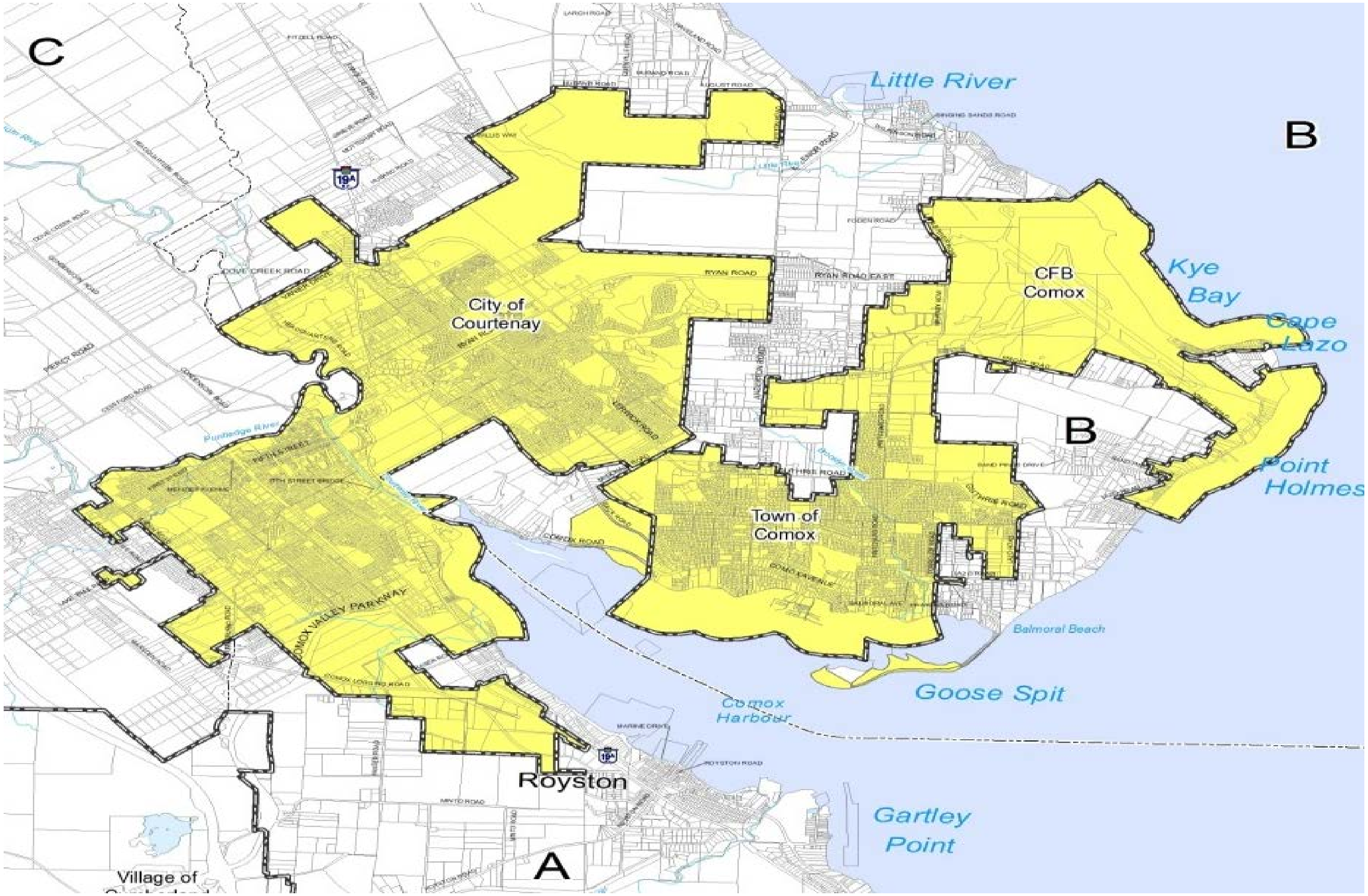
Comox Valley Sewage Service Liquid Waste Management Plan

