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Technical Memorandum

DATE: July 15, 2026

TO: Sterling Chan
Manager of Engineering and Infrastructure
Fraser Valley Regional District (FVRD)

FROM: John Wang, P.Eng (BC)
Kyle Cousineau, EIT (BC)

RE: **OSBORNE ROAD DIKE FEASIBILITY STUDY**
Assessment of Improvement Options
Our File 2080.054-300

Kerr Wood Leidal Associates Ltd. (KWL) was retained by Fraser Valley Regional District (FVRD) to undertake a feasibility study on improvement options for the Osborne Road Dike (the dike), which is an unregulated, non-standard dike, commonly referred to as an orphan dike. The dike is located in Electoral Area E southeast of Chilliwack, BC. The study was initiated in response to increasingly severe and frequent high-water events along this reach of the Chilliwack River resulting in bank erosion and overland flooding of adjacent private properties. While damages are repaired as necessary through emergency funding from the Province, the community has inquired about longer-term solutions including having the FVRD become the diking authority to provide operations and maintenance of the dike. This feasibility study will be used to support the FVRD and the local community in determining a preferred path forward.

1. Project Scope

The feasibility study is separated into two phases:

- **Phase 1** – Preliminary (or pre-feasibility) assessment of improvement options for community consultation and selection of a preferred option.
- **Phase 2** – Conceptual design of the selected preferred option for regulatory consultation and grant applications.

This memo summarizes the work completed for **Phase 1** of the feasibility study, which includes the following scope of work:

- Evaluation of advantages and disadvantages of various improvement options.
- Consideration of regulatory permitting requirements and timelines for each option.
- Development of conceptual figures for each option identifying the works and impacts to private properties.
- Development of plan maps identifying properties that would benefit from dike improvements for each option.
- High-level capital cost estimates and analysis of annual debt servicing costs.
- High-level annual operating and maintenance cost estimates.

It is noted that the scope of work does not include geotechnical and archaeological assessments. These should be included for a later stage of design to confirm design parameters and feasibility of the preferred option.

2. Background

2.1 Site History

Osborne Road Dike is an approximately 430 m long unregulated and non-standard dike located from Stapley Road at the upstream end to approximately 90 m downstream of Osborne Road. The dike and associated bank protection were constructed by the Province of British Columbia in 1990 following a significant flood event on the Chilliwack River. As an orphan dike, it is not maintained by either formal diking authority or a private owner. The dike was not constructed to modern BC dike standards for flood protection and does not tie into high ground at its upstream end. The location and extents of the existing dike are shown in Figure 1.

N

Chilliwack Lake Rd

Mission

Fraser River

Chilliwack

Project Location

Abbostford

Private Property
Parcel Lines

005-503-213

001-890-166

003-303-181

005-466-052

Sheldon Rd

005-207-827

006-491-464

Sta. 0+200

Sta. 0+250

Sta. 0+300

Sta. 0+150

Osborne Rd

006-990-355

Chilliwack River

006-491-553

006-491-570

Stapley Rd

000-510-211

Sta. 0+350

Sta. 0+100

006-491-600

Existing Riprap
Revetment

Exist. Dike
Alignment

Sta. 0+400

Sta. 0+050

013-074-652

Sta. 0+00

Chilliwack River

Exist. Dike Footprint (Approx.)

Chilliwack River

Emergency Riprap Works
Adjacent to Orphan
Structure (2025-2026)

0 25 50 75 100 m

Paper Size = ANSI B
At Full Size, this border measures 280 mm x 430 mm

0 5 10 25 50 millimetres

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OSBORNE ROAD DIKE FEASIBILITY STUDY
EXISTING CONDITIONS
LOCATION MAP
FIGURE 1

Since its construction, the dike has experienced several high-water events leading to damages and subsequent repairs. In 2020, KWL assessed the dike as part of a province-wide review of orphan dikes completed for the Fraser Basin Council (KWL, 2020). At that time, the dike was rated in *Poor* condition, with a high likelihood of damage or failure during a future high-water event.

Occurrences of high-water events and repairs known to KWL are listed in Table 1.

Table 1: History of Damages and Repairs at Osborne Road Dike (Known to KWL)

Time of Occurrence	Description of Event	Reference Document
November 2006	• A flood event damaged the dike and riprap, with overtopping observed at several locations. • Repairs were completed along the lower portion of the dike, including placement of additional riprap, while the upper portion remained in its original condition.	KWL 2007
November 2021	• A series of atmospheric river events (AREs) resulted in high flows which transported large volumes of woody debris through the river system. The combination of high flows and large woody debris led to bed scour and debris strikes which initiated bank erosion on the lower 40 m of dike. • Emergency works, monitored by KWL, were completed in early January 2022 and included placement of BC Ministry of Transportation and Transit (MoTT) Class 500 kg riprap along the bank.	(KWL, 2021)

December 2025	• On December 11, 2025, an ARE transported significant volumes of sediment and woody debris through the river, accumulating at existing log jams upstream of the dike and contributing to formation of new log jams.
	• Damage occurred to approximately 25 m of the dike, including 10 m to 25 m of complete dike loss at the upstream end of the dike adjacent to 48962 Sheldon Road, overland flooding, and sediment deposition across adjacent properties.
	• Emergency works, monitored by KWL, were completed between December 13 and December 15, and included:
	  ○ placement of BC MoTT Class 500 kg riprap along the bank of the orphan dike;
	  ○ construction of a groyne adjacent to the orphan dike to direct flows towards the center of the channel; and,
	  ○ installation of temporary Hesco barriers along the east property line of 48962 Sheldon Road.
	• The following observations for the made by KWL following emergency works:
	  ○ Additional bank stabilization upstream and adjacent to the orphan dike are required to mitigate against scouring of existing riprap and overtopping upstream of 48962 Sheldon Road; and,
	  ○ Further erosion of a scour hole located immediately upstream of the groyne adjacent to the orphan dike could destabilize the repairs.
	  ○ KWL recommended filling the scour hole and installing riprap adjacent to the groyne.
		(KWL, 2026a)

Time of Occurrence	Description of Event	Reference Document

March 2026	• Between March 15 and March 20, 2026, an ARE generated approximately 150 mm of rainfall, leading to significant erosion of areas immediately upstream of the dike at 48962 Sheldon Road and 48982 Sheldon Road.
	• Emergency works, monitored by KWL, were completed on the bank adjacent to the orphan dike between March 19 and March 20, and included:
	  ○ Placement of BC MoTT Class 500 kg riprap along an approximately 45 m long section of eroded bank;
	  ○ Re-grading vertical slopes to 1.5H:1V to 2H:1V slopes;
	  ○ Supplementing the existing groyne with additional riprap; and,
	  ○ Infilling the scour hole previously identified in December 2025.
	• KWL recommended the following short and long-term actions:
	  ○ Assess the installed riprap revetment under low-flow conditions to observe for erosion and/or scouring at the toe;
	  ○ Monitor the remainder of the dike and upstream existing bank protection adjacent to the dike during high flow to identify vulnerabilities. Evaluate bank protection if channel migration occurs to assess the risk to the dike and adjacent properties;
	  ○ Upgrades to the dike to modern dike standards (i.e., safely withstand the 200-year design flood event).
	  ○ Periodic routine monitoring (including pre- and post-freshet, and increased monitoring after significant flow events) of the log jams in the vicinity of the Osborne Road Dike to document changes in debris accumulation, channel blockage and flow distribution, and;
	  ○ Trigger based emergency assessment of the Osborne Road Dike if the channel has become fully blocked with debris or a flood watch or flood warning is issued.
		(KWL, 2026b)

2.2 Elevation Data

The horizontal and vertical datums for the project are NAD83 UTM Zone 10N and CGVD28, respectively. Elevation (topographic) data available for the project are as listed in Table 2. All elevations stated in this memo are in CGVD28 unless otherwise indicated.

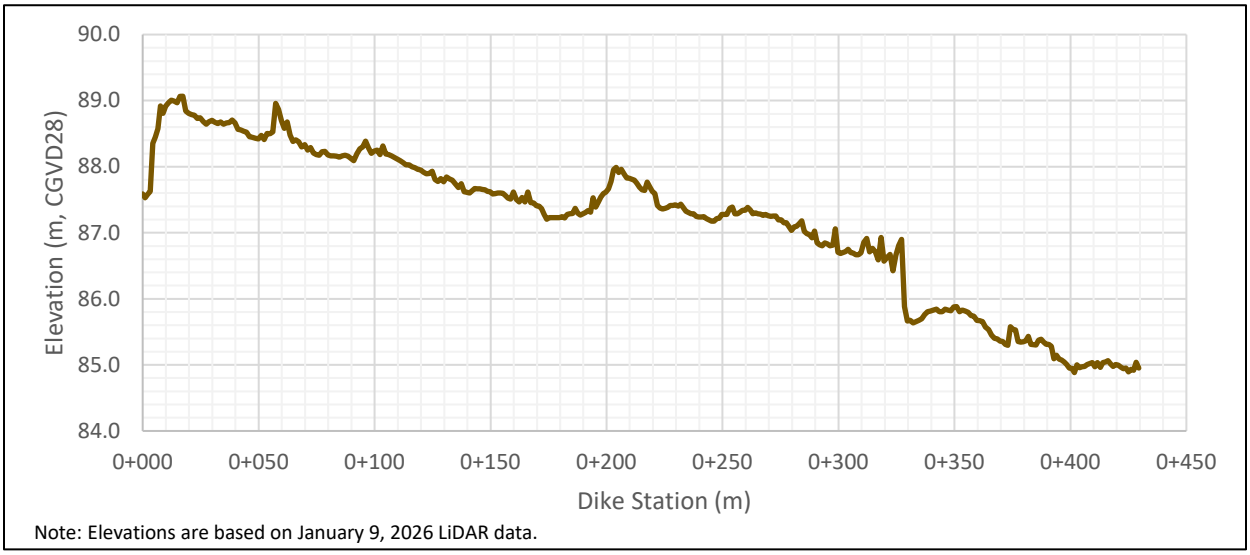
Given its recency, topographic data collected on January 9, 2026 was used as the basis for this assessment for the purpose of cost estimation. It should be noted since collection of this survey, topographic changes have likely occurred at the dike due to the March 2026 ARE.

