Pemberton Valley Dyking District April 13, 2017 Annual General Meeting Report

Pemberton Valley Dyking District – Who are we and what do we do?

The Pemberton Valley Dyking District is a local government agency incorporated by Letters Patent under the Local Government Act.

The PVDD's Letters Patent is dated January 31, 1947 making it the first government agency established in Pemberton. The PVDD letters patent states " The object of the said improvement district shall be the acquisition, maintenance, repair, replacement, improvement, and operation of works for the reclamation and development of the lands in the improvement district by dyking, draining, pumping, and incidental matters thereto".

Improvement districts finance their operations and services through taxes and/or tolls collected directly from landowners in their boundaries. With the challenging geography, many water ways and large dyking infrastructure that exist within the PVDD boundaries combined with the small tax base it is only possible for the PVDD to fund the maintenance of the existing dyke infrastructure. When large capital projects are identified as a high priority the PVDD has been very successful in locating and securing funding from the provincial and federal governments to complete these projects.

Although improvement districts are independent, public corporations, they are also subject to supervision by the provincial Ministry of Community Sport and Cultural Development. The PVDD boundary as identified in the letters patent was amended in March 2014 to remove all IR lands.

In 1947 the Prairie Farm Rehabilitation Administration (a branch of the Agriculture and Agri-Food Canada) began construction of the dyke system, realignment of the Lillooet River and lowering of Lillooet Lake. The PVDD took over responsibility for maintaining the infrastructure

that was built and with the help of outside government funding developed the system that exists today.

The PVDD also reports to the provincial Inspector of Dykes, the provincial agency responsible for regulating all dykes in the province.

Board of Trustees

The PVDD is administered by an elected Board of Trustees that consists of 5 Board members. To date there has been no remuneration for the Board positions.

Staff

Staff positions are equivalent to 2 3/4 fulltime positions and include:

- Administration – Job shared by two administrators – Equivalent to 1 1/2 full time position due to extra work load during tax time.
- Operations and Maintenance Manager – Equivalent to 1 full time position
- Equipment Operator – Equivalent to 1/4 of a full time position (depending on year).

Assets

- Office building and shed
- Fenced and gated lot with secure container located in the industrial park
- 2008 Hitachi 225 excavator
- 2007 JD6615 Tractor with side and rear mower
- Small Jet boat
- Various tools
- 2 Quarries (Green River and Valleau) material to be used for dyking purposes only
- 2011 Chevy 1500 Pick-up Truck

Rivers and Creeks

- Lillooet River

- Ryan River
- Miller Creek
- Pemberton Creek
- Birkenhead River

PVDD Dyking Infrastructure

- 44 kms of dykes
- 25 kms of ditches
- 25 kms of rip rap bank protection
- 25+ culverts with flap gates

Annual Maintenance

- Inspections – All dykes and associated infrastructure are inspected twice annually, in the spring before the freshet and in the fall after the freshet.
- Mowing – 44 kms of dykes are mowed annually. It takes a minimum of 4 passes to complete the mowing that is the equivalent of mowing 352 kms if a single pass was required. Takes about 6 weeks.
- Rip Rap Repair – The rip rap has stood up well over the years however there are areas that occasionally need maintennce.
- Tree Removal – In the Dike Maintenance Act it is prohibited to allow trees or vegetation other than grass to grow in the dyke. The PVDD conducts vegetation control annually in order to comply with this Act.
- Ditch Maintenance – The ditches under the PVDD's jurisdiction are required to drain the land that is located on the land side of the dykes. The ditches require cleaning once every 3 to 5 years in order to efficiently convey water and drain the land.
- Gravel Removal – Gravel removal is required in:
    - Lillooet River – 15,000 m^3 every 3 years
    - Miller Creek – 1500 m^3 every 2 years
    - Pemberton Creek – Approx. 2000 m^3 once every 5 years

- Volumes vary depending on frequency and magnitude of high water events

- Culverts/flap gates – Culverts need to be inspected and relined when they become corroded as replacing culverts buried deep within the dyke is very expensive. All flap gates are serviced and maintained.
- Beavers - The beaver population in the valley has increased dramatically in the last few years and unplugging culverts and dealing with dams is a regular occurrence.
- Quarries – It is important to keep material on hand and ready to go for upcoming projects and emergency works if required. The PVDD annually conducts quarry development to ensure this material is available.