TAC & PAC Meeting 7

September 30, 2019

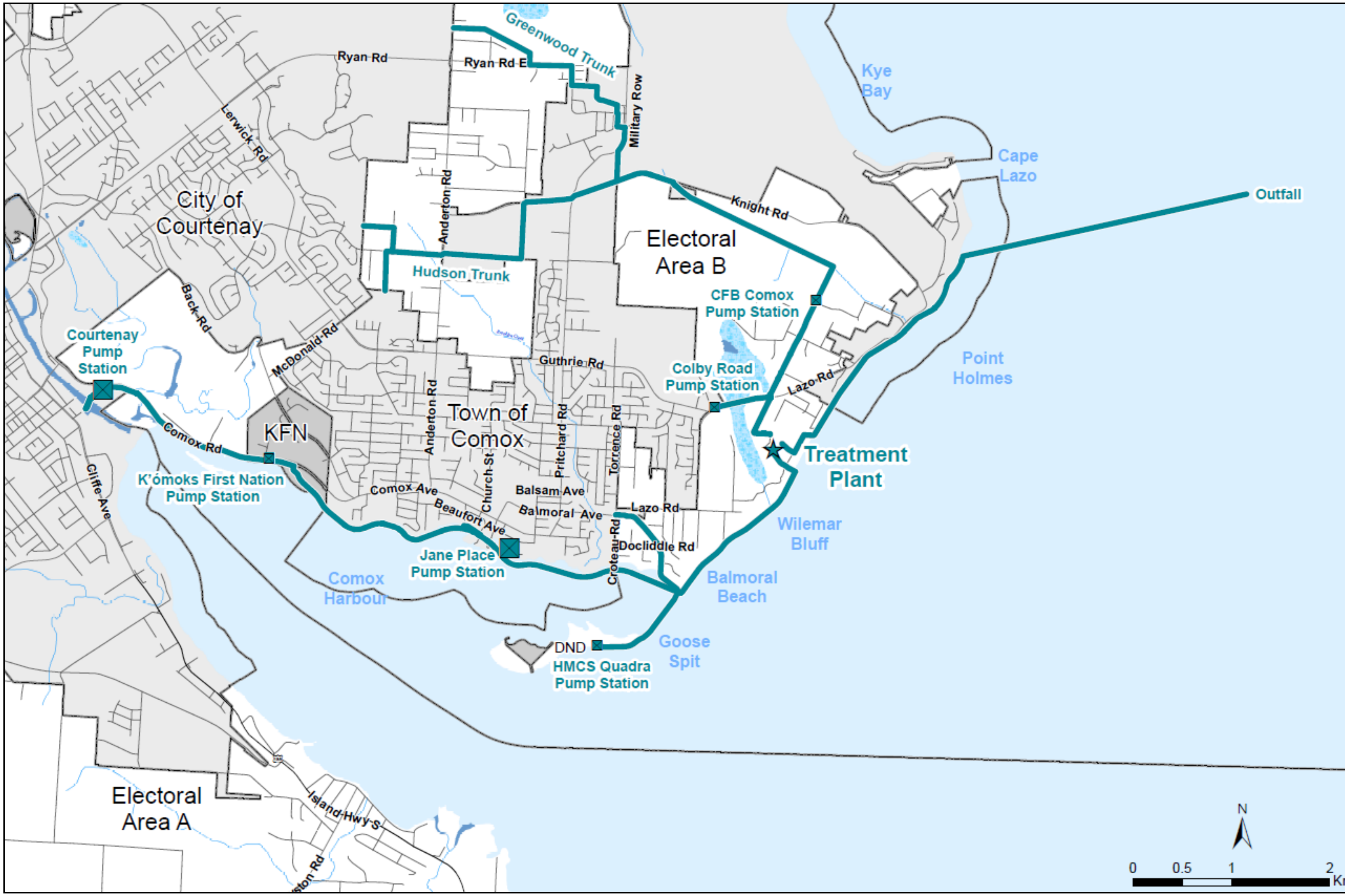
Comox Valley
REGIONAL DISTRICT

Comox Valley Sewerage Service



Comox Valley
REGIONAL DISTRICT

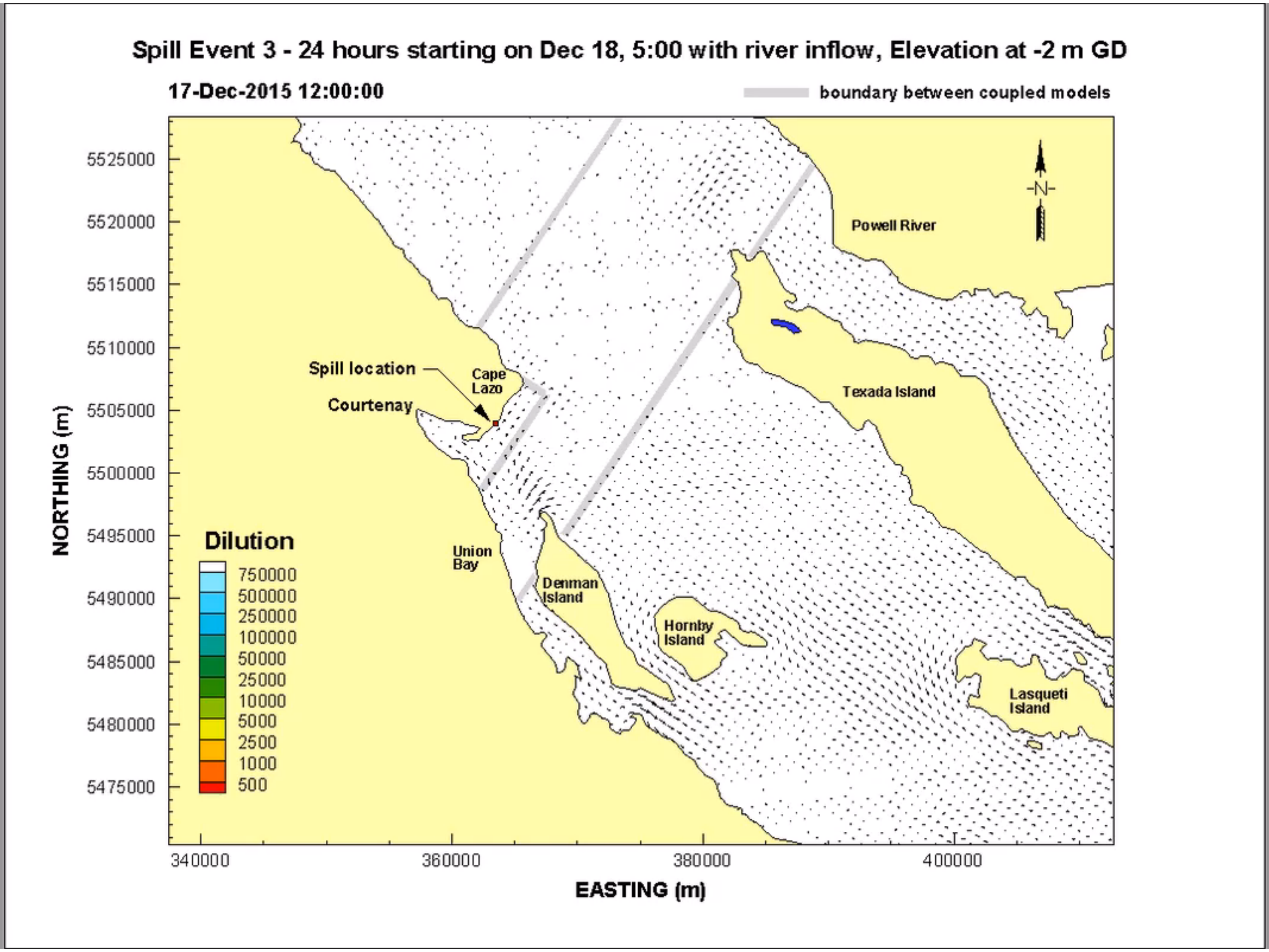
Regional Infrastructure