Table 2: Summary of Elevation Data Available for the Project

No.	Surveyed By	Date of Survey	Vertical Datum
1	McElhanney	January 9, 2026	CGVD28 (HTv2.0)
2	McElhanney	April 17, 2021	CGVD28 (HT2)
3	Natural Resources Canada (NRCan)	2021	CGVD2013

2.3 Existing Conditions

Osborne Road Dike is understood to be a homogeneous earthfill dike comprised of locally borrowed sand and gravel materials. No geotechnical information about the dike was available to KWL for this assessment. In general, the dike has crest widths ranging between 2.5 m and 4.5 m, waterside slopes between 1.5H:1V and 2H:1V, and landside slopes at or greater than 2.5H:1V. Deviations from these ranges exist along the dike in localized sections. Crest elevations along the dike are variable and there are locations that are susceptible to outflanking by floodwaters. The upstream end of the dike is not tied into high ground and also vulnerable to outflanking. A profile of the dike crest, which ranges from approximately El. 89 m near the upstream end to El. 85 m at the downstream end, is shown in Figure 2.



Note: Elevations are based on January 9, 2026 LiDAR data.

Figure 2: Existing Osborne Road Dike Crest Profile

The dike is located on a reach of the river that is bifurcated into two main channels of similar widths by river islands. The majority of the dike, from Sta. 0+000 to Sta. 0+350, only receives flow from the north channel of the river. At the upstream end of the dike, the north channel branches further into two stems, one of which directly impinges on the dike. From analysis of historic photos and anecdotal evidence from residents, the river previously flowed predominantly through the southern stem; however, as a result of recent severe high water events that have deposited significant volumes of large woody debris through the reach, the majority of flows now enter the northern stem, concentrating high velocities directly at the dike and upstream bank areas under flood conditions. This has led to considerable bank erosion as discussed in Table 1.

Following emergency works at the upstream end of the dike in December 2025 and March 2026, approximately 350 m of the dike and a further 45 m of bank upstream of the dike are now armoured with riprap protection. The size of riprap varies. Riprap installed as part of the original construction and earlier repairs are estimated to be roughly equivalent to BC MoTT Class 25 kg riprap to Class 100 kg riprap, while those installed recently as part of emergency works are classified as BC MoTT Class 500 kg riprap.

The dike is located adjacent to several private properties along Sheldon Road and Osborne Road. Some areas of the dike footprint (i.e., landside slopes) are located within private property while some landowners have built out features beyond their property lines onto or near the dike toe. Property parcel lines and the existing dike footprint are shown in Figure 1.

3. Design Basis

3.1 Provincial Dike Standards

Provincial dike standards refer to design criteria and guidance provided in the *Dike Design and Construction Guide – Best Management Practices for British Columbia* (BC Ministry of Water, Land, and Air Protection, 2003). While the guidance document provides a comprehensive discussion on dike design and construction practices, in the context of this assessment, design criteria specifically used to guide the design and assessment of improvement options are as follows:

- Design Flood Level/Minimum Dike Crest Elevation: 200-year return period flood
- Crest Width: 4 m (minimum)
- Waterside Slope: 2.5H:1V (minimum)
- Landside Slope: 3H:1V (minimum)
- Seepage Mitigation: low-permeability till core.

It is highlighted that criteria related to hydrotechnical design (e.g., design flood level, freeboard) and geotechnical design (e.g., design/selection of dike fill materials, seismic assessment) have not been considered herein either due to the early stage of design or lack of available existing information. Depending on the preferred improvement option, additional studies and analyses will be undertaken in a subsequent stage of design in accordance with the criteria specified in the guidance document.

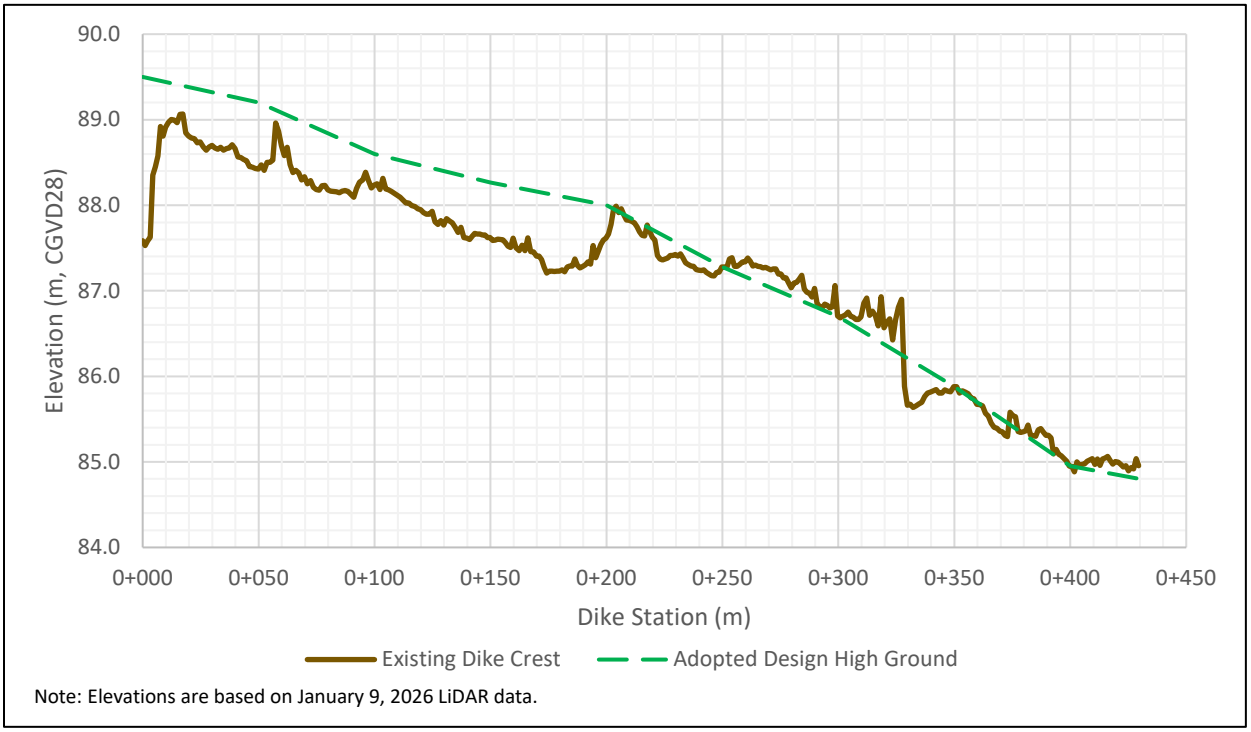
3.2 Design Dike Crest (High Ground)

As stated in Section 3.1, hydrotechnical design to confirm the 200-year design flood level has not been undertaken for this assessment. At this stage, it has been assumed that Osborne Road Dike will be raised and tied-in to *high ground* to improve flood protection and mitigate against outflanking. For the purpose of this assessment, high ground is considered to be the road elevations on Sheldon Road and Chilliwack Lake Road adjacent to the dike. Neither road follows the dike entirely, and as such, some approximation of equivalent road elevations had to be made. The adopted high ground profile for design is listed in Table 3 and shown with the existing dike crest profile in Figure 3. As shown in Figure 3, the upstream half of the dike, between Sta. 0+000 and Sta. 0+200, is up to 1 m below high ground, while most of the downstream half is at or near high ground. For the purpose of this assessment, all upstream extensions of the dike to tie into high ground will be maintained at crest El. 89.5 m corresponding to the high ground elevation at dike Sta. 0+000.

Additional analysis (e.g., hydraulic modeling) may be warranted, following selection of the preferred option, to confirm the design flood level and freeboard requirements.

Table 3: Dike High Ground Elevations

Dike Station (m)	High Ground Elevation (m)
0+000	89.5
0+050	89.2
0+100	88.6
0+150	88.3
0+200	88.0
0+250	87.3
0+300	86.7
0+350	85.9
0+400	85.0
0+430	84.8



Note: Elevations are based on January 9, 2026 LiDAR data.

Figure 3: Dike High Ground Profile

4. Options Assessment

4.1 Description of Options

Three categories of options are considered for the options assessment:

- **Option 1 - Regulated Dike**: FVRD establishes a service area, becomes the local diking authority for Osborne Road Dike, and improves flood protection along the dike.
- **Option 2 - Status Quo**: Osborne Road Dike remains an orphan dike and FVRD remains only responsible for emergency management.
- **Option 3 - Managed Retreat**: Flood-affected properties along Osborne Road Dike are acquired and landowners are relocated to new homes.

One or more permutations are proposed for each category as summarized in Table 4. Further discussions on each option are provided in their respective sub-sections below.

Table 4: Summary of Improvement Options

Category	Option No.	Option Name	Category Description	Option Details
1 - Regulated Dike	1a	Raise Dike and Rebuild Bank Protection	• FVRD to become local diking authority for Osborne Road Dike. • FVRD provides funding for dike operations, maintenance, and repairs through the creation of a service area to tax benefitting properties. • Landowners of benefitting properties to provide FVRD with statutory right-of-way allowances along the dike for maintenance and repairs.	• FVRD to provide an expanded level of service by upgrading the dike to meet provincial diking standard requirements for crest width, bank slopes, and inclusion of a low-permeability seepage mitigation zone: ○ As discussed in Section 3, additional assessment is required to confirm if proposed raise to high ground meets the 200-year design flood levels. • Osborne Road Dike to be raised to high ground as defined in Section 3.2. • All existing riprap bank protection to be removed (either disposed or salvaged) and replaced with suitably sized riprap materials. • Two alternative upstream dike tie-in alignments are proposed, depending on classification as a standard or non-standard dike.
	1b	Maintain Dike and Repair Bank Protection		• FVRD to provide a baseline level of service by maintaining the existing dike mostly as-is, raising low spots as needed, and installing new or repairing existing riprap bank protection: ○ Existing riprap bank protection to be retained and only replaced during construction if deemed damaged or inadequate.
2 – Status Quo		Site-Specific Improvements by Private Landowners	• Osborne Road Dike remains an orphan dike and will not be maintained or improved. • FVRD remains only responsible for emergency management.	• Improvements to individual properties such as house raising and installation of bank protection are completed by private landowners on a case-by-case basis. The type(s) and extent of improvements are at the discretion of the landowners.
3 – Managed Retreat			• Flood impacted properties along the dike are acquired, relocating private landowners away from the flood risk. • Dike and acquired properties are abandoned, and no additional maintenance of the dike is undertaken for the foreseeable future.	