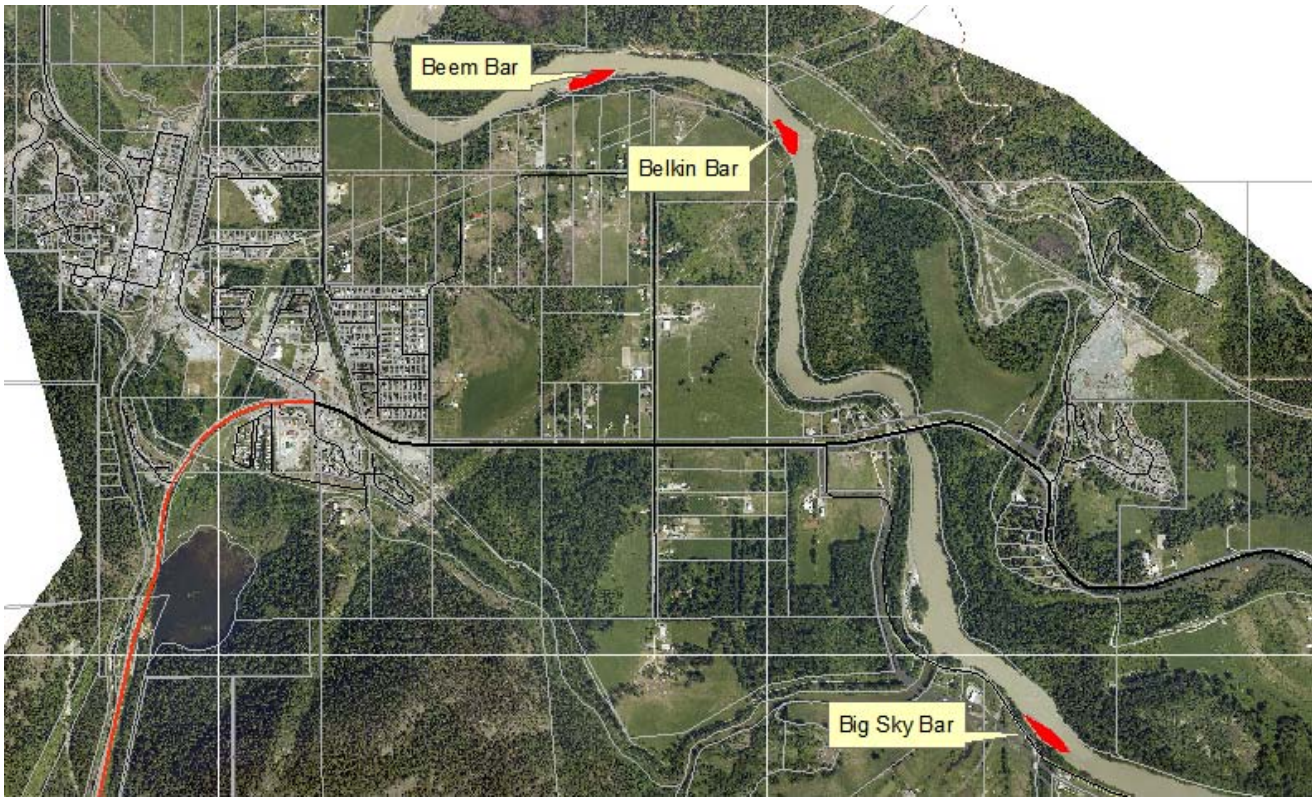
2016 Project Summary:

2016/17 has been a very busy and productive time for the PVDD. Projects that were undertaken and completed were:

Lillooet Sediment Removal

The Lillooet River sediment management plan requires that 15,000 m^3 of sediment is removed once every three years. In 2013 38,000 m^3 of sediment was removed, the larger volume was required to catch up for many years of not removing sediment. In order to follow the Lillooet River sediment management plan it was required to remove 15,000 m^3 in 2016. The sediment removal locations took place at three locations that included:

1. Beem Bar
2. Belkin Bar
3. Big Sky Bar



The work was accomplished during the months of February and March 2016 and the final volume removed was 18,000 m^3. The extra 3,000 m^3 was a result of additional works to construct back channels that create valuable fish habitat as shown below.

Beem Bar April 2016.

Pemberton Creek Emergency Sediment Removal

As a result of the September 2015 high water event it was identified by a detailed survey that 1200 m3 of sediment needed to be removed from Pemberton Creek to maintain adequate dyke elevations. Pemberton Creek is an important fish bearing stream and in order to remove sediment in an environmentally acceptable manner it was required to establish two back channels, one above the Highway 99 bridge (125m in length) and one below (310m in length)

that serve as diversion channels during sediment removal and also serve as addition permanent fish habitat. During the months of August and September 2016 the work was accomplished and included:

- The relocation of the access road to the Stewardship Pemberton facility.
- Construction of the two back channels.
- Diversion of the creek into the back channels and sediment removal.

The lasting legacies of this project are:

- The ability to easily divert the creek and remove sediment in the future.
- The creation of a park like setting in both upper and lower zones.

Arn Canal Vegetation Management

During August 2016 phase two of the Arn Canal vegetation management was completed. With the completion of phase two the Arn canal has now been managed since August 2015 (phase one) to ensure maximum unrestricted flow along the entire length of the canal.

November 9th, 2016 Pemberton Valley High Water Event Summary

- On the afternoon of Nov 8 the PVDD noticed a rapid rise in the Lillooet River at approx 3:30 pm. The PVDD immediately contacted the River Forecast Center (RFC) for assistance to forecast river behavior. The response from the RFC came in at approx. 4:30pm and indicated the river would crest at 770 m^3/sec on the afternoon of Nov 9th at or above the 1 in 5 year return period. The PVDD asked the RFC if the high alpine temps and potential for snow melt had been considered in the forecast and the response was no it hadn't and the RFC then came back at approx 5:00pm with an amended forecast factoring in the snow melt. The new forecast predicted the Lillooet River to Crest at approx 850 m^3/sec on the afternoon of Nov 9th.