2003: Damage to Forcemain

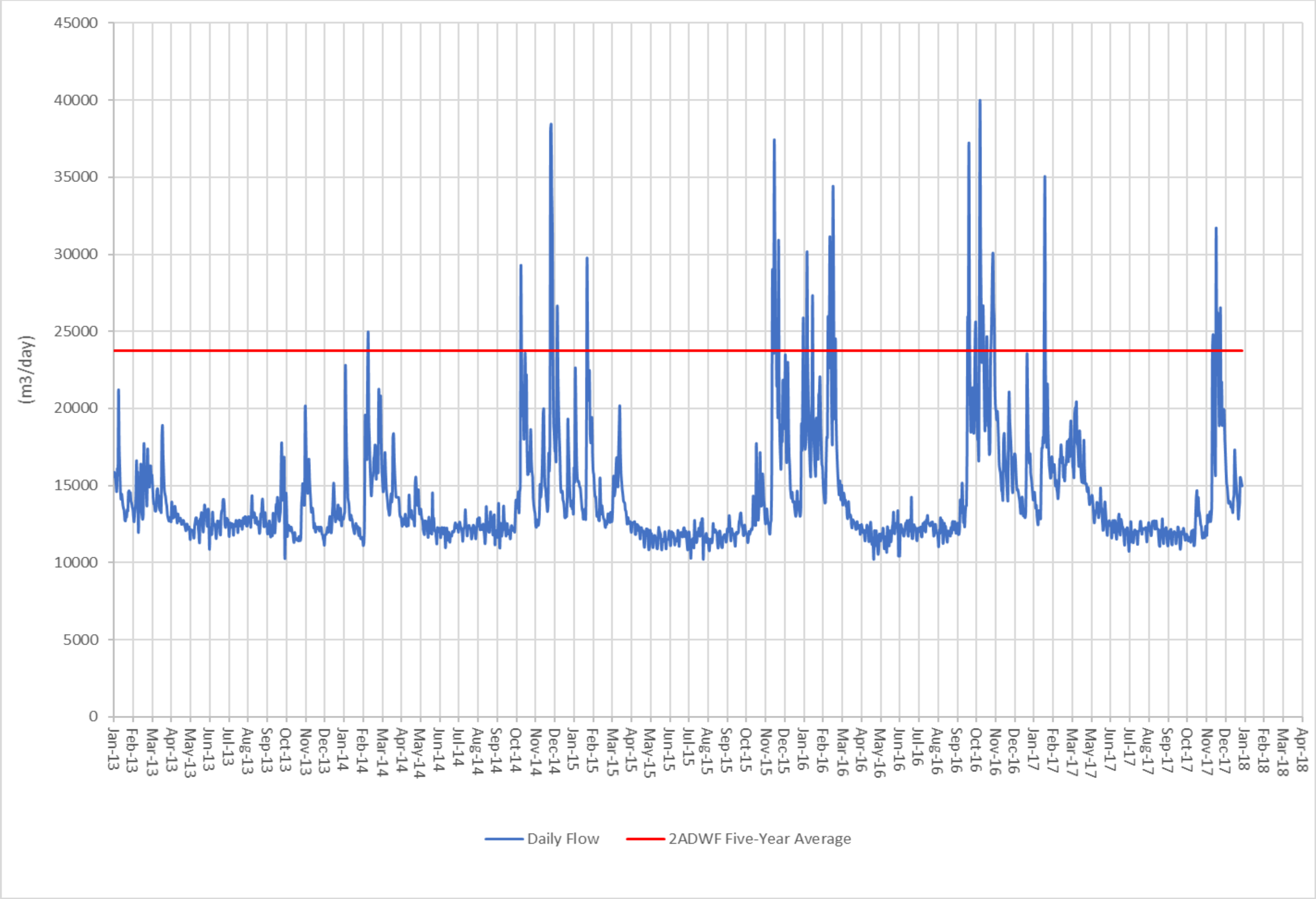

Exposed forcemain


Gabion baskets



Comox Valley
REGIONAL DISTRICT

Capacity driver = winter flows



Comox Valley
REGIONAL DISTRICT

LWMP Components and Objectives

Conveyance (Pump Station & Pipes)