4.1.1 Option 1 – Regulated Dike

Under Option 1, FVRD will become the formal diking authority for Osborne Road Dike and take on responsibilities for the dike. This would enable FVRD to undertake proactive improvement measures along the entire dike rather than only providing support in emergency situations. To fund management of the dike, FVRD would establish a taxable service area comprising all private properties protected by the dike (see Section 4.2). As a diking authority, FVRD would also have improved eligibility for funding programs such as the federal Disaster Mitigation and Adaptation Fund (DMAF) and Disaster Financial Assistance Arrangements (DFAA), as well as provincial grants. The regulatory process and requirements for "adopting" an orphan dike is outlined in Section 4.4.

Within Option 1, there are various levels of improvements that can be implemented to provide varying levels of flood protection. As it would be infeasible to explore every permutation of improvements under Option 1, this study assesses the following two options:

- Option 1a, under which a high (or expanded) level of improvement would be made to significantly increase the level of flood protection along the dike.
- Option 1b, under which a relatively minimum (or baseline) level of improvement would be made primarily to address major flood vulnerabilities along the dike.

If Option 1 is selected, additional work would be undertaken to develop and design a suitable improvement plan based on available funding, landowner needs, and regulatory requirements amongst other considerations.

Option 1 will have considerable impact on private properties. As a diking authority, FVRD would require statutory right-of-way (SROW) access along the entire length of dike for maintenance access. Depending on the final dike alignment, different SROW footprints may be required. If the dike is raised and/or widened (e.g., Option 1a), FVRD would also have to acquire portions of private properties to accommodate a larger dike footprint. Features such as deck patios, sheds, and fences that have been built within or in close proximity to the Option 1 footprint are not legally permitted on a regulated dike and would have to be removed. Existing and proposed encroachment of the dike onto private properties are shown in Figure 1, and Figure 4, Figure 5, and Figure 7 respectively. FVRD would financially compensate each affected private landowner for the loss of property/land use for an amount commensurate with the loss in property value.

Option 1 will also have the largest disturbance footprint (among all options) and therefore the most impact on the environment. Placement of hard armouring at the dike will require a commensurate level of environmental offsetting, either directly at the revetment (e.g., planted riprap) or at a suitable off-site area(s). The cost and extent of habitat offsetting have not been estimated in this assessment should be considered when determining a preferred option.

At this stage, it is assumed that the proposed dike configurations under Option 1 will be geotechnically stable. This must be confirmed by a qualified geotechnical professional at the next stage of design. Assessments should include slope stability analysis and a seismic assessment (if required) as described in the *Dike Design and Construction Guide* (BC Ministry of Water, Land, and Air Protection, 2003) and *Seismic Design Guidelines for Dikes* (BC Ministry of Forests, Lands and Natural Resource Operations - Flood Safety Section, 2014).

Option 1a – Raise Dike and Rebuild Bank Protection

For Option 1a, FVRD would raise the dike to high ground and rebuild the bank protection from the bank toe. This provides the highest level of flood protection among all assessed improvement options but is also the costliest (see Section 4.3). Raising of the dike would be in accordance with provincial dike standards as much as feasible. The existing dike would be excavated from the waterside toe at a 3H:1V slope and raised to the design high ground using geotechnically suitable fill material. The dike would have a minimum crest width of 4 m with a 1 m wide central zone of low permeability till assumed sufficient for seepage mitigation. BC MoTT Class 500 kg riprap, which has been used during recent emergency repairs and appears stable under high flows, will be placed across the waterside slope for erosion protection. Additional launching riprap of the same class will be added at the toe for scour protection.

Under Option 1a, there is potential for Osborne Road Dike to be converted to a standard dike if the raised crest meets or exceeds the 200-year flood water levels. If Osborne Road Dike becomes a standard dike, FVRD would have the option to extend the length of the dike upstream and/or downstream to protect additional properties beyond those it currently protects. Two alternatives for upstream tie-in to high ground are proposed that correspond to scenarios in which the dike remains a non-standard dike or becomes a standard dike:

- Baseline Tie-In: Extending the dike approximately 65 m upslope (i.e., northeast) to the intersection of Stapley Road and Sheldon Road, which would maintain roughly the same area of flood protection as existing. If Osborne Road Dike remains a non-standard dike, this alternative is the only one permitted under the DMA.
- Extended Tie-In: Extending the dike upstream along the riverbank (i.e., southeast) approximately 140 m up to 49002 Sheldon Road, providing flood protection to an additional two properties. This alternative is only permitted if Osborne Road Dike becomes a standard dike.

Conceptual plans and a typical dike cross-section for Option 1 are shown in Figure 4 to Figure 6.

Option 1a will require a larger SROW footprint than Option 1b, and will also have a larger environmental disturbance footprint than Option 1b as the entire riprap revetment will be rebuilt. Accordingly, compensation and offsetting costs are expected to be higher for Option 1a than for Option 1b.

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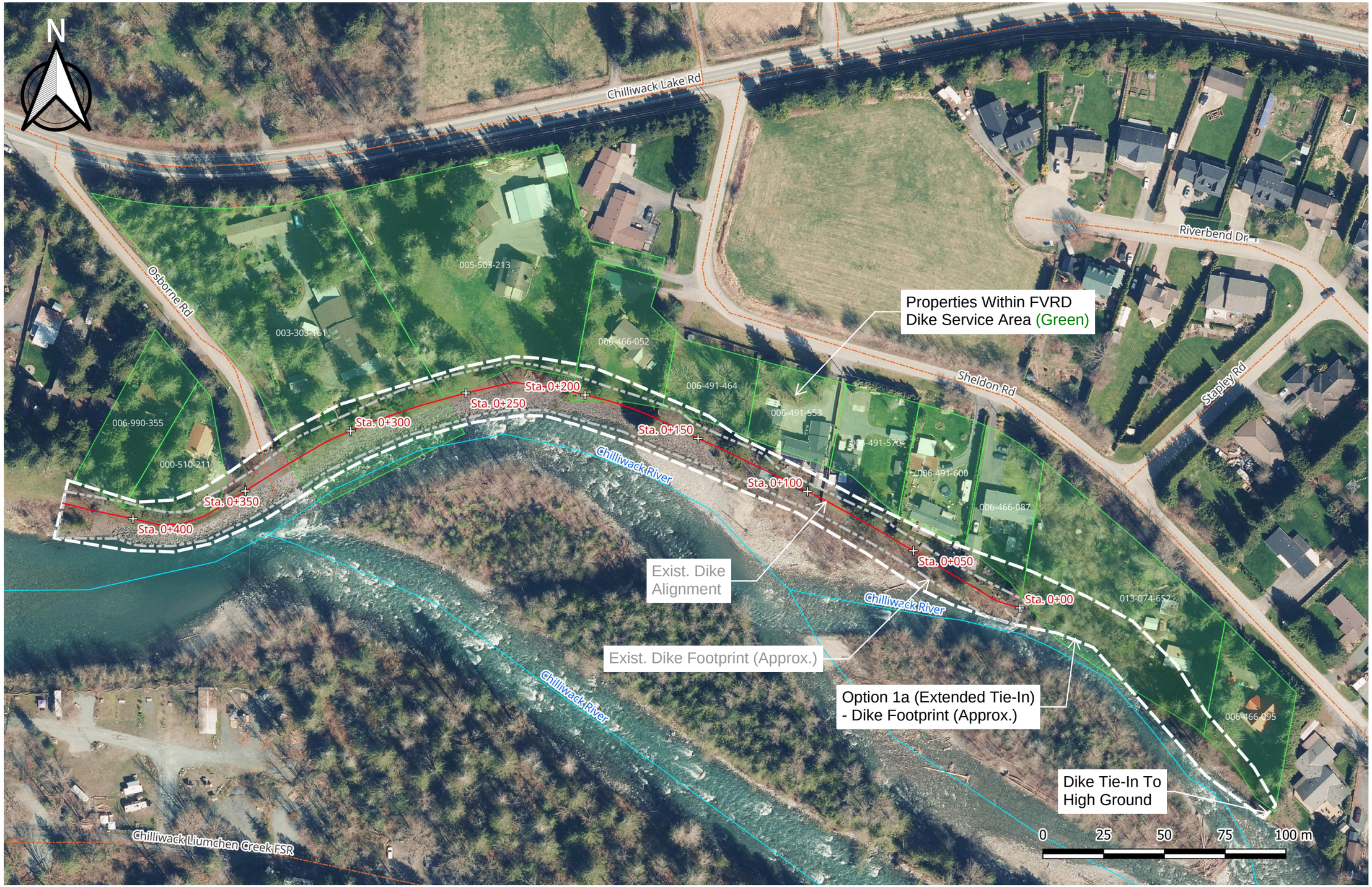
OSBORNE ROAD DIKE FEASIBILITY STUDY
OPTION 1A: RAISE DIKE & REBUILD (BASELINE)
PLAN MAP
FIGURE 4