- The PVDD continued to monitor river levels and patrol flap gates and culverts for potential back flow situations and notified the VOP and SLRD of the situation and that if

the forecast was right there would be potential for minor flooding in low lying areas due to heavy rainfall. At this time the SLRD asked if the RFC would be issuing a high stream flow advisory as the river levels would reach a 1 in 5 year return period which triggers a high stream flow advisory. The PVDD called the RFC and asked that a high stream flow advisory be issued for the Pemberton Valley/Lillooet River, it did not seem that this was going to happen till this call was made. The advisory was issued at 6:51 pm on Tuesday Nov 8th.

- At approx 11:00pm on Nov 8th a call was received indicating potential road washout and flooding at Geese road.
- At 11:00pm the PVDD called the VOP to assist and close the flap gates on the Arn Cannel which was done by 12:30am Nov 9th.
- At 12:00am Nov 9th, the PVDD attended Geese road area and observed the road had washed out and that there was no apparent flooding but there was potential depending on future river levels.
- At 2:00am the PVDD noted that the Lillooet River gauge was showing 850 m^3/sec and was not rising, 1 patrol person was watching the Ryan River for potential flooding over Meadows road.
- At 6:00 am Nov 9th, additional patrols were commenced from one end of the valley to the other and it was found that the Ryan was going to over top Meadows Road. Calls started coming in from one end of the valley to the other. Constant communication was established with the VOP and SLRD with the SLRD communicating with the Lil'wat Nation. It was also found that the Lillooet gauge near Pemberton had stopped working at 850m^3/sec so there was no useful data available from this gauge from the 850m^3/sec reading onwards from approx 2:00am on Nov 9th. The Forestry bridge gauge continued to function but relays only elevation and not discharge information so it is of limited use in forecasting downstream in the vicinity of the Village of Pemberton.

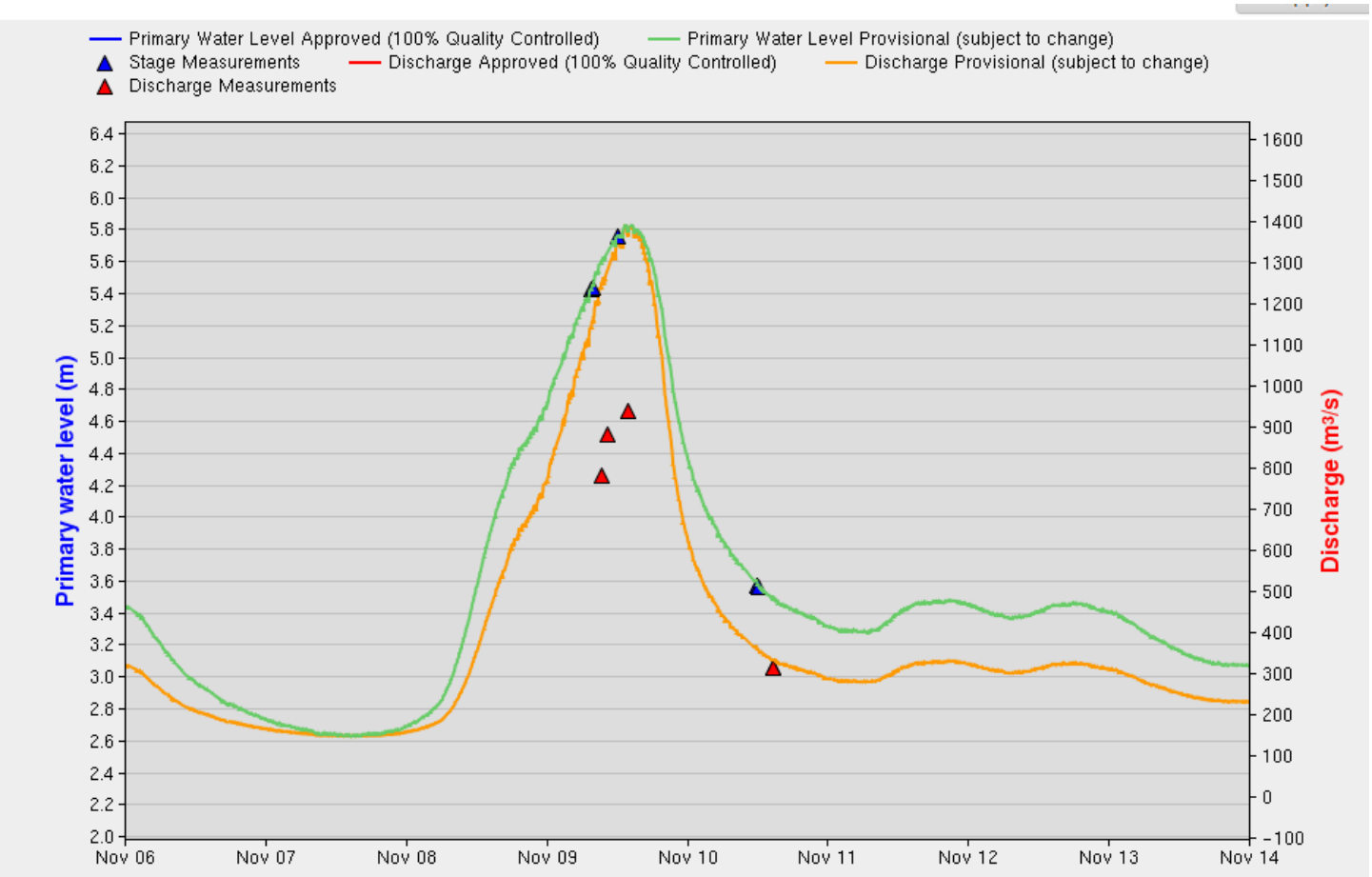


Figure 1 – WSC Lillooet River Gauge Near Pemberton

Lillooet River – The Lillooet River Crested at 1:00pm at the Forestry Bridge and 11:00pm at the Lillooet Highway 99 Bridge at 1400 m^3/Sec. My thought is Lillooet Lake influenced the slow elevation drop in Pemberton.