- Identify optimum long term conveyance solution

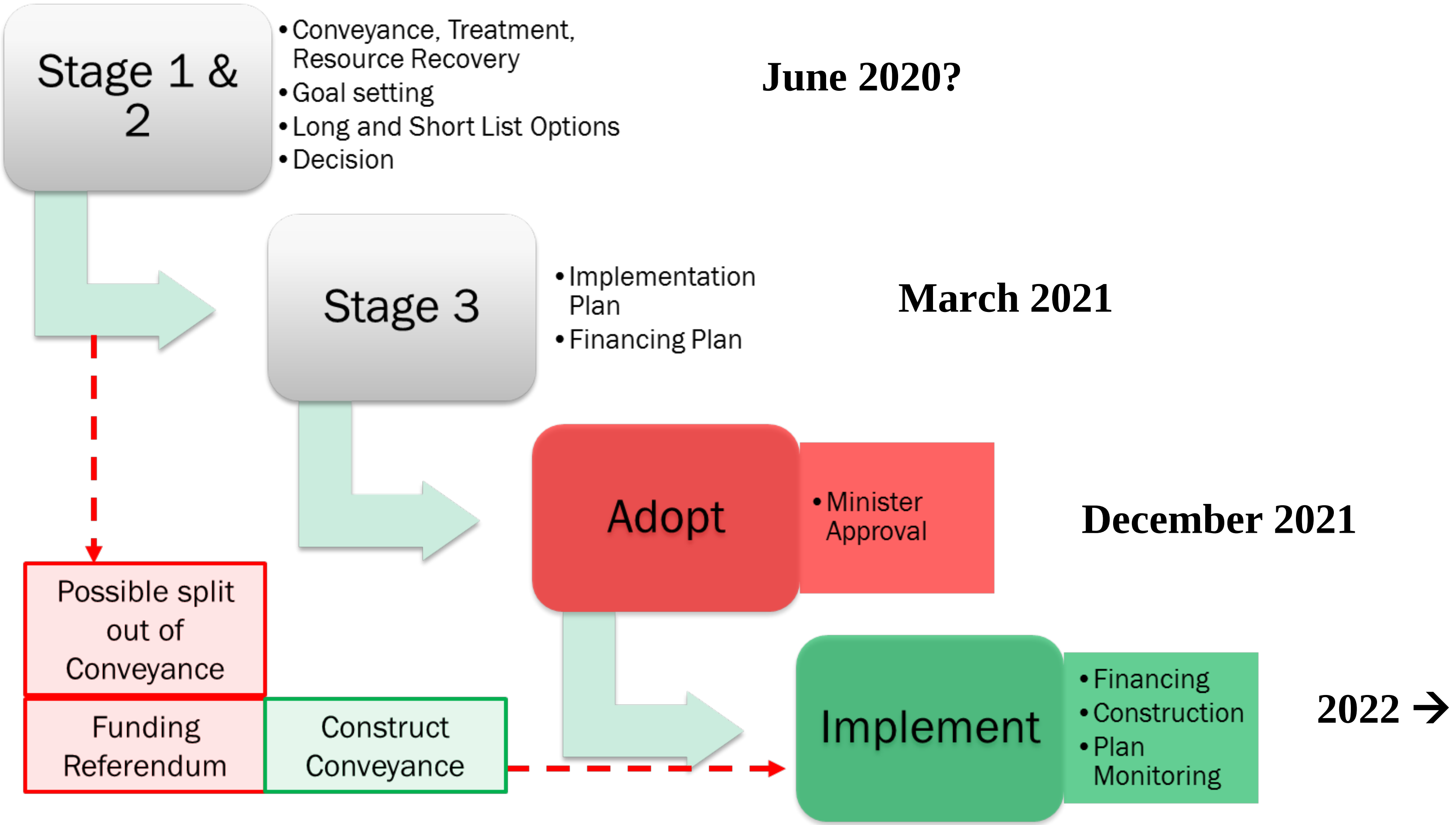
Treatment

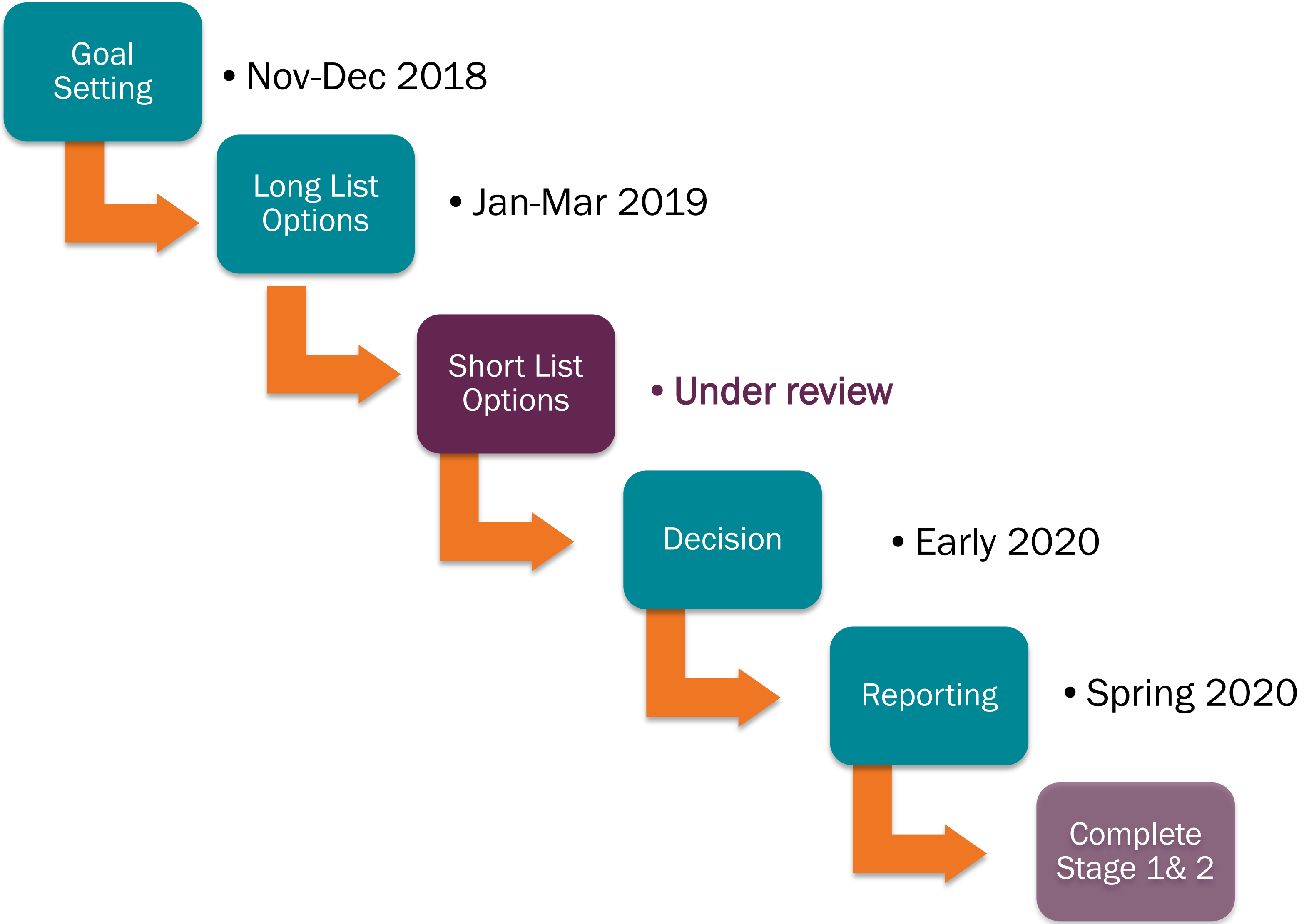
- Identify level of treatment for upgraded CVWPCC