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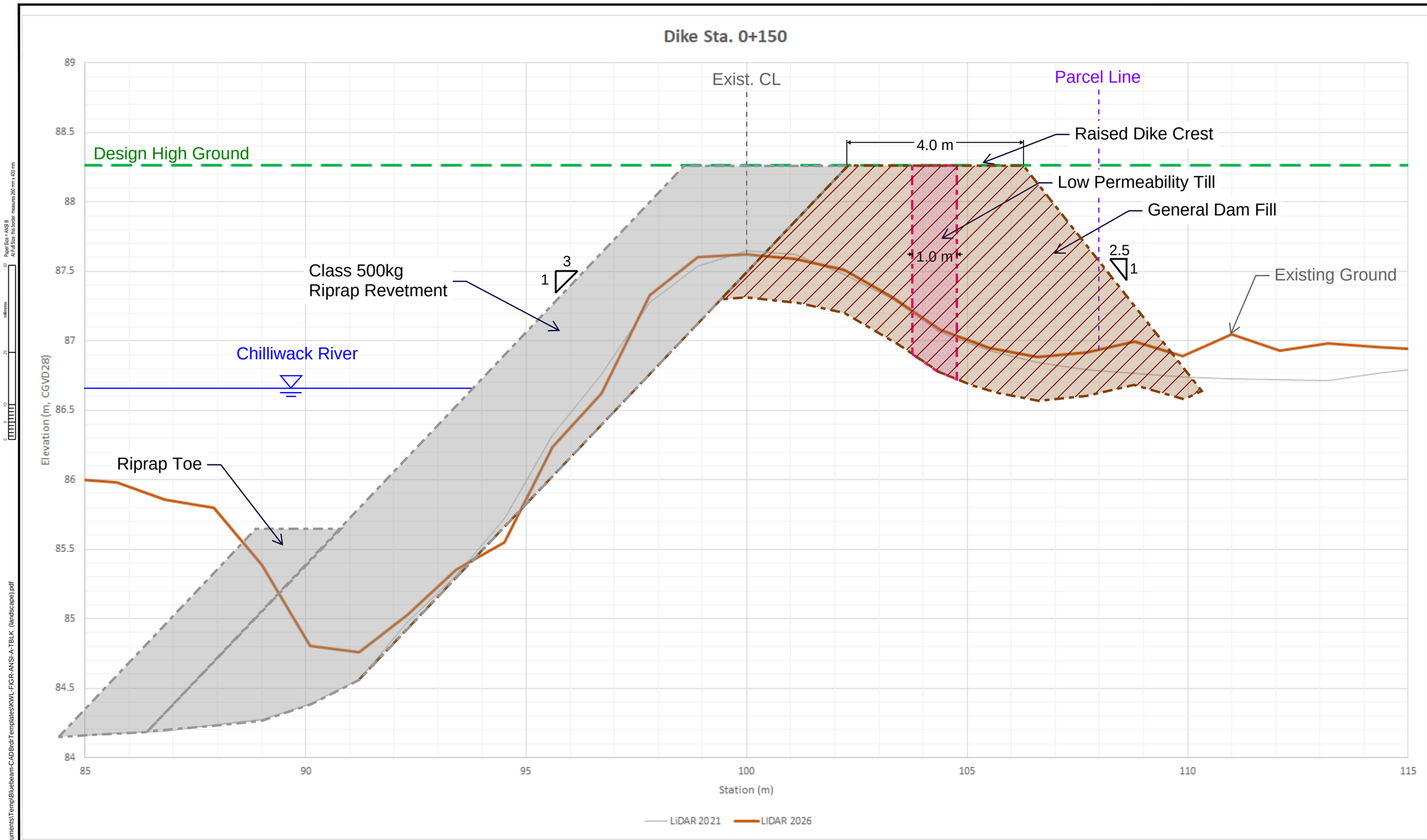
OSBORNE ROAD DIKE FEASIBILITY STUDY
OPTION 1A: RAISE DIKE & REBUILD (EXTENDED)
PLAN MAP
FIGURE 5



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OSBORNE ROAD DIKE FEASIBILITY STUDY
OPTION 1A: RAISE DIKE & REBUILD BANK PR.
TYPICAL CROSS-SECTION
FIGURE 6

Option 1b – Maintain Dike and Repair Bank Protection

For Option 1b, FVRD would generally maintain the dike at its current crest elevation and only raise the crest at notable low spots (e.g., around Sta. 0+175). Similarly, most of the existing riprap bank protection, from approx. dike Sta. 0+140 to Sta. 0+410 (see Figure 1), would be retained and repaired if deemed damaged or inadequately constructed. Additional BC MoTT Class 500 kg riprap would only be placed between Sta. 0+010 to Sta. 0+140 where there is no existing bank protection. A launching riprap toe will be installed for scour protection along the entire revetment. This option provides a moderate improvement in flood protection across the dike by removing the most apparent vulnerabilities but does not increase the height of flood protection.

Under Option 1b, the dike would be extended approximately 65 m upslope to the intersection of Stapley Road and Sheldon Road for tie-in (i.e., baseline tie-in under Option 1a). As a non-standard dike, extending the dike upstream to protect additional properties is not permitted under the DMA.

A conceptual plan and typical dike cross-section of Option 1b are shown in Figure 7 and Figure 8, respectively.

OSBORNE ROAD DIKE FEASIBILITY STUDY
OPTION 1b: MAINTAIN DIKE & REPAIR BANK PR.
PLAN MAP
FIGURE 7

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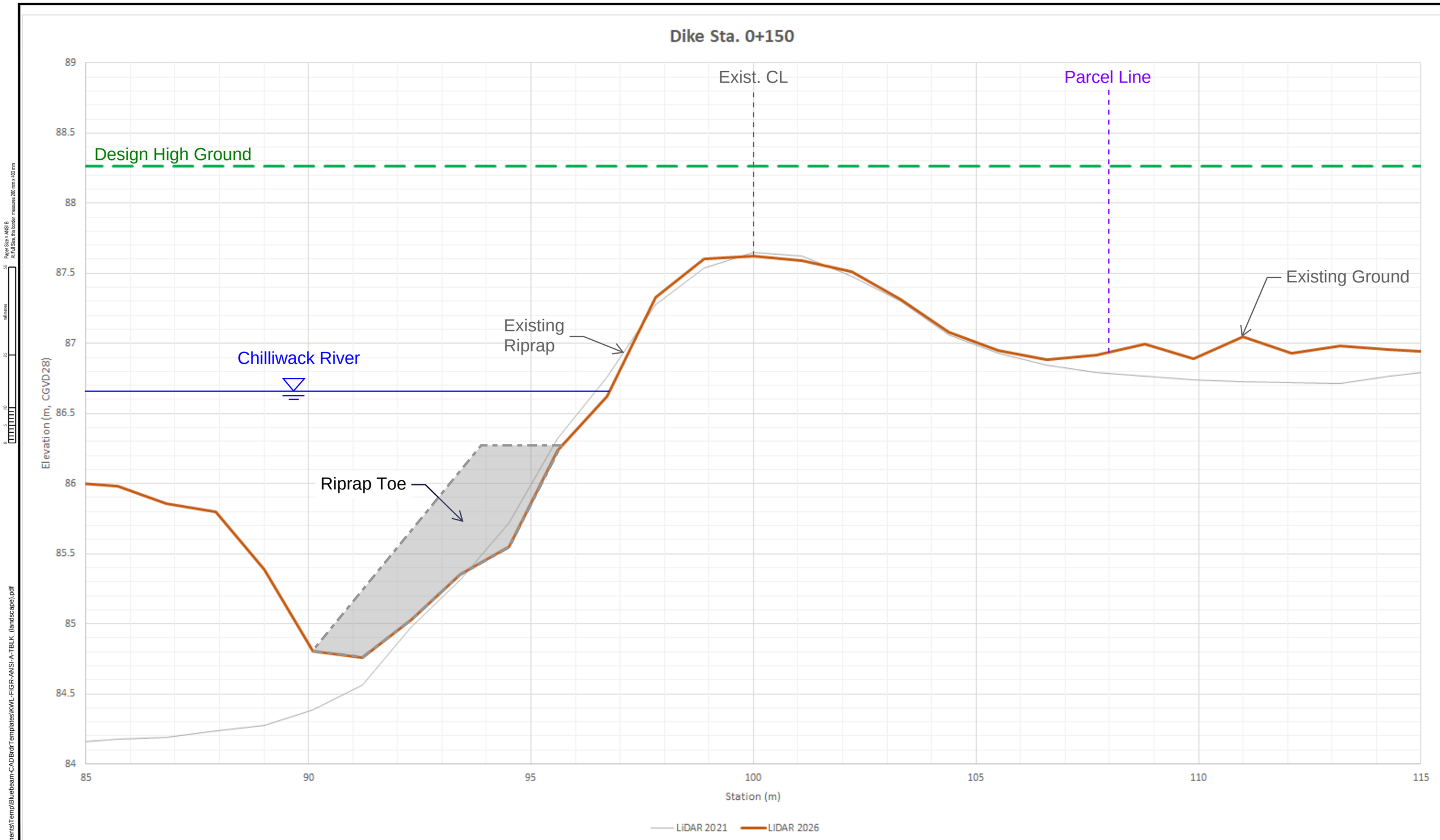

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OSBORNE ROAD DIKE FEASIBILITY STUDY
OPTION 1b: MAINTAIN DIKE & REPAIR BANK PR.
TYPICAL CROSS-SECTION
FIGURE 8

4.1.2 Option 2 – Status Quo

Under Option 2, the status quo is maintained and Osbourne Road Dike remains an orphan dike and will not be maintained or improved. Without regular maintenance, the dike and the level of flood protection it provides are anticipated to continue deteriorating due to high flows, weathering, animal activities, etc.

FVRD will remain the local authority for Emergency Management (regardless of dike status) and therefore be responsible for emergency response along the dike. During future flooding events, FVRD may undertake emergency response works similar to those completed during the December 2025 and March 2026 AREs (see Section 2.1). However, reliance on FVRD to complete emergency response works should not be considered a reliable approach to flood protection as there are many limitations/uncertainties:

- Fundamentally, reliance on a deteriorating orphan dike structure for flood protection is a risk.
- Emergency response funding requests to the Ministry of Emergency Management and Climate Readiness (EMCR) may not be approved.
- FVRD may not have capacity to carry out some or all of the required works. In larger events such as the 2021 ARE, there could be multiple incidents spread across the region requiring response.
- Emergency works may not be completed in a timely manner to prevent damages since they are typically undertaken in response to events that have or are likely to occur. Often times, emergency works cannot be undertaken until after properties have been impacted.
- Emergency response works are intended to be temporary in nature and may be required to be removed following an event.
- Bank protection installed during an emergency is often not as robust as bank protection installed under favorable weather/river conditions due to:
    - Difficulties procuring the recommended fill material gradations.
    - Difficulties or inability to key-in riprap at the bank toe.
    - Poor/unsafe working conditions under high flow and low visibility.
- Future changes in legislation could impact the degree of emergency response that FVRD is able to provide.