Response

Issues noted Wed, Nov 9th, included:

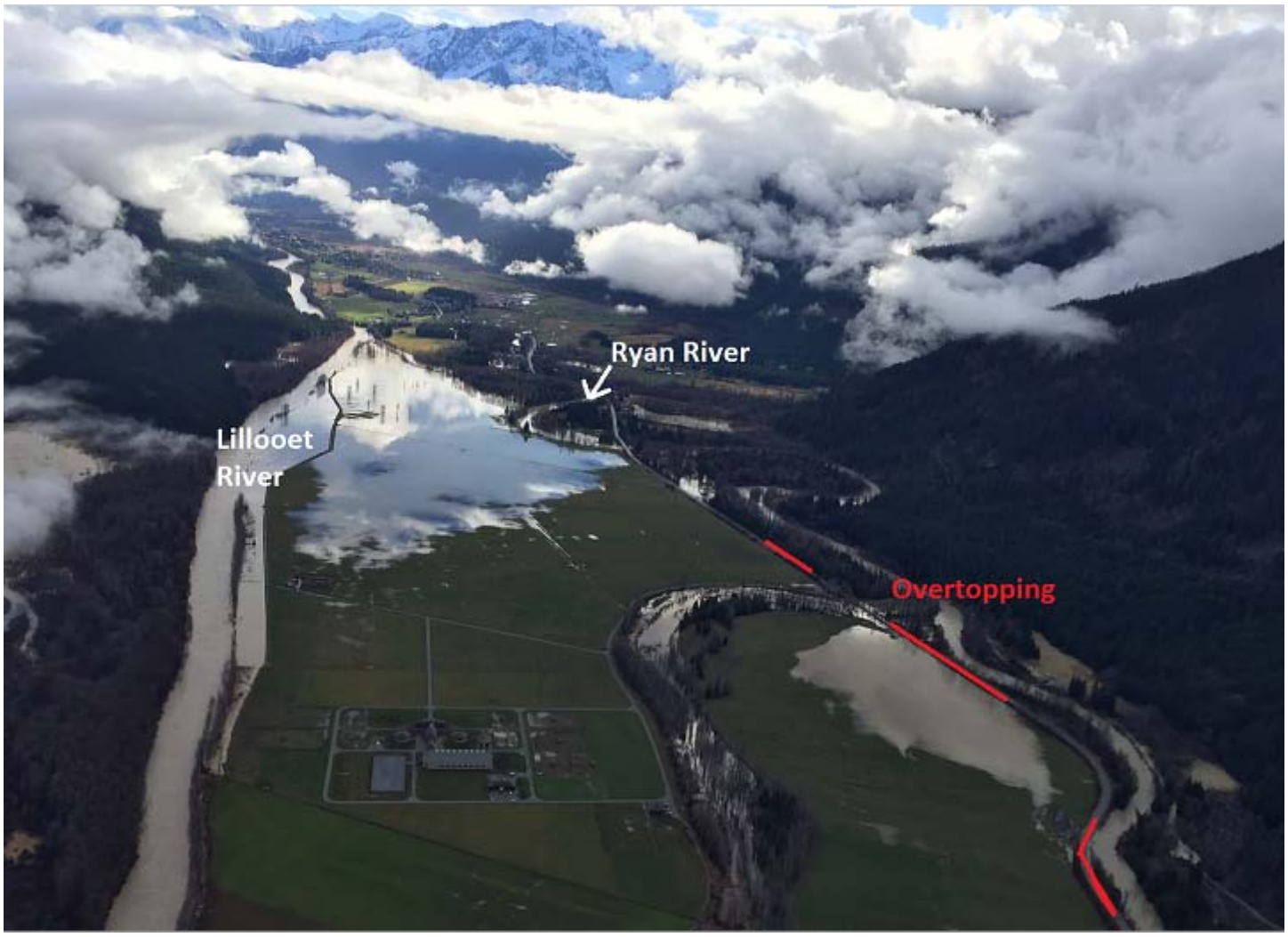
- **Arn Canal –** The Lillooet had back flowed up Pemberton Creek and closed the outlet gates on the Arn canal. This situation causes the Arn to rise steadily until the Lillooet River drops to approx 700m^3/sec. The construction of an emergency berm and pumping was required to protect the Peaks town home community from certain

flooding. This commenced at 7:30am and was completed at 9:30 pm on Nov 9th. Work was accomplished under a VOP task number. The PVDD and VOP co-managed this project.