Resource Recovery

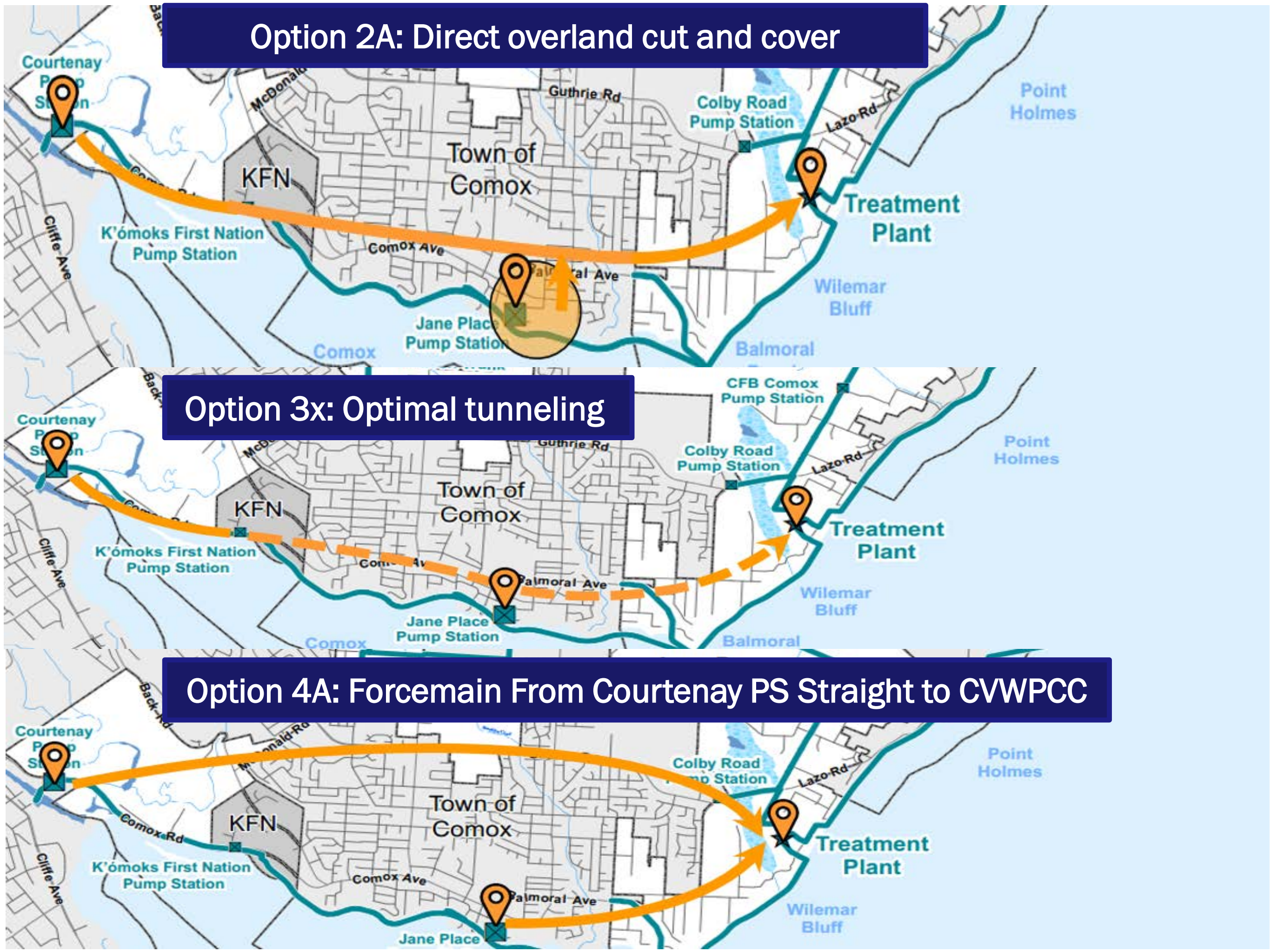
- Identify other potential opportunities to extract beneficial resources from treatment process

LWMP Process Timeline




Goal Setting
• Nov-Dec 2018
Long List Options
• Jan-Mar 2019
Short List Options
• Under review
Decision
• Early 2020
Reporting
• Spring 2020
Complete Stage 1& 2

Outcome of last TAC PAC meeting



Comox Valley REGIONAL DISTRICT

So what have we been up to?