Under Option 2, individual landowners have the choice to implement improvements on their properties as necessary for flood protection. Without a local diking authority, landowners would be limited in the types of improvements they are permitted to make. Primarily, no modifications can be made to the dike in accordance with the DMA. These include raising the dike with earth fill, installing a permanent flood barrier/wall (e.g., concrete blocks) over the crest of the dike, and replacing or modifying existing riprap bank protection. Further, landowners are not permitted to carry out works that would transfer risks of flooding onto a neighboring property and exacerbate impacts. It is not always clear if a proposed change has potential to transfer flood risks, and each one must be evaluated by a qualified professional on a case-by-case basis to demonstrate otherwise. Still, various improvement options are available to landowners including, but not limited to:

- Raising the foundation of their home *(requires a building permit)*.
- Installing new riprap protection along the riverbank where there is no existing bank protection (*requires WSA authorization)*.
    - There may be regulatory requirement to provide habitat compensation or offsetting for disturbance to aquatic/riparian habitats.

- Raising land to construct a permanent flood barrier (e.g., fill berm) around their property (*may require a building permit, depending on barrier configuration*).
    - There is potential for a land raise to transfer flood risks to a neighboring property, and the landowner must consultant the appropriate qualified professional(s) to confirm there is little to no risk of doing so before undertaking the works.
    - Further clarification with the Province is required to confirm if the barrier can be extended into the existing dike, provided no dike modifications are made.
- Maintaining or having immediate access to temporary flood protection measures (e.g., Sandbags, bulk bags etc.) available to deploy in emergency response to flood events.
    - FVRD has provided public sandbagging stations (i.e., sand, sandbags) to residents during past flood events (Sandbag Policy #0340-31). A new station is proposed for residents living in Electoral District E.

In addition to the reasons stated above, consultation with a qualified professional is also recommended to define the design criteria for and design the improvements works including the minimum height to raise their house or land as well as the dimensions and size of riprap bank protection to achieve the necessary level of flood protection for their property. However, it is acknowledged that the additional cost to retain a qualified professional could be undesirable or prohibitive.

For Option 2 to be effective, it is preferable if the affected landowners work collectively to improve a longer extent of the dike. Improvements that are isolated to only one or a select few properties may not address the overall flood risks. As well, if the upstream end of the dike is not tied-into high ground and armoured, the dike would remain at risk of overtopping and/or outflanking during flooding. The high-cost implications of improvement options and/or potential differences in opinion between private landowners could delay or inhibit the implementation of any improvement.

Improvement works, including any requirements for engineering design, permitting, and additional assessments, would be funded by the landowners under this option. Provincial and federal grants and funding programs may be available for private flood protection works to alleviate costs.

4.1.3 Option 3 – Managed Retreat

Under Option 3, all private properties currently protected by Osborne Road Dike would be acquired to facilitate the relocation of landowners away from the river. Whereas other options provide measures to mitigate flood risks, Option 3 would remove landowners from these risks entirely. Once these properties are acquired, the existing buildings would be demolished and the remaining land and dike abandoned. Landowners would relocate to new homes at their own expense.

The feasibility of this option is contingent on support from Province and affected landowners. A managed retreat would have a significant capital cost investment and could only be undertaken if the Province provided most of the funding. As such, it would be necessary to demonstrate to the Province that the affected landowners are amenable to voluntary buyouts and would agree to a reasonable compensation. Additional consultation with the Province would be undertaken to gauge the likelihood of funding.

Once a managed retreat is implemented, no ongoing operating and maintenance costs are anticipated for the foreseeable future. However, there is potential long-term risk of flooding of upland (or upstream) properties if the dike was no longer maintained and allowed to erode and eventually breach. For example, as the dike erodes and the existing dike reach widens, there is possibility that the highest erosive forces migrate upstream and affect properties that are currently not subject to flood risks. A detailed assessment of the cascading effects of a managed retreat should be undertaken if this option is advanced.

This may include hydraulic modeling under difference scenarios to estimated flood extents as well as a high-level study of river geomorphology. At this stage, it is assumed that only properties adjacent to the existing dike (see Table 5) will be bought out, excluding 48982 Sheldon Road and 49002 Sheldon Road.

4.2 Properties Protected by Osborne Road Dike

A preliminary list of private properties benefitting from dike flood protection under Option 1, which would define the boundary(s) of the dike service area, is presented in Table 5. These properties are highlighted in green and/or orange in Figure 4, Figure 5, and Figure 7. Additional assessment (i.e., hydraulic modeling) is required to confirm the final boundary of benefitting properties.

Table 5: List of Private Properties Protected by Osborne Road Dike Under Option 1

Civic Address	PID	Protected Under	Total Assessed Value[1]	Building Size[1] (ft^2)	Land Size[2] (m^2)
4205 Osborne Rd	006-990-355	Option 1a & 1b	$676,000	1,292	1,546
4185 Osborne Rd	000-510-211	Option 1a & 1b	$648,000	1,241	1,412
4210 Osborne Rd	003-303-161	Option 1a & 1b	$1,465,000	2,333	8,660
48860 Sheldon Rd	005-503-213	Option 1a & 1b	$1,183,000	2,542	7,588
48882 Sheldon Rd	006-466-052	Option 1a & 1b	$818,000	2,157	2,125
48902 Sheldon Rd	006-491-464	Option 1a & 1b	$255,000	Vacant	1,675
1-48922 Sheldon Rd	006-491-553	Option 1a & 1b	$799,000	956	1,696
48942 Sheldon Rd	006-491-570	Option 1a & 1b	$613,200	685	1,692
48952 Sheldon Rd	006-491-600	Option 1a & 1b	$605,400	744	1,821
48962 Sheldon Rd	006-466-087	Option 1a & 1b	$659,300	924	1,999
48982 Sheldon Rd	013-074-652	Option 1a (baseline) & 1b *(Partially)* Option 1a (extended) *(fully)*	$863,000	861	5,342
49002 Sheldon Rd	006-466-095	Option 1a (extended)	$1,032,000	2,099	1,708

Notes:
1. Values are as provided by BC Assessment for the 2026 assessment.
2. As measured based on parcel boundaries provided by ParcelMap BC.

4.3 Preliminary Cost Estimates

Order-of-magnitude capital and operating and maintenance costs were estimated for each option to support the options evaluation.

4.3.1 Capital Costs

Order-of-magnitude capital costs were estimated using conservative assumptions on construction quantities and rates, land compensation rates, and project contingency. A summary of capital cost ranges for all options is listed in Table 6. Detailed capital cost breakdowns and/or clarifications for all options are presented in their respective subsections.

Table 6: Summary Capital Cost Ranges for Improvement Options

Option	Option Name	Range of Estimated Capital Costs[1]
Option 1a	Raise Dike and Rebuild Bank Protection – Baseline Tie-In	**$8,126,000 to $16,920,000**[2],[3]
Option 1a[4]	Raise Dike and Rebuild Bank Protection – Extended Tie-In	**$9,554,000 to $19,772,000**[2],[3]
Option 1b	Maintain Dike and Repair Bank Protection	**$3,624,000 to $7,757,000**[2],[3]
Option 2	Site-Specific Improvements by Private Landowners	**-**
	Raise House Foundations	**$50,000 to $150,000 per House**
	Install Riprap Bank Protection[5]	**$90,000 to $129,000**[6] (48982 Sheldon Road – 51 m length, accounting for existing riprap) **$28,000 to $39,000**[6] (48962 Sheldon Road – 10 m length, accounting for existing riprap) **$63,000 to $90,000**[6] (48952 Sheldon Road – 32 m length) **$65,000 to $93,000**[6] (48942 Sheldon Road – 33 m length) **$72,000 to $103,000**[6] (48922 Sheldon Road – 37 m length)
	Construct Permanent Fill Berm	**$50 to $70 per m** (0.3 m height) **$140 to $190 per m** (0.6 m height) **$320 to $430 per m** (1 m height)
	Install Temporary Flood Measures[7]	**Sandbags**[8],[9] **$18 per m** (0.3 m height) **$40 per m** (0.6 m height) **$82 per m** (1 m height) **Bulk Bags**[10] **$158 per m** (1 m height)
	Equipment/Labour Rates	**Landowner** **$500/day + $500 delivery & return** (Bobcat mini excavator rental) **$600/day** (Tandem truck rental) **Contractor** **$6,500/day**[11] (equipment, fill delivery, and labour)
Option 3	Managed Retreat	**$10,063,000 to $15,211,000**

Notes:

1. Total costs are rounded to the nearest $10,000.
2. Cost ranges are based on the estimated range of unit rates for construction materials and activities.
3. Costs include allowances for pre-construction costs (e.g., engineering, environmental, permitting) at 25%, indirect construction costs (e.g., access, water management, survey) at 20%, and contingency at 50%.
4. Option 1a – Extended Tie-In is only feasible if the proposed raise to high ground elevations meets or exceed the 200-year design flood level. This will be confirmed at a later stage of design if this option is selected.
5. Only properties without existing riprap armouring are listed. Extent of required riprap armouring may differ from those assumed for cost estimate. Total assumed length is indicated to allow for calculation of cost per unit length.
6. Costs include installation of Class 500 kg Riprap and underlying granular filter, plus allowances for engineering and permitting costs at 15% and contingency at 25%. Cost range is based on estimated high and low unit rates for materials.
7. Does not include allowances for potential indirect costs (e.g., engineering, permitting) or fuel and transport incurred by the landowner to procure, install, (and subsequently) remove the temporary measures. A 25% contingency is included for both sandbags and bulk bags.
8. Assume sandbags are 14” W x 26” L in dimension, cost $1.5 per bag, filled with sand at a unit rate of $22/$m^3$, and installed manually by the landowner without additional equipment or contractor support.
9. Does not consider potential for use of FVRD sandbagging stations which would provide landowners with access to free sand and sandbags.
10. Assume bulk bags are 1 m L x 1 m H when filled, cost $39 per bag, filled using 25 mm clear crush at a unit rate of $87/$m^3$, and installed with contractor support (i.e., excavator/loader, laborers). Does not include additional cost for removal of bags.
11. Contractor day rate provided by Richco Contracting Ltd. with June 2026 fuel adjustment and includes a 245 excavator, tandem dump truck, three labourers, and truck/tools.