- **Ole Jensen –** At 9:00am Nov 9th, the PVDD attended Ole Jensen's property to find that the Lillooet was overtopping the berm constructed during the Sept 20, 2015 high-water event. Additional material was brought in to increase the berm elevation.

Ole Jensen's Nov 9 10:00am.

- **Ryan River –** At 8:00 the Ryan River overtopped Meadows Road but the road remained open with caution signs posted.



Lillooet and Ryan River at 12:00pm on Nov 9th, 2016

- **Sturdy Farm –** At 11:00am the PVDD attended the Sturdy farm at the owners request. It was found that the Lillooet River had overtopped the bank and was flowing into the farm. The owner was notified by the PVDD that the river was forecasted to crest by mid afternoon Nov 9th and that if assistance was required to contact the SLRD EOC.

Sturdy Farm 12:10pm Nov 9th.

- **Miller Lillooet Dyke –** The PVDD was notified at 3:00pm on Nov 9th that piping under the Miller Lillooet Dyke was occurring in 3 locations near the McEwan farm and one location near the highway 99 Lillooet River Bridge. The PVDD attended and noted piping and called John Paddle with FLNRO Deputy Inspector of Dikes for assistance and he suggested to monitor and have materials on hand to contain the boils if required. The PVDD also requested an engineer to evaluate, this happened on the morning of Nov 10th at 8:30am.

Piping Miller Lillooet Dike at Gilmore farm Nov 9th 3:00pm

Piping Miller Lillooet Dike near McEwan Farm Nov 9, 2016 4:15pm

Miller Lillooet Dike Piping causing flooding on Oberson Property Nov 9 4:30pm.

- **Pemberton Airport/Golf Course/FLNRO Fire Base –** The airport road was closed at 12:00pm on Nov 9th as the airport, Big Sky Golf Course, Meadows Golf Course, VOP water treatment plant and Forestry Fire base were all flooded from the Lillooet and Green Rivers.

Pemberton Airport Nov 9 12:00pm.

Meadows Road Washout – At approx 10:00pm Nov 8th, the Lillooet River washed out Meadows Road just north of Geese Road.

Meadows road Washout Nov 9 12:30pm.

Miller Creek Weir – The Miller Creek weir was destroyed by extreme flows and completely filled with gravel. This weir had been excavated and cleaned out Sept 23rd, 2015 just after the September 15 2016 high water event.

Miller Weir Nov 9 12:00pm.

Miller Weir December 1 2016

Miller Gravel Deposition – Miller Creek experience severe gravel deposition just above and below the Highway 99 Bridge. The bar below the bridge was removed as Response after the Sept 20th, 2015 high water event.

Miller gravel Deposition Above Highway 99 Bridge Nov 17 2016

Miller Gravel deposition Below Highway 99 Bridge Nov 17 2016. This bar was completely removed Sept 23rd 2015.

Pemberton Creek Gravel Deposition – Pemberton Creek experience considerable gravel deposition. Deposition amounts have been determined to be in the 1200 m^3 range.

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PEMBERTON VALLEY DYKING DISTRICT

Pemberton Creek Lower Zone Nov 9 2016.

Pemberton Creek Gravel Deposition in upper Zone Nov 17 2016.

Ayers Dyke Bank Failure – There are 2 areas along the Ayers Dyke that experienced bank failures that are now compromising the dyke.

Ayers Dyke Bank Failure Nov 17 2016

Dream Catcher Farm Lillooet River – The armored bank of the Lillooet River at Dream Catcher farm experience dramatic impact from large woody debris. Bank armor repairs are required along the top 1/3 of the Armor where armor rock has been dislodged.

Dream Catcher Armor Damage – Nov 12 2016

Meadows Road Bank failure – Meadows Road experienced a bank failure at the Ronayne farm. MOTI issue and they were notified by the PVDD.