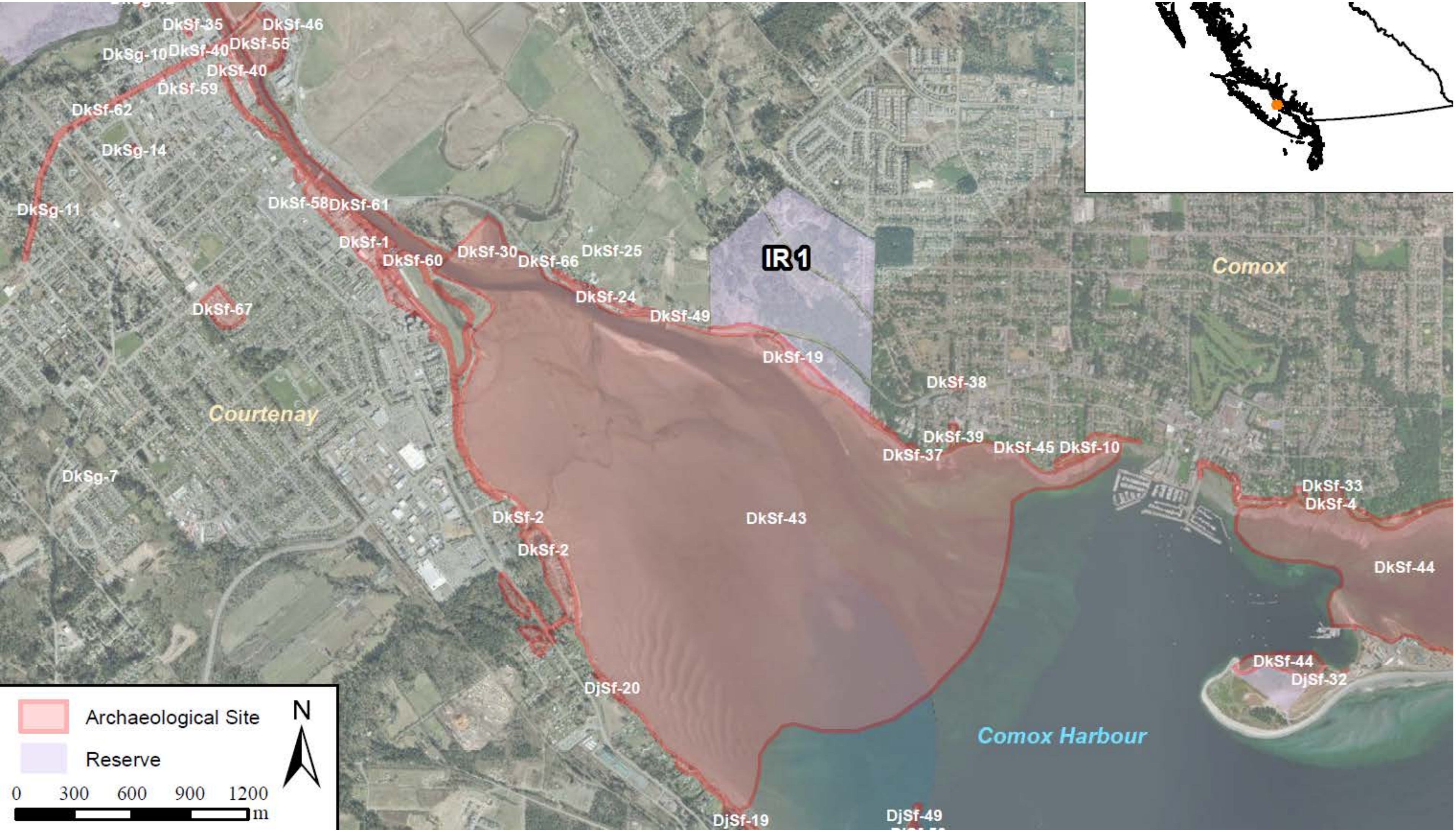
- KFN consultation
- Odour control/impact of CVSS infrastructure on Area B
- Area B representation

Comox Valley
REGIONAL DISTRICT


Summer 2019
KFN
Fall 2019
Advisory Committees
Short List Decision
Sewage Commission
Fall 2019
Public Consultation
Winter 2019
KFN
Winter 2020
Advisory Committees
Preferred Option Decision
Sewage Commission

What We Heard from the KFN

- Heritage impact
- Spiritual/emotional impact
- Construction impacts
- Environmental Risks
- Community benefit



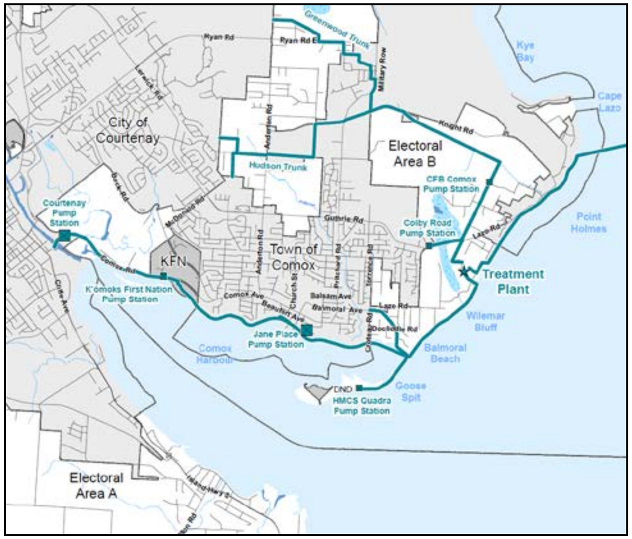
Comox Valley
REGIONAL DISTRICT

CVWPCC odour

- Follow up odour dispersion modelling
- Communications protocol
- Good neighbor agreement
- Nov/19 report:
  - Covering bioreactors
  - Odour standard at facility