Option 1 – Regulated Dike

For Option 1, order-of-magnitude capital costs were estimated using conservative assumptions on construction quantities (e.g., earthworks excavation, fill placement) and unit rates based on past project experiences. Major construction cost items include bulk excavation of the existing dike, placement of dike fills, and placement of riprap erosion protection. Key assumptions made in the cost estimates are as follows:

- Stripping and foundation preparation will extend to 300 mm depth beneath existing ground.
- No geotechnical ground improvements are required.
- All existing dam fills including riprap are non-salvageable and are disposed at an off-site facility.
- For Option 1b, it is assumed that 10% of the existing riprap will be replaced with new riprap. The existing riprap revetment is assumed to have an average thickness of 500 mm.
- The average scour depth is 1 m below existing riverbed.

Costs leading up to construction, including engineering, environmental, engagement and consultation, permitting, and construction procurement are assigned a nominal allowance of 25% of the total construction costs. Indirect construction costs including mobilization and demobilization, access, water management, erosion and sediment control, survey, are similarly assigned a nominal allowance of 20% of the total construction costs but could differ depending on construction complexity and requirements.

For both Option 1a and Option 1b, the largest environmental costs will be those required by regulators for habitat offsetting. Habitat offsetting requirements (and therefore costs) are proportional to the total area(s) of disturbance, and given the large footprints of disturbance anticipated, there could be significant habitat offsetting costs. However, as these options have not been developed sufficiently to estimate the footprint for offsetting, let alone the types of offsetting that are feasible, it is not practicable to estimate environmental costs at this stage.

In addition to construction costs, compensation payments will also be made to private landowners for acquisition of portions of their properties to enable dike raising and establishment of an SROW. Compensation costs are not standardized and must be negotiated on a case-by-case basis based on the fair value of the land taken, cost for disturbance to the property during the transfer of ownership (e.g., removal of fencing), and loss of value of the remaining property due to the acquisition. As KWL is not qualified to assess factors related to property value, compensation costs (including legal fees) are simplified as percentages of the total market value[1] of the property. For Option 1a, compensation costs range from 30% (lower bound) to 50% (upper bound) of the market value due to property acquisition and establishment of an SROW, while for Option 1b, compensation costs range from 20% (lower bound) to 40% (upper bound) as only establishment of an SROW is required. Compensation costs are calculated for all applicable benefitting properties listed in Table 5. It is entirely possible that compensation fees for individual or all properties are lower/higher than those estimated, and an appraisal by a qualified professional should be undertaken if these options are preferred. The potential reluctance of one or multiple landowners to forfeit property could also drive-up cost or even make either of these options impracticable.

[1] Total market value is the combined *Land* and *Buildings* values for each property as provided by BC Assessment (https://www.bcassessment.ca/) based on the 2026 assessment.

At this stage of the Project, an allowance of 50% is also added for project contingencies based on the level of uncertainty in the options. This is a significant allowance that would be gradually reduced as project understanding improves and uncertainties are removed.

Capital cost breakdowns for Option 1a (both upstream tie-in alternatives) and Option 1b are included from Table 7 to Table 9.

Table 7: Estimated Major Capital Costs for Option 1a – Baseline Tie-In

Construction Item	Estimated Quantity	Unit	Unit Cost Range[1]	Potential Cost Range
Foundation Preparation (e.g., Topsoil Stripping)[2]	1,800	m^3	$85 to $120	$153,000 to $216,000
Bulk Excavation and Disposal[2]	2,800	m^3	$85 to $120	$238,000 to $336,000
Placement of Low-Permeability Fill	700	m^3	$150 to $225	$105,000 to $157,500
Placement of General Dam Fill	3,800	m^3	$75 to $125	$285,000 to $475,000
Placement of Class 500 kg Riprap Revetment	6,200	m^3	$200 to $300	$1,240,000 to $1,860,000
Placement of Granular Filter Under Riprap	2,500	m^3	$100 to $125	$250,000 to $312,500
Placement of Class 500 kg Riprap Toe Berm	2,000	m^3	$200 to $300	$400,000 to $600,000
			Construction Total	**$2,761,000 to $3,957,000**
			Pre-Construction Cost (@25%)	**$667,750 to $3,957,000**
			Indirect Construction Cost (@20%)	**$534,200 to $791,400**
			Contingency (@50%)	$1,936,475 to $4,352,700
			Land Compensation Costs[4]	**$2,316,570 to $3,860,950**
			PROJECT TOTAL	**$8,125,995 to $16,919,050**

Notes:
1. Estimated conservatively based on past project experiences. Does not account for constraints related to proximity of site to borrows, contractor availability, requirements for specialized equipment, etc.
2. Excavation quantity estimated using January 2026 survey data collected by McElhanney.
3. Refer to Figure 6 for assumed dike cross-sectional geometry.
4. Compensation costs range between 30% to 50% of the total property value of applicable properties (for this option) in accordance with BC Assessment.

Table 8: Estimated Major Capital Costs for Option 1a – Extended Tie-In

Construction Item	Estimated Quantity	Unit	Unit Cost Range[1]	Potential Cost Range
Foundation Preparation (e.g., Topsoil Stripping)[2]	2,000	m^3	$85 to $120	$170,000 to $240,000
Bulk Excavation and Disposal[2]	3,100	m^3	$85 to $120	$263,500 to $372,000
Placement of Low-Permeability Fill	800	m^3	$150 to $225	$120,000 to $180,000
Placement of General Dam Fill	3,900	m^3	$75 to $125	$292,500 to $487,500
Placement of Class 500 kg Riprap Revetment	7,300	m^3	$200 to $300	$1,460,000 to $2,190,000
Placement of Granular Filter Under Riprap	3,000	m^3	$100 to $125	$300,000 to $375,000
Placement of Class 500 kg Riprap Toe Berm	2,300	m^3	$200 to $300	$460,000 to $690,000
			Construction Total	**$3,066,000 to $4,534,500**

Construction Item	Estimated Quantity	Unit	Unit Cost Range[1]	Potential Cost Range
Pre-Construction Cost (@25%)				**$766,500 to $4,534,500**
Indirect Construction Cost (@20%)				**$613,200 to $906,900**
Contingency (@50%)				$2,222,850 to $4,987,950
Land Compensation Costs[4]				**$2,885,070 to $4,808,450**
PROJECT TOTAL				**$9,553,620 to $19,772,300**

Notes:
1. Estimated conservatively based on past project experiences. Does not account for constraints related to proximity of site to borrows, contractor availability, requirements for specialized equipment, etc.
2. Excavation quantity estimated using January 2026 survey data collected by McElhanney.
3. Refer to Figure 6 for assumed dike cross-sectional geometry.
4. Compensation costs range between 30% to 50% of the total property value of applicable properties (for this option) in accordance with BC Assessment.

Table 9: Estimated Major Capital Costs for Option 1b

Construction Item	Estimated Quantity	Unit	Unit Cost Range[1]	Potential Cost Range
Foundation Preparation (e.g., Topsoil Stripping)[2]	200	m^3	$85 to $120	$17,000 to $24,000
Bulk Excavation and Disposal	400	m^3	$85 to $120	$34,000 to $48,000
Placement of General Dam Fill	700	m^3	$75 to $125	$52,500 to $87,500
Replacement of Existing Riprap	250	m^3	$250 to $350	$62,500 to $87,500
Placement of Class 500 kg Riprap Revetment	1,600	m^3	$200 to $300	$320,000 to $480,000
Placement of Granular Filter Under Riprap	700	m^3	$100 to $125	$70,000 to $87,500
Placement of Class 500 kg Riprap Toe Berm	2,000	m^3	$200 to $300	$400,000 to $600,000
Construction Total				**$956,000 to $1,414,500**
Pre-Construction Cost (@25%)				**$239,000 to $1,414,500**
Indirect Construction Cost (@20%)				**$191,200 to $282,900**
Contingency (@50%)				$693,100 to $1,555,950
Land Compensation Cost[4]				**$1,544,380 to $3,088,760**
PROJECT TOTAL				**$3,623,680 to $7,756,610**

Notes:
1. Estimated conservatively based on past project experiences. Does not account for constraints related to proximity of site to borrows, contractor availability, requirements for specialized equipment, etc.
2. Excavation quantity estimated using January 2026 survey data collected by McElhanney.
3. Refer to Figure 8 for assumed dike cross-sectional geometry.
4. Compensation costs range between 20% to 40% of the total property value of applicable properties (for this option) in accordance with BC Assessment.

Capital costs for Option 1a and Option 1b can be funded through debt financing, grant funding, or a combination of both. Amortized capital costs were estimated using the Municipal Finance Authority (MFA) of BC's long-term debt amortization tool (provided by FVRD) if the entire cost must be financed. Both options were amortized over a 20-year period to yield the annual principal and interest payments listed in Table 9. The initial term (Years 1-10) used a projected 10-year relending interest rate of 4.1% provided by MFA. The remaining 10 years (Years 11 – 20) were split into two 5-year terms using a 5-year relending interest rate at 3.47%.

Table 10: Option 1 - Capital Cost Amortization over 20 Years

Option	Years	Starting Principal Balance[3]	Annual Payment[1][3]	Interest Payment[2][3]
1a – Baseline Tie-In ***(Lower Range)***	1 – 10	**$ 8,126,000**	$ 469,000	$ 167,000
	11 – 15	$ 4,659,100	$ 383,000	$ 81,000
	16 – 20	$ 2,501,000	$ 346,000	$ 43,000
1a – Baseline Tie-In ***(Upper Range)***	1 – 10	**$16,919,000**	$ 977,000	$ 347,000
	11 – 15	$ 9,701,000	$ 798,000	$ 168,000
	16 – 20	$ 5,208,000	$ 720,000	$ 90,000
1a – Extended Tie-In ***(Lower Range)***	1 – 10	**$ 9,554,000**	$ 551,000	$ 196,000
	11 – 15	$ 5,478,000	$ 451,000	$ 95,000
	16 – 20	$ 2,941,000	$ 407,000	$ 51,000
1a – Extended Tie-In ***(Upper Range)***	1 – 10	**$ 19,772,000**	$ 1,141,000	$ 405,000
	11 – 15	$ 11,337,000	$ 933,000	$ 197,000
	16 – 20	$ 6,087,000	$ 841,000	$ 106,000
1b ***(Lower Range)***	1 – 10	**$ 3,624,000**	$ 209,000	$ 74,000
	11 – 15	$ 2,078,000	$ 171,000	$ 36,000
	16 – 20	$ 1,116,000	$ 154,000	$ 19,000
1b ***(Upper Range)***	1 – 10	**$ 7,757,000**	$ 448,000	$ 159,000
	11 – 15	$ 4,448,000	$ 366,000	$ 77,000
	16 – 20	$ 2,388,000	$ 330,000	$ 41,000

Notes:
1. Interest rates as per http://mfa.bc.ca/long-term-lending-rates.
2. Annual Payment = Principal Payment + Interest Payment.
3. Balances and payments are rounded to the nearest $1000.

