin Island Tribe.		Y
Oct. 2017	Coho Water Resources, 2017a. **Skookum Basin Geology and Hydrogeology.** Technical memorandum prepared for the Squaxin Island Tribe. Dated October 8, 2017.		Y
Oct. 2017	Coho Water Resources, 2017b. **Skookum Basin Instream Flow Regulations and Water Rights.** Technical memorandum prepared for the Squaxin Island Tribe. Dated June 29, 2017.		Y

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
Oct. 2017	Coho Water Resources, 2017c. **Salish Hill Geological Reconnaissance.** Technical memorandum prepared for the Squaxin Island Tribe. Dated October 15, 2017.		Y
June 2017	Coho Water Resources, 2017d. **Well Log Database.** Technical memorandum prepared for the Squaxin Island Tribe. Dated June 30, 2017.	On-going maintenance of this database is recommended.	Y
June 2017	Coho Water Resources, 2017e. **Wellhead Protection Plan for Production Wells 1 & 2.** Technical memorandum prepared for the Squaxin Island Tribe. Dated June 28, 2017.		Y
June 2017	Coho Water Resources, 2017f. **Emergency Water Supply Plan.** Technical memorandum prepared for the Squaxin Island Tribe. Dated June 28, 2017.	Provides guidance to the Tribe on how to respond if the water supply is reduced or lost.	Y
June 2017	Coho Water Resources, 2017g. **Contaminant Source Inventory.** Technical memorandum prepared for the Squaxin Island Tribe. Dated June 20, 2017.		Y
2014	Caldwell, J.E., 2014. **Skookum Creek Watershed Limiting Factors and Available Information: Discussion Paper.** Technical memorandum prepared for the Squaxin Island Tribe.		Y
2014	Ecology, 2014. **The 2014 SWMMWW:** 2012 Stormwater Management Manual for Western Washington, as Amended in December 2014. Publication Number 14-10-055.		Y
2008	Indian Health Service, 2008. **Squaxin Water System Improvements.** Projects: PO-03-J68, PO-00-J08, PO-95-706/713/860. Squaxin Island Indian Reservation. Mason County, Washington. US Department of Health and Human Services. Indian Health Service.		Y

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
March 2006 (Report), 2007 (Plan)	Washington State Department of Ecology, 2006. **Tributaries to Totten, Eld, and Little Skookum Inlets: Fecal Coliform Bacteria and Temperature Total Maximum Daily Load (TMDL).** Water Quality Improvement Report. Publication No. 06-03-007.	Focused on surface water resource. Includes FLIR survey and instream piezometers.	Y
2006	Konovski, J., 2006. **Skookum Watershed Action Plan.**		N
2006	Becker, D. 2006. **Source Water Assessment of Squaxin Island Tribe Community Water System.**	Includes partial inventory of Squaxin-related wells with GPS coordinates, recorded in GIS layer.	Y
July 2006	Morris, V., 2006. **Environmental Review Document, Little Creek Golf Course Property.**	Internal review document.	Y
July 2006	The Coot Company, 2006. **Mitigation Compensation Plan for the Little Creek Golf Course Property.**		Y
2006	Romero, N., 2006. **Ground Water Levels 2005 to 2006.** Squaxin Island Tribe internal document.	Transducer data for MW-2, -3(a,b) and -4(a,b).	Y
Jan 2006	The Coot Company, 2006. **Wetlands Inventory for the Little Creek Golf Course Property.**		Y
May 2005	Romero, N. 2005. **Status on Assessment of Available Water Supplies in the Skookum Valley Aquifer System.** Draft internal document prepared for the Squaxin Island Tribe.		Y
2004	Mobrand Biometrics (2004). EDT Analysis of Habitat Potential and Restoration Options: Coho in South Puget Sound Streams.		N

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
2004	Logan, R.L. and T.J. Walsh, 2004. **Geologic Map of the Summit Lake 7.5-minute Quadrangle, Thurston and Mason Counties, Washington.** Washington Division of Geology and Earth Resources Open File Report 2004-10.		Y
March 2003	Pitre, C.V. and P. Beetlestone, 2003. **Kennedy-Goldsborough Watershed (WRIA 14) –** Phase II, Level 1 Assessment. Prepared by Golder Associates Inc. for the WRIA 14 Planning Unit.		Y
2003	Logan, R.L., 2003. **Geologic Map of the Shelton 1:100,000 Quadrangle, Washington.** Washington Division of Geology and Earth Resources Open File Report 2003-15.		Y
Aug. 2003	Indian Health Services (2003). **Project Summary/Preliminary Engineering Report Sanitation Facilities for the Squaxin Island Tribe, Squaxin Reservation, Mason County, Washington.**		Y
November 2002	Pacific Groundwater Group (2002). **Hydrogeologic Characterization and Groundwater Supply Sustainability at Little Creek Casino – Final Report.** Prepared for the Squaxin Island Tribe.	Includes installation of monitoring well near Skookum Creek.	Y
November 2002	Kuttle, M., Jr. (2002). **Salmonid habitat limiting factors; Water Resources Inventory Area 14, Kennedy-Goldsborough basin.** Washington State Conservation Commission.		Y
2001	Sherrod, B.L. (2001). **Evidence of earthquake-induced subsidence about 1100 yr ago in coastal marshes of southern Puget Sound, Washington.** Geological Society of America Bulletin 113(10):1299-1311.		Y