Area B representation

- First came up during Comox 2 project
- Included in utility governance study
- CRRA currently advocating for Area B director on SC
- SC approved Area B director to Oct and Nov meetings for relevant topics
- SC directed staff to develop policy for possible role

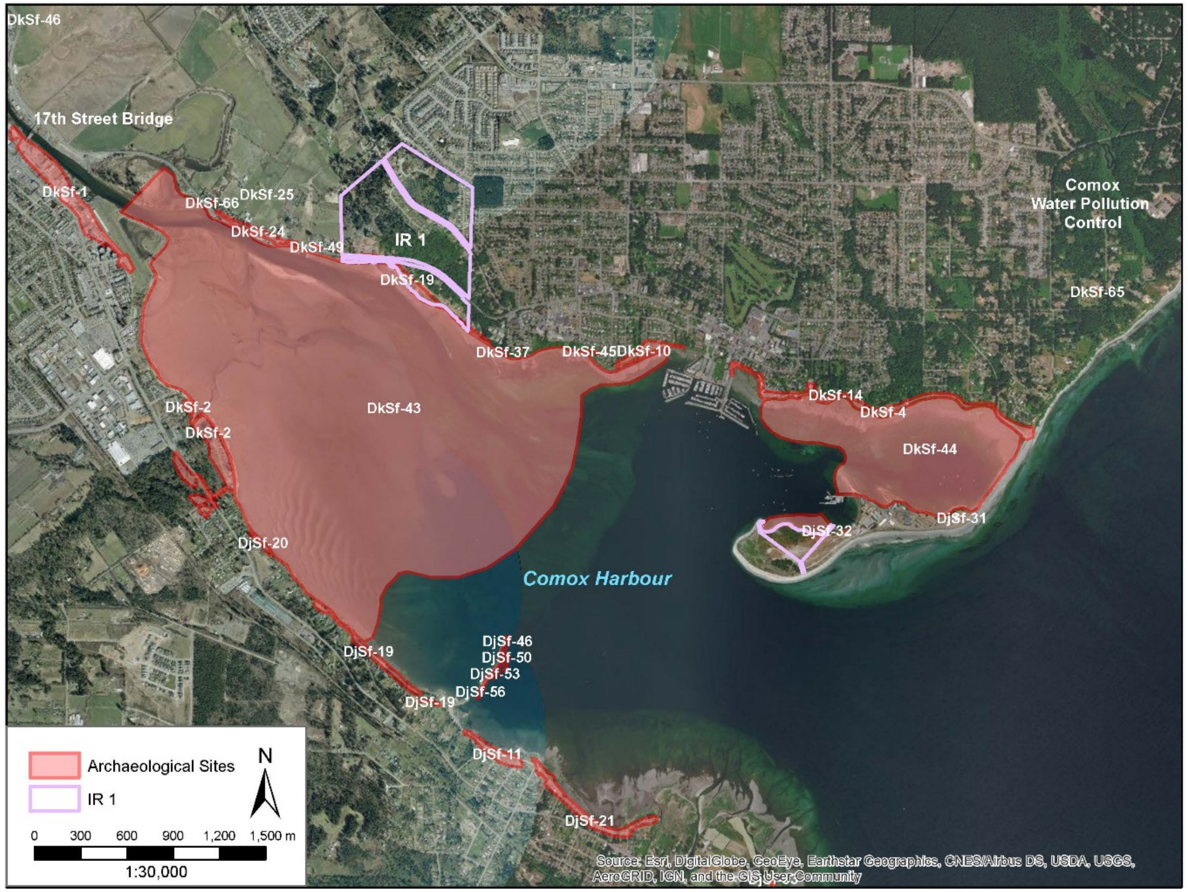


LWMP Public Consultation Plan

QUESTIONS?