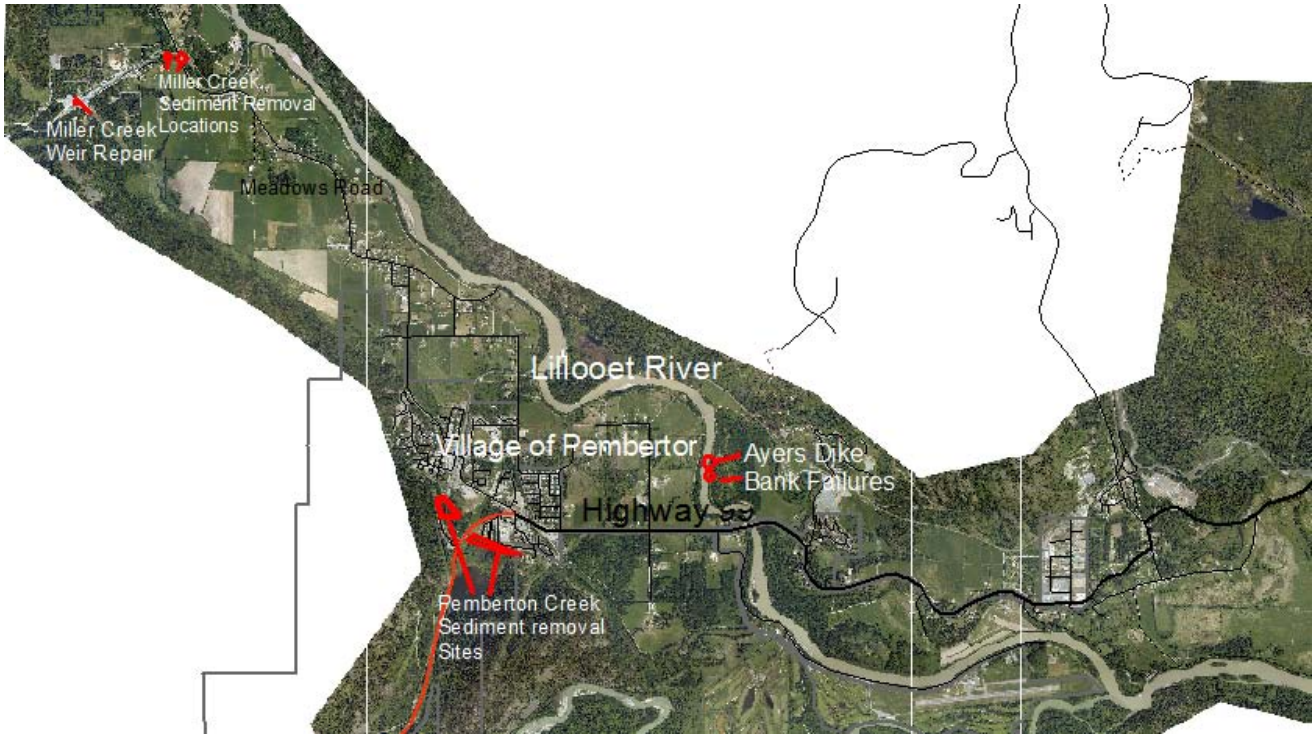
Meadows road Bank failure at Ronayne farm Nov 17 2016.

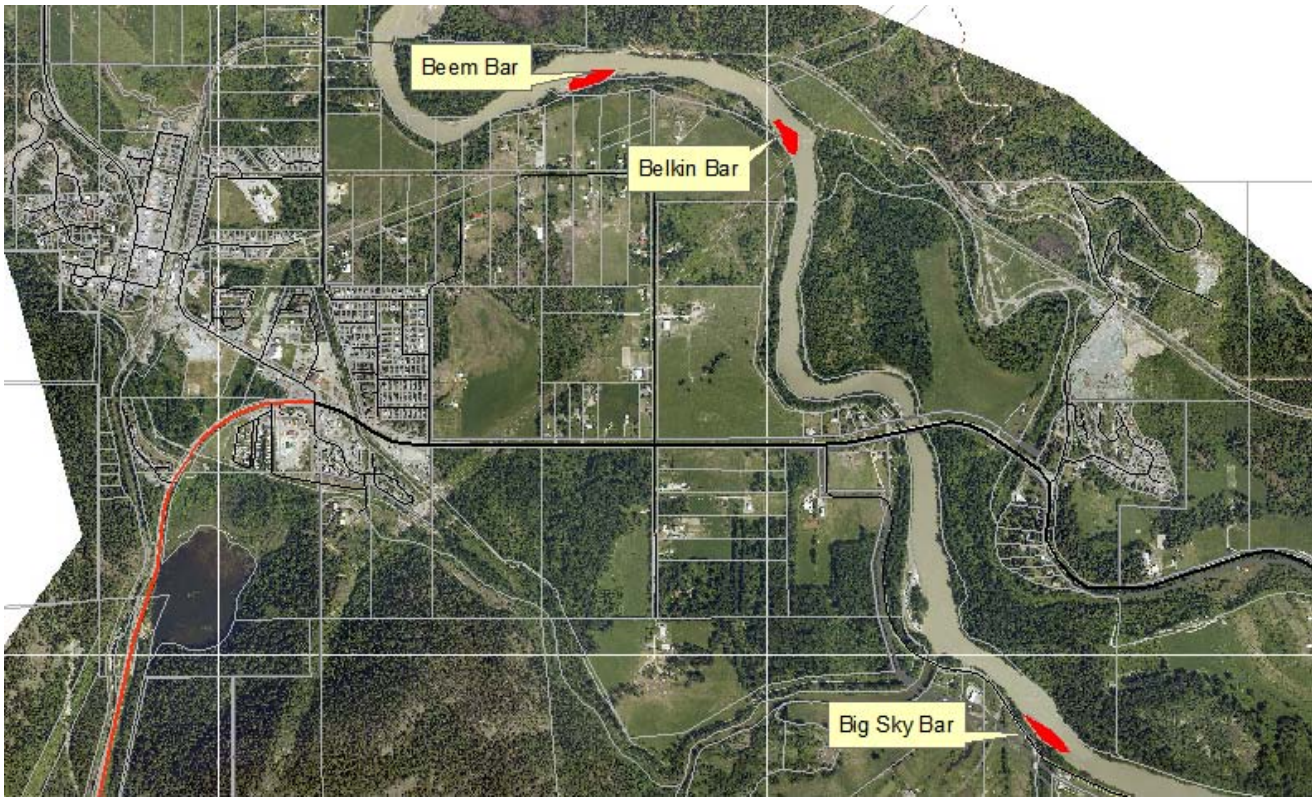
Grandmother Slough/IR2 – The PVDD briefly attended Grandmother Slough and IR2 where there was substantial flooding to homes and a trailer park and the situation was under the control of the Lil'wat Nation and SLRD.