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
2001	Indian Health Service (2001). **Report on Installation of Community Drainfield.**		Only map and well logs.
1999	Moreland, T. (1999). **Squaxin Island Tribe Water Resources Inventory, Part 2 of 3, Ground Water/Surface Water Quantity.**	Contents, location of parts 1, 3 not known.	Y
1999	Taylor, Moreland and Stevie (1999). **Little Skookum Inlet Watershed Assessment.**	Each chapter includes relevant references. Table of contents re-created.	Y – partial
1999	Squaxin Island Tribal Utility Water Department (1999). **1999 Squaxin Island Tribe and Little Creek Casino Water Quality on Tap Report.**	Public notice of water quality. Brief history of Tribal water system since 1979. 7 pgs.	Y
1996	Schuett-Hames, D., H. Flores, and I. Child. 1996. **An assessment of salmonid habitat and water quality for streams in the Eld, Totten-Little Skookum and Hammersley Inlet-Oakland bay watersheds in Southern Puget Sound, Washington, 1993-1994.** Prepared for the Squaxin Island Tribe - Natural Resources Department, Shelton, WA.		N
1995	American Engineering Corporation (1995). **Little Creek Casino Source Development Project Report.** Prepared for the Squaxin Island Tribe.		Y

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
1995	American Engineering Corporation (1995). **Little Creek Casino On-Site Sewage Disposal System Operation and Maintenance Manual.** Prepared for the Squaxin Island Tribe.		N
May 1994	Harza Northwest, Inc., 1994. **Squaxin Island Tribe Center – Casino and Sports Center – Hydrogeology.**	Includes installation of monitoring well and pumping test of existing well near present-day KTP. 10 pages plus figures and appendices.	Y
1994	Brian F. Mooney Associates (1994). **Draft environmental assessment for the Squaxin Island Tribe Indian gaming facility.**	Cited in Morris and others, 2006	N
1993	Schuett-Hames and H.R. Flores (1993). **Environmentally Sensitive Areas: Selected Sites of Mason County.** Prepared for the Squaxin Island Tribe, Shelton, WA.	23 maps	N
1991	Flores, H., D. Schuett-Hames, and F. Wilshusen (1991). **Monitoring of the Skookum/Totten and Eld inlet watersheds by the Squaxin Island Tribe: 1990-1991.** Squaxin Island Natural Resources, Shelton, WA.		N
1988	The Evergreen State College (1988). **Environmental Report to the Little Skookum/Totten Resource Committee for the Little Skookum Sub-Area Plan.** Prepared by students of "Habitats: Marine, Terrestrial, and Human," The Evergreen State College, Olympia, WA.		N
1987	Fortier, H. L. (1987). **Skookum Creek Salmon Hatchery Feasibility Study for Squaxin Island Tribe.** Prepared by R. W. Beck and Associates in association with Fish Management Consultants. Seattle, WA.		N

DATE OF ISSUE	TITLE AND AUTHOR	COMMENTS, CONTENTS	REPORT IN HAND?
May 1986	Hart Crowser (1986). **Results of Test Well Drilling.** Prepared for Washington Department of Fisheries.	Includes report on test well drilled and decommissioned. 4 pages plus figures.	Y
March 1986	Hart Crowser (1986). **Preliminary Hydrogeologic Evaluation – Skookum Creek Site, Kamilche, Mason County.** Prepared for the Washington State Department of Fisheries. Service Contract #1591. Hart-Crowser Project J-1670, March 6, 1986.	5 pages plus figures.	Y
1970	Molenaar, D. and Noble (1970). **Geology and Groundwater of SE Mason County.** USGS Water Supply Bulletin 29.	Compiles well locations and selected well logs, including those in Kamilche Valley.	Y

ATTACHMENT B

TIMELINE OF EVENTS RELATED TO WATER RESOURCES OF SKOOKUM VALLEY

Timeline of Events Related to Water Resources of Skookum Valley

Includes Tribal Enterprises, Water Supply Systems, and Water Treatment Facilities. Initial data summarized by Erica Marbet, June 2016, in an email to Dan Neelands (SIT Construction Manager). Additional details and formatting added by Sherry Wilhelm, Coho Water Resources, from late 2016 onward.