Archaeological Overview of LWMP

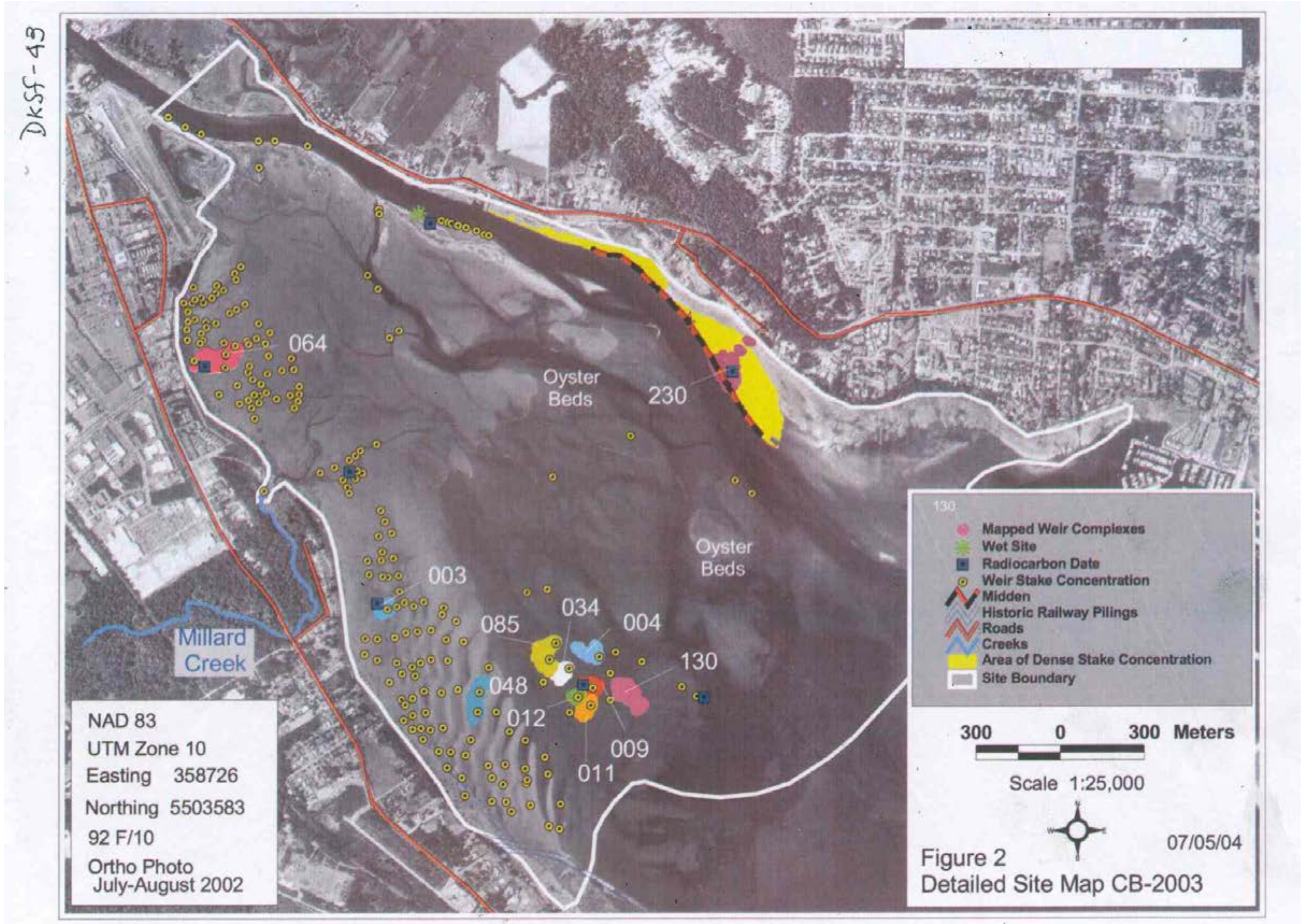
Archaeological site locations



Fish weir stake at Goose Spit

Excavating fish weir panel at IR1

Overview of fish weir complexes



Systematic data recovery of shell midden deposits

Example of soil profile from SDR unit

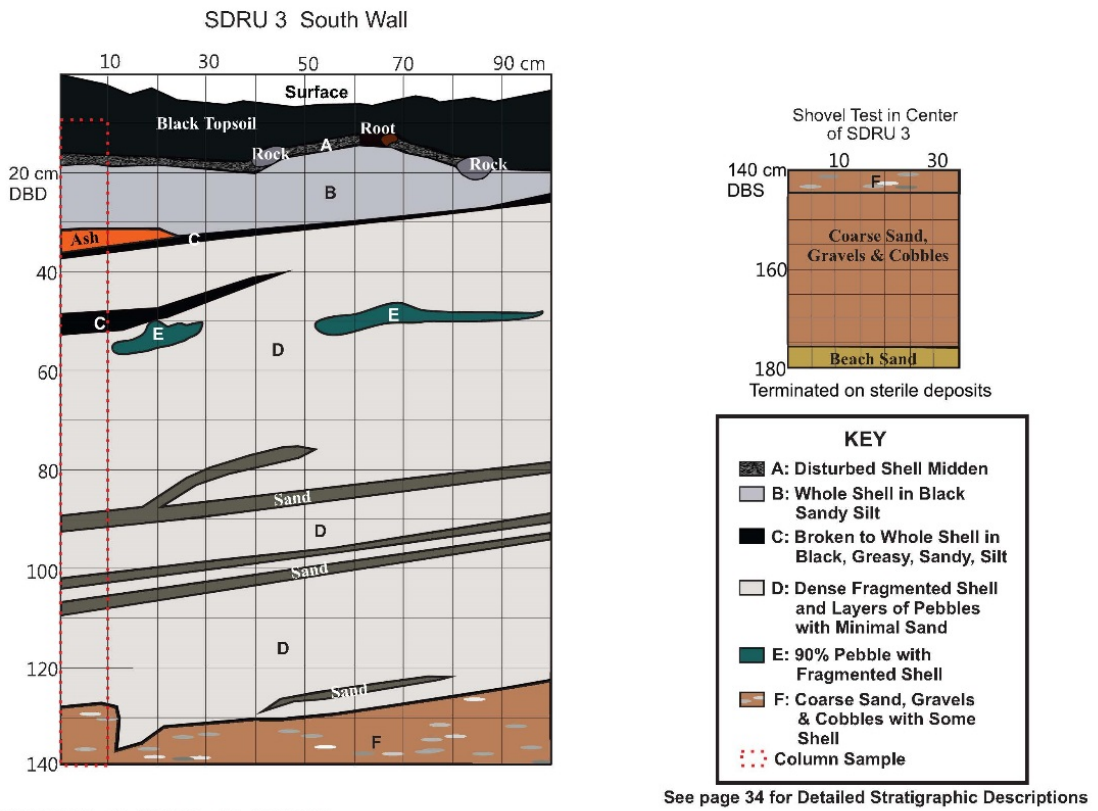


Figure 6. SDRU 3 South Wall Profile, DjSf-26

Baseline Archaeological Services Ltd.
HIP 2009-0251
32
Systematic Data Recovery
DjSf-25 & DjSf-26

Previous disturbances along Comox Road

Disturbed shell midden deposits along Comox Road

Disturbed shell midden deposits along Comox Road

Bone points–common artifact in shell middens

Excavations at Sandpiper liftstation

CVRD - Liquid Waste Management Plan

Trenchless Conveyance Options

Comox Valley Regional District

Presented by:
Doug Grimes, P. Geo
September 30, 2019
grimes@mcmjac.com

Outline