Post Flood Patrol Findings

1. Miller Weir – The miller weir was severely damaged and requires repair.

2. Miller Gravel Removal – Two bars require removal to maintain dike , one above the Highway 99 Bridge and one below the bridge.
3. Ayers Dyke Bank Failures – In a 300 m section of the Ayers Dyke there are multiple banks failures that now threaten the dyke. This area was never armored and has now eroded the bank to the point of threatening the dyke.
4. Dream Catcher Armor Repair – Repair approx 50m of bank armor.
5. Pemberton Creek Gravel Deposition/Survey – A cross section survey was required to assess the scope of the Gravel deposition in Pemberton creek and it was determined that approx 1200 m^3 of material was deposited.
6. Lillooet River Gravel Deposition – In February/March 2016 the PVDD removed 18,000 of gravel from 3 bar location on the Lillooet River. It was found that all three bars were full of gravel and required removal of approx 14,000 m^3 to maintain dike freeboard.





Conclusion

Again for the second time in two years the River Forecast Center was unable to provide the warning necessary to adequately prepare for this event and the one in September 2015. If it wasn't for the phone calls from the PVDD it is very doubtful that they would have given any warning what so ever and the forecast they did give was out by 550m^3/sec, the difference between a 1 in 5 years return and close to a 200 year return. This is by far the biggest issue and needs to be addressed.

With the support of the DFA program all required repairs will be completed with the province funding 80% of the cost and the PVDD is funding the remaining 20% of costs. The repairs that required completion prior to the onset of the 2017 freshet have been completed. Further

work in Pemberton Creek and Miller Creek require the work to be completed during the August/Sept 2017 fish window.

September 21, 2015 High Water Event

100%	$ 410,000
80% Province	$ 328,000
20% PVDD	**$ 82,000 – Not Budgeted**

Nov 9, 2016 High Water Event Recovery Costs Estimates:

100%	$413,000
80% Province	$330,400
20% PVDD	**$ 82,600 – Not Budgeted**

2017 Project Summary

Emergency Works Required as a result of the Nov 9, 2017 High Water Event

Miller Creek Gravel Removal - Recovery

On April 3rd and 4th 2017 emergency works were completed on Miller Creek that included:

- Weir repair
- Removal of 1000 m3 of sediment was removed from the sediment catchment basin.
- Bank Armoring along the creek above the catchment basin.

During the August fish window further emergency work will be required and includes:

- Removal of an additional 1500 m3 of sediment from the catchment basin.
- Removal of 2 gravel bars, 1 above and 1 below Meadows Road Bridge.
- Add more large rock to Weir.

Lillooet Sediment Removal – Recovery

A post high water survey was conducted of the 3 bars where 18,000 m3 of sediment was removed from the Lillooet river in March 2016 and indicated that 14,000 m3 of sediment had been deposited on the 3 bars as a result of the Nov 2017 high water event. The PVDD conducted a Request for Proposal process to accomplish this removal as cost effectively as possible, Coastal Mountain Excavation was the successful proponent. The work was completed during the Month of March and first week of April 2017.

Big Sky Bar

Belkin Bar

Beem Bar

Ayers Dyke Bank Armor

Two areas adjacent to the Ayers Dyke were damaged by erosion as a result of the Nov 2017 high water event and required repair prior to the 2017 freshet. This work was completed in the first week of April 2017.

Pemberton Creek

As a result of a detailed survey conducted after the Nov 2016 high water event it has been identified that 1200 m3 of sediment must be removed from Pemberton Creek to ensure adequate dyke freeboard. This work will be conducted during the August/September 2017 fish window.

Lillooet River Armor Repair

20 Km north of Pemberton existing armor along the bank of the Lillooet River was damaged as a result of the Nov 2016 high water event and requires minor repair. This work will be completed prior to the 2017 freshet.

Birkenhead River

As part of the post construction monitoring plan for the work that was conducted on the Birkenhead River in 2013 that included the removal of 9000 m^3 of sediment to reestablish the main channel behind the Pole yard it is required to conduct:

1. Fish stranding surveys.
2. Flow measurements in the main and side channels in the vicinity of the works.

These monitoring requirements were completed in early April 2017 during low flow conditions and no problems were indentified, the river and side channels are all functioning as designed.

Birkenhead River April 5 2017

Flood Plain Mapping

The PVDD in cooperation with the VOP, SLRD and Lil'wat applied to the National Disaster Mitigation Program for funding to remodel the Lillooet River and create updated modernized Flood Plain Mapping for the Pemberton Valley that will provide very valuable information to assist with forecasting. The application was pulled from the NDMP process by the province and the province has since approved the funding with 100% of the required $600,000 coming

from the province. This project will commence in May 2017 and end in March 2018 and will be managed by the PVDD.

The objective is to create a series of new modernized flood hazard maps for the Pemberton Valley Floodplain and to develop the 200 year Design Flood Hazard map. The reaches to be mapped and corresponding floodplains include:

- 50 km reach of the Lillooet River valley between Lillooet Forest Service Bridge and Lillooet Lake;
- 12 km reach of the lower Birkenhead River;
- 15 km of the Ryan River;
- 4 km of Miller Creek;
- 4 km of Pemberton Creek.