Date	Tribal Development Event	Water Resources, Water Supply and Wastewater Treatment Event
2017	Warehouse built in western overflow parking lot.	Coho Water Resources issues several reports, including well head protection plan, emergency water supply plan and contaminant source inventory.
2016	Marijuana grow operation started. Community Garden started.	"Grow Operation" well drilled – to support marijuana grow operation. Knight property well tapped to support Community Garden. Lindor well also used by Community Garden.
2016	Cunningham property purchased.	
2015	Elevation opened.	
2014		Salmon and streams – limiting factors (Caldwell) study issued.
2013		Cemetery well drilled.
2012	Oct.: RV park opened. Western overflow parking lot cleared (between 11/11 and 5/13, according to Google Earth images).	
2011	Fall: Salish Cliffs Golf Course opens.	
2010	Complete clearing land for cemetery (approx.., see air photos). Second tobacco factory expanded to double size. Golf course construction continues.	
2009	July: KTP Express built	July: Old water treatment plant and drain field taken out of service.

Date	Tribal Development Event	Water Resources, Water Supply and Wastewater Treatment Event
2008		New water system, including distribution system, completed (see "As-Built" in WaterSystem2008.pdf). Water supply for residential area switched from Squaxin Wells 1-3 to PW1 and PW2 west of casino (not done yet when Source Assessment completed in 2006, so when switched exactly?).
2007		Summer: Started disposing of water (from Dan Neelands in response to question about when started using reclaimed water – confirmation needed)
2006	Fall: Hotel wing 2 opened. (news release April 2007) First tobacco factory converted to events center. Groundbreaking for golf course.	Winter (~Jan.-Feb.): Storage/irrigation pond for reclaimed water in/near golf course constructed. April: PW2 reconditioned. Fall: Wastewater treatment plant built. It was built specifically to service the 2nd tower and events center. The drain fields (filter beds) up on the hill in the reservation neighborhood were inadequate. Dec.: Source Assessment of SIT Water System (Becker) issued. Golf course wetlands, etc., investigations conducted.
2005	Second tobacco factory built. Late 2005: Begin clearing land for cemetery.	
2004	Child Development Center opens.	Before July 2005: Stormwater retention pond west of casino constructed (from air photo record). Oct.: Collection of stream discharge measurements began
2003	Spring: Hotel wing 1 – constructed? (Opened Dec. 2003?)	Dec.: PW1 and PW2 drilled – not clear when put in use. Oct.-Nov.: Two test wells drilled, one for Child Development Center and one near location of current production wells. Aug.: Test well drilled near location of current production wells.
2002		PGG Hydrogeological Characterization – includes installation of monitoring well near Skookum Creek.

Date	Tribal Development Event	Water Resources, Water Supply and Wastewater Treatment Event
2001	First tobacco factory built.	Eight monitoring wells installed under IHS direction around wastewater drainage bed on hillside in Little Creek subbasin.
1990s	Sept. 1995 - Little Creek Casino opened.	1999: Moreland report 1995: Two wells drilled on Little Creek Casino site (SIT and LCCR Tap Report (1999)). The Kamilche Trading Post gas station and general store were built before the casino, but after 1990 (see Google Earth historical coverage). 1995: Harza investigation of hydrogeology at site of current casino. Includes installation of monitoring well and pumping test of existing well near present-day KTP. 1995: Sewage treatment system including septic tanks and disposal bed near site of current water tank. Two monitoring wells for disposal bed installed and sampled. (See Taylor and others, 1999, p. A5-34) 1990s: Problems with Tribal water supply identified (too close to drain fields/septic systems, low summer water levels, tank reservoir too small) 1990: Add'l supply added and SIT water system expanded. (SIT and LCCR Tap Report (1999))
1980s		1986: Hart Crowser issues Preliminary Hydrogeologic Evaluation of Skookum Creek site for potential hatchery, includes report on test well drilled and decommissioned in area of current casino.
1970s		1979: SIT water system constructed by IHS and started service around 1979. (SIT and LCCR Tap Report (1999)) 1976: Production wells (Squaxin 1 and 2) drilled on reservation land. 1970: Molenaar and Noble study published: USGS Water Supply Bulletin 29 – Geology and Groundwater of SE Mason County – documents "representative" well logs, including those in Kamilche Valley