Option 2 - Status Quo

Costs for Option 2 were estimated based on the publicly established going rates for materials, equipment, and services (e.g., labour, operators). These costs may differ for individual landowners for various reasons including:

- Differing unit rates available to individuals due to smaller size of work or availability of materials/equipment/services; and,
- Access to existing materials/equipment/services that would make certain improvements financially favorable to implement (e.g., sandbags).

In general, if an improvement is deemed feasible to implement by the landowner themselves, only costs for materials and equipment rentals are provided. However, certain work such as installation of riprap bank protection that require a larger operation have been costed assuming engagement with a licensed contractor. For improvements that potentially require engineering and environmental consultation and/or permitting, an allowance of 15% has been added onto the direct construction costs. A project contingency of 25% is added for all improvements to account for uncertainties and potential issues incurred during construction (e.g., increased cost of materials, wastage, difficult access, etc.). These allowances are lower than for Option 1 due to the lower complexity of the work.

The cost to raising the foundation of a house will be among the most expensive of the various improvements considered under Option 2. To raise the foundations, the final cost includes work to:

- Obtain a building permit;
- Complete structural and geotechnical engineering assessments;
- Physically raise the house structure and remediate/repair the foundation; and,
- Relocate interior and exterior utilities (e.g., plumbing, electrical, HVAC).

There are uncertainties with house raising that can drive up this cost including but not limited to, ground conditions, potential damages incurred during the work, and additional work required to restore the house to functional condition once lifted.

The cost to install bank protection for individual properties has been estimated similarly to Option 1. Only properties without existing bank protection, the four located farthest east along the dike, are eligible for installation of a riprap revetment. It is assumed that the landowner would hire a contractor to install Class 500 kg Riprap to a thickness of 1.2 m along the existing waterside dike slope, with no additional excavation at the toe to extend the riprap armouring for scour protection. Riprap placement would only be allowed up to the existing dam crest elevations as the dike cannot be raised further under this option. As with Option 1, habitat offsetting may be required by regulators due to impacts in the river; however, this cost is not estimated at this stage due to various uncertainties and unknowns.

The cost to install a permanent fill berm assumes that the berm will have a 1 m wide crest and 2H:1V side slopes. The berm is assumed to be constructed by the landowner using a rental truck and excavator, provided the necessary permits are obtained and the applicable bylaws are followed, but can also be undertaken by a licensed contractor at a higher fee. Given the changing ground elevations along the dike, unit rates for three berm heights are presented.

Sandbags are likely the most affordable improvement due to the low cost of materials and relative ease of installation. Landowners may also have the option to acquire and fill sandbags at designated FVRD sandbagging stations ahead of a forecasted flood event, provided this service continues to be offered, which would further reduce the cost of this improvement. However, this reduction in cost is excluded from the estimates to provide comparable rates with other improvement options. Costs are based on the installation of 14” W x 26” L sandbags filled manually by the landowner and stacked in a roughly pyramidal configuration. Three different costs are provide based on the desired height of the sandbags. Cost to dispose or relocate the bags are not included as there are various options (e.g., store locally, return to FVRD stations).

A more robust but costlier temporary option is to install bulk bags. As bulk bags are 1 m in height and length when filled, a single bag should provide sufficient flood protection to high ground for all private properties. Due to the weight of these bags, it is infeasible to install them by hand. Similar to installation of a fill berm, the landowner would have to either rent their own truck and excavator or engage with a licensed contractor at a higher fee. Costs to dispose or relocate the bags are not included.

Option 3 - Managed Retreat

For a managed retreat, the primary capital cost will be the buyout of all impacted properties. As there is limited precedence on the cost of a managed retreat in BC, it is difficult to provide a reliable estimate at this stage of the assessment. Soley for the purpose of this estimate, it is assumed that the cost to buyout each property will range from 100% (lower bound) to 150% (upper bound) of the total market value[1] of the property. These estimates are assumed to include legal fees (e.g., title transfer). An additional capital cost will be that to demolish and dispose of buildings on each property. It is assumed that the unit rate for demolition and disposal ranges from $10 per square feet (lower bound) to $30 per square feet (upper bound) for the total square footage of each building, as indicated by BC Assessments.

Assessment costs including engineering, environmental, engagement and consultation, and permitting are assigned a nominal allowance of $250,000. A contingency of 25% is included to account for the potential need to buyout additional properties, demolition of additional buildings, and completion of residual maintenance activities along the dike.

Table 11: Estimated Major Capital Costs for Option 3

Civic Address	PID	Total Assessed Value[1]	Buyout Cost Range[2]	Building Size[1] (ft^2)	Demolition Cost Range[3]
4205 Osborne Rd	006-990-355	$676,000	$845,000 to $1,183,000	1,292	$12,920 to $38,760
4185 Osborne Rd	000-510-211	$648,000	$810,000 to $1,134,000	1,241	$12,410 to $37,230
4210 Osborne Rd	003-303-161	$1,465,000	$1,831,250 to $2,563,750	2,333	$23,330 to $69,990
48860 Sheldon Rd	005-503-213	$1,183,000	$1,478,750 to $2,070,250	2,542	$25,420 to $76,260
48882 Sheldon Rd	006-466-052	$818,000	$1,022,500 to $1,431,500	2,157	$21,570 to $64,710
48902 Sheldon Rd	006-491-464	$255,000	$318,750 to $446,250	Vacant	$0
1-48922 Sheldon Rd	006-491-553	$799,000	$998,750 to $1,398,250	956	$9,560 to $28,680
48942 Sheldon Rd	006-491-570	$613,200	$766,500 to $1,073,100	685	$6,850 to $20,550
48952 Sheldon Rd	006-491-600	$605,400	$756,750 to $1,059,450	744	$7,440 to $22,320
48962 Sheldon Rd	006-466-087	$659,300	$824,125 to $1,153,775	924	$9,240 to $27,720
				Buyout Total	**$7,721,900 to $11,582,850**
				Demolition Total	**$128,740 to $386,220**
				Direct Cost Total	**$7,850,640 to $11,969,070**
				Contingency (@25%)	$1,962,660 to $2,992,268
				Assessment Costs[4] (e.g., engineering, consultation)	**$250,000**
				PROJECT TOTAL	**$10,063,300 to $15,211,338**

Notes:
1. Values are as provided by BC Assessment for the 2026 assessment.
2. Buyout costs range between 100% to 150% of the total property value of applicable properties in accordance with BC Assessment.
3. Demolition (and disposal) costs range between $\$10/ft^2$ and $\$30/ft^2$ for the total building size in accordance with BC Assessment.
4. An allowance of $250,000 is included to cover costs for engineering and environmental assessments, engagement and consultation, and any permitting requirements.

4.3.2 Operating and Maintenance Costs

Annualized operating and maintenance (O&M) costs are estimated for Option 1 based on assumed levels of effort required for informal and formal inspections, maintenance and repairs, and documentation activities. O&M costs are not considered for Option 2, as maintenance would be funded privately by the landowner on an as needed basis, or Option 3 as there would be no maintenance work required. O&M activities are as required under the *Dike Maintenance Act* and described in the following documents:

- *Flood Protection Works Inspection Guide* (BC Ministry of Environment, 2000)
- *Dike Operation and Maintenance Manual Template* (BC Ministry of Environment, 2001)

Expected O&M activities for Osborne Road Dike and estimated annualized costs per benefitting property for Option 1 are listed in Table 12. As listed in Table 5, Option 1a (Baseline Tie-In) and Option 1b will protect 10 properties while Option 1a (Extended Tie-In) will protect 12 properties. It is anticipated that O&M costs would be funded through taxation of benefitting properties.

Table 12: Estimated Annualized O&M Costs for Improvement Options

O&M Activity	Annual Cost		
	Option 1a Baseline Tie-In	Option 1a Extended Tie-In	Option 1b
Operational Support *(e.g., corporate overheads, insurance, etc.)*	$3,100	$4,200	$3,100
Engineering Staff Time *(Inspections by FVRD staff, oversight of contractors and consultants, financial administration, vegetation removal using hand tools – supplemental to vegetation contractor)*	$6,900	$9,100	$6,900
Annual Inspection *(undertaken by a qualified professional. Includes travel and expenses)*	$3,100	$3,100	$3,100
Vegetation Control *(Removal of trees and brush, including cost to utilize a conventional mower and long reach excavator with mower attachment. Assumed to be carried out annually by third party contractor)*	$3,100	$4,100	$3,100
Dike Maintenance *(e.g., repairs to berm crest, access route, damage from animal activity. Assumed to be carried out annually)*	$1,800	$2,300	$1,800
Riprap Repair or Re-Work (1)(2)(3)	$7,800	$9,100	$20,500
Total Annual Estimated Cost	**$25,800**	**$31,900**	**$38,500**
Total Annual Estimated Cost Per Benefitting Property(4)	**$2,580**	**$2,660**	**$3,850**

Notes:
1. Emergency repairs are not included due to overlap with repair or re-work to riprap. It should be acknowledged that annual repairs may be warranted during high-flow events.
2. Option 1a - Repair or re-work approximately 5% of total riprap every 10 years.
3. Option 1b - Repair or re-work approximately 10% of total riprap every 5 years, due to smaller size of existing riprap.
4. Costs for Option 1a (Baseline Tie-In) and Option 1b are distributed among 10 benefitting properties while costs for Option 1a (Extended Tie-In) are distributed among 12 benefitting properties.