Mapping methods must conform to current guidelines and standards including those under development, namely:

- APEGBC Professional Practice Guidelines for Flood Mapping in BC (expected release April 2017);
- National Guidelines (Under development with expected release 2017/18) and
- MFLNRO Flood Hazard Area Land Use Management Guidelines (2004).

To achieve this objective the tasks involved include:

1. Obtaining Channel and Floodplain data, including but not limited to:

    a. Topographic, land use and cadastral information;
    b. LiDAR and orthographic data;
    c. Bathymetry data;
    d. Data must be provided to PVDD and the Province of BC once project is completed.

2. Conducting a desktop geomorphological review and assessment of channel stability to determine aggradation/degradation trends in the Lillooet River and tributaries. The review and assessment to include, but not be limited to:

a. Current channel sedimentation locations and assessment of impacts to flood flows and conveyance of Design Flood event.
b. Future sediment sources from landslides and assessment of the likelihood and magnitudes of future sediment deposition.
c. Assessment of freeboard considerations.

3. Conducting hydrologic review, analyses including recommendations for future considerations. Review and analysis to include, but is not limited to:

    a. Literature review of the history of flooding in Pemberton Valley including reports on determination and quantifying the design flood.

    b. Investigating the WSC Lillooet River near Pemberton (08MG005) gauge and comparing it to new gauges in the area.

    c. Reviewing the historic stage-discharge relationships for the Lillooet River gauge.

    d. Determining Lillooet Lake flood Levels based on recorded levels and lake discharge rating curves.

4. Carrying out frequency analyses and determining the 2, 10, 50, 100, 200 and 500 year return period peak flows and associated flow hydrographs for the Lillooet River and tributaries.

5. Conducting hydraulic analyses for 2, 10, 50, 100, 200 and 500 year return period scenarios consisting of, but not limited to:

    a. Establishing one dimensional hydraulic model to compute flood profiles;

    b. Incorporating climate change scenarios and modifying hydrographs accordingly;

    c. Determining flood water level profiles for each return period;

    d. Identifying dike over-topping locations for each return period;

e. Determining dike breach locations and breach parameters;

f. Digital model and results must be provided to PVDD and the Province of BC once project is completed.

6. Undertaking one-and two-dimensional coupled hydraulic modeling to simulate dike breach scenarios at up to 10 key locations along the diked portions of the Lillooet River and tributaries. This is to determine the inundation extents, depth of flows, velocities and flood durations in the floodplain for the 2, 10, 50, 100, 200 and 500 year return period flow scenarios. This includes, but is not limited to:

   a. Testing, calibration and validation of hydraulic models. Models can be open source.

   b. Determining the dike breach location that creates the "worst case scenario" resulting in greatest inundation extent, depth of flow, highest velocities and longest flood duration in the flood plain and along the river bank and dike. This is for each of the flow scenarios.

7. Developing a series of composite envelope flood hazard maps for each return period that demonstrates the worst case scenario of inundation showing area, water level, velocity, flood duration and dike breach location that could occur at any location along the dikes. This is to include, but not limited to:

   a. Producing flood hazard maps for each scenario. Mapping to be compatible with the Federal NEMS management system. (Note: Mapping must be provided to PVDD, Public Safety Canada and the Province of BC once project is completed.)

   b. Producing a Flood hazard map for the 200 year design flood scenario. This map is intended to become the "designated" floodplain map. (Note: Mapping must be provided to PVDD, Public Safety Canada and the Province of BC once project is completed.) This map to include:

      i. the design flood water level profile;

ii. dike footprint locations and crest elevations, dike extents that are vulnerable to overtopping;

iii. flood extent, depths, velocities and flood durations;

iv. flood construction levels (FCL) including freeboard allowance;

v. hydrometric gauge locations;

vi. critical infrastructure and assets (dikes and right of ways, flood boxes and pumping stations, roads, railways, hospitals, airports, municipal buildings, sewers and sanitary and utility buildings, emergency services, etc.) and any other information useful for flood emergency planning and response purposes.

8. Preparing a report to document all tasks and deliverables including, but not limited to, those listed above. Report must include, but is not limited to a discussion and recommendations on:

a. Climate change impacts and associated hydrologic and hydraulic impacts to Pemberton Valley;

b. Future sedimentation trends;

c. Raw data types, source, dates, accuracy and limitations;

d. Modeling type, methodology, accuracy and limitations;

e. Considerations of future modelling and mapping and updating thereof;

f. Considerations on future emergency response and preparedness;

g. Flood Mitigation Planning.

Annual Inspections and Maintenance

In April 2017 the annual inspection of the PVDD dyking infrastructure will take place and any deficiencies found will be repaired prior to the 2014 freshet. In late May the annual maintenance will start and includes:

- Ditch Maintenance
- Tree Removal
- Mowing
- Culvert and flap gate repairs

The PVDD would like to take this opportunity to thank the provincial government for supporting for all the folks that work in and call the Pemberton Valley home. The last two years have been challenging from a dyking perspective due to two consecutive very high water events and the province was definitely there for us when we needed them.

2017 Annual General Meeting Report Prepared by: Steve Flynn