4.4 Regulatory Permitting and Timelines

Table 13 outlines legislation that may be applicable to dike improvement works. Final applicability will depend on the confirmed project scope and design. Additional discussion on the regulatory process is included in this section.

Table 13: Regulatory Screening Table for Improvement Options

Legislation	Agency	Area of Regulation	Required Permits/Actions/Approvals	Anticipated Timeline to Receive Permit or Approval
Federal				
Fisheries Act[1]	Fisheries and Oceans Canada (DFO)	Protection of fish and fish habitat.	• Apply for a *Fisheries Act* Authorization to the Fish and Fish Habitat Protection Program • Obtain a licence to fish for scientific, experimental, or educational purposes to authorize the salvage of fish from the work area during construction.	6-12 months (Authorization) 45 days (Fish Licence)
Migratory Birds Convention Act[2]	Environment and Climate Change Canada	Prohibiting injury, molestations, and destruction of migratory birds and their nests.	• Bird nesting surveys should be completed by a Qualified Environmental Professional (QEP) prior to any vegetation clearing that must occur within the bird nesting window (typically March 1 to August 17). • No permitting required unless a migratory bird nest is identified which must be moved.	N/A
Species at Risk Act[3]	Environment and Climate Change Canada	Species at risk and their critical habitat.	• No permitting is currently anticipated. Permitting is only required if there are aquatic species at risk or their critical habitat present OR if there are terrestrial species at risk or their critical habitat present on federal land. Neither of which is true for the Osborne Road dike.	N/A
Navigable Waters Act[2]	Transport Canada (TC)	Requires approval or notification for any works that may interfere with navigation on navigable waters in Canada.	• The Project is likely to be classified as Minor Works under the Act. A Notification on the Common Project Search Registry will need to be posted prior to construction. Public notice may also be required.	2 months
Provincial				
Agricultural Land Commission Act[4]	Agricultural Land Commission	Land use and activities within the Agricultural Land Reserve.	• The dike is not within Agricultural Land Reserve. As such, permitting under the Agricultural Land Commission Act is not anticipated.	N/A
Environmental Management Act (Contaminated Sites Regulation)	Ministry of Environment	Identification, investigation, and remediation of contaminated sites.	• Engage a qualified professional to assess dam fill materials (to be excavated) for possibility of exceedance(s) above BC CSR limits. • Conduct a site investigation of local background concentrations if on-site soil disposal is desired. A release notice may be required.	TBD
Water Sustainability Act[5]	Ministry of Water, Lands, and Resource Stewardship	Regulate activities being carried out in and about a stream.	• Submit a Notification of Authorized Change under clause *39(1)(k) - Repair or maintenance of existing dike OR.* • Apply for a Section 11 Change Approval for the construction of a dike or erosion protection works.	45 days (Notification) 12 months (Change Approval)
Dike Maintenance Act		Approval for the design and construction of new dikes or changes to existing dikes	• Apply for a dike maintenance act (DMA) approval.	3-6 months
Wildlife Act[6]		Regulates works that impact wildlife species in BC.	• The Project must not result in possession, taking, injury, molestation or destroying of birds, their eggs, certain species' nests, or wildlife. • Ensure conflicting trees or vegetation do not contain nests of eagle, peregrine falcon, gyrfalcon, osprey, heron, or burrowing owl. • Obtain permits to salvage wildlife and non-salmonid fish from the work area during construction.	45 days (Fish Collection Permit) 3-4 months (General Wildlife Permit)
Weed Control Act[7]	Ministry of Forests	Requires all land occupiers to control the spread of provincial and/or regional noxious weeds on their land.	• Ensure proper identification and management of invasive plants throughout project works.	N/A
Land Act[8]		Use of crown land.	• Area below high-water mark of the Chilliwack River is considered crown land. Obtain permit over Crown Land through Change Approval process. • Obtain Permit over Crown Land (PCL) through Change Approval process to authorize works on provincial land (i.e., any work below the high water mark).	Linked to Section 11 Change Approval (see above)
Heritage Conservation Act		Sites with historical, cultural, and/or archaeological value.	• Consult a professional archaeologist to determine requirements for permits depending on preferred improvement option. Should be undertaken promptly as permit approval timeline can be lengthy.	TBD

Notes:
[1]*Fisheries Act,* R.S.C., 1985, c. F-14
[2]*Migratory Birds Convention Act*, SC 1994, c. 22
[3]*Species at Risk Act*, SC 2002, c. 29
[4]*Agricultural Land Commission Act*, [SBC 2002}, c.36
[5]*Water Sustainability Act,* [SBC 2014], c. 15
[6]*Wildlife Act,* [RSBC 1996], c. 488, S. 34
[7]*Weed Control Act* [RSBC 1996], c.487
[8]*Land Act,* [RSBC 1996], c. 245

[2] Canadian Navigable Waters Act R.S.C., 1985, c. N-22

For Option 1, the transition of Osborne Road Dike from an unregulated orphan dike to a regulated dike with the FVRD acting as the Diking Authority will require Provincial approval under the Dike Maintenance Act (DMA). Based on conversations with the Inspector of Dikes (IoD) office, this application is less onerous than the application to undertake changes to a dike (either regulated or unregulated). DMA applications require submission of background information on the proposed works, investigative reports complete with plans, maps and figures, as well as detailed engineering design plans. Typical application timelines range from one month to three months but can sometimes take longer depending on level of complexity and reviewer availability. Additional re-design or information may be required to address any comments from the Inspector of Dikes.

Primary environmental approvals required for the improvement options include those under the *Water Sustainability Act* (WSA) and *Fisheries Act*. These permits are required for works in and adjacent to streams that have potential to harm or alter fish and fish species. Given the proximity to and significant footprints of works in the Chilliwack River under Option 1, a WSA Change Approval and DFO Authorization are anticipated to be required. Both approvals typically have lengthy review timelines and could take upwards of a year to receive depending on complexity of the design, identified impacts and requirements for habitat compensation (i.e., offsetting). To obtain these approvals, it is recommended to retain a Qualified Environmental Professional (QEP) to assess the site and prepare an Aquatic Effects Assessment (AEA) complete with an impact analysis, habitat balance and offsetting plan.

Additional permitting requirements may include obtaining fish and wildlife salvage permits, completion of an archaeological overview assessment (AOA) and archaeological impact assessment (AIA) if known archaeologically sensitive areas are present.

Certain improvement measures under Option 2 such as house raising or local land raising offset from the dike may not require these permits. Work outside of the high-water mark also may not require a WSA approval. A WSA approval will be required for works below the high-water mark for all options.

4.5 Options Comparison

A summary of advantages and disadvantages for each improvement option is listed in Table 14.

Table 14: Comparison of Improvement Options

Category	Option No.	Option Name	Advantages	Disadvantages
1 – Regulated Dike	1a	Raise Dike and Rebuild Bank Protection	• Provides the highest level of flood protection among all options. ○ Improvements will reduce frequency of emergency and overland flooding. • Diking authority designation enables regular inspection and maintenance, and more direct and swift flood response. • Diking authority designation improves eligibility for funding from DMAF, DFAA, and provincial grants. • If dike is upgraded sufficiently to be reclassified to a provincial standard dike, it could enable FVRD to extend the dike to protect additional properties.	• Highest amortized annual costs to implement, among all options. • Dike raising and widening will encroach on some private properties. • FVRD requires a statutory right-of-way along entirety of dike for operations and maintenance, further reducing property for certain landowners.

	1b	Maintain Dike and Repair Bank Protection	• Provides a moderate level of flood protection along the entire dike (albeit lower than that of Option 1a).
			  ○ Improvements will reduce frequency of emergency and overland flooding.
			• Diking authority designation enables regular inspection and maintenance, and more direct and swift flood response.
			• Diking authority designation improves eligibility for funding from DMAF, DFAA, and provincial grants.
			• Less costly to implement than Option 1a.
				• Moderate amortized annual costs to implement.
				• FVRD requires a statutory right-of-way along entirety of dike for operations and maintenance, further reducing property for certain landowners.
				• Upgraded dike would not be to provincial standards.
				  ○ As a non-standard dike, the FVRD would not be permitted to extend the dike farther upstream (or downstream) to protect additional properties.
				• Dike would remain more vulnerable than under Option 1a for higher return period floods.

2 – Status Quo		Site-Specific Improvements by Private Landowners	• Enables private landowners to implement improvements most beneficial to them/their property. • No loss of land through dike raising or establishment of a dike statutory right-of-way.	• Individual improvements may not improve the dike as a whole or address root causes of flood issues. • Improvements may not be designed/constructed to provide a standard level of flood protection (e.g., for a 200-year flood event), thereby requiring more frequent repairs. • All improvements must be privately funded although grants and funds may be available to subsidized certain types of improvement works. ○ Option has high-cost implications for landowners with the highest flood risks.
3 – Managed Retreat			• Removes at-risk landowners away from flood risks entirely. • No ongoing maintenance or repair costs for the foreseeable future.	• High amortized annual cost to implement. • Could lead to undesirable changes in the river that affects properties currently not impacted by the flood.

5. Next Steps

Suggested next steps for FVRD to advance the Osborne Road Dike Feasibility Study to construction include:

- Engaging with the local community, First Nations groups, and other stakeholders to solicit feedback on design concepts and incorporate suggestions into later stages of design. Maintain engagement throughout the design process.
- Engaging with a Professional archaeologist to identify sensitive areas and whether authorization under the Heritage Act is required.
- Completing feasibility design of the preferred option, incorporating feedback from consultation.
- Engaging the Inspector of Dikes with the proposed design for feedback, depending on preferred option.
- Identifying and applying for grants and funding to support construction of the project.
- Initiating permitting processes for all necessary regulatory permits (e.g., Fisheries Act, Water Sustainability Act).
- Identifying high value enhancement sites at or adjacent to the dike if environmental offsetting is deemed necessary.
- Retaining engineering consultants to support preparation of engineering designs and required documentation for the *Dike Maintenance Act* application.
- Pending regulatory approval, finalizing detailed design of remediation option and prepare construction tender package.

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6. Closing

We trust this memorandum meets FVRD's needs at this time; however, if there is any further information required, please do not hesitate to contact the undersigned.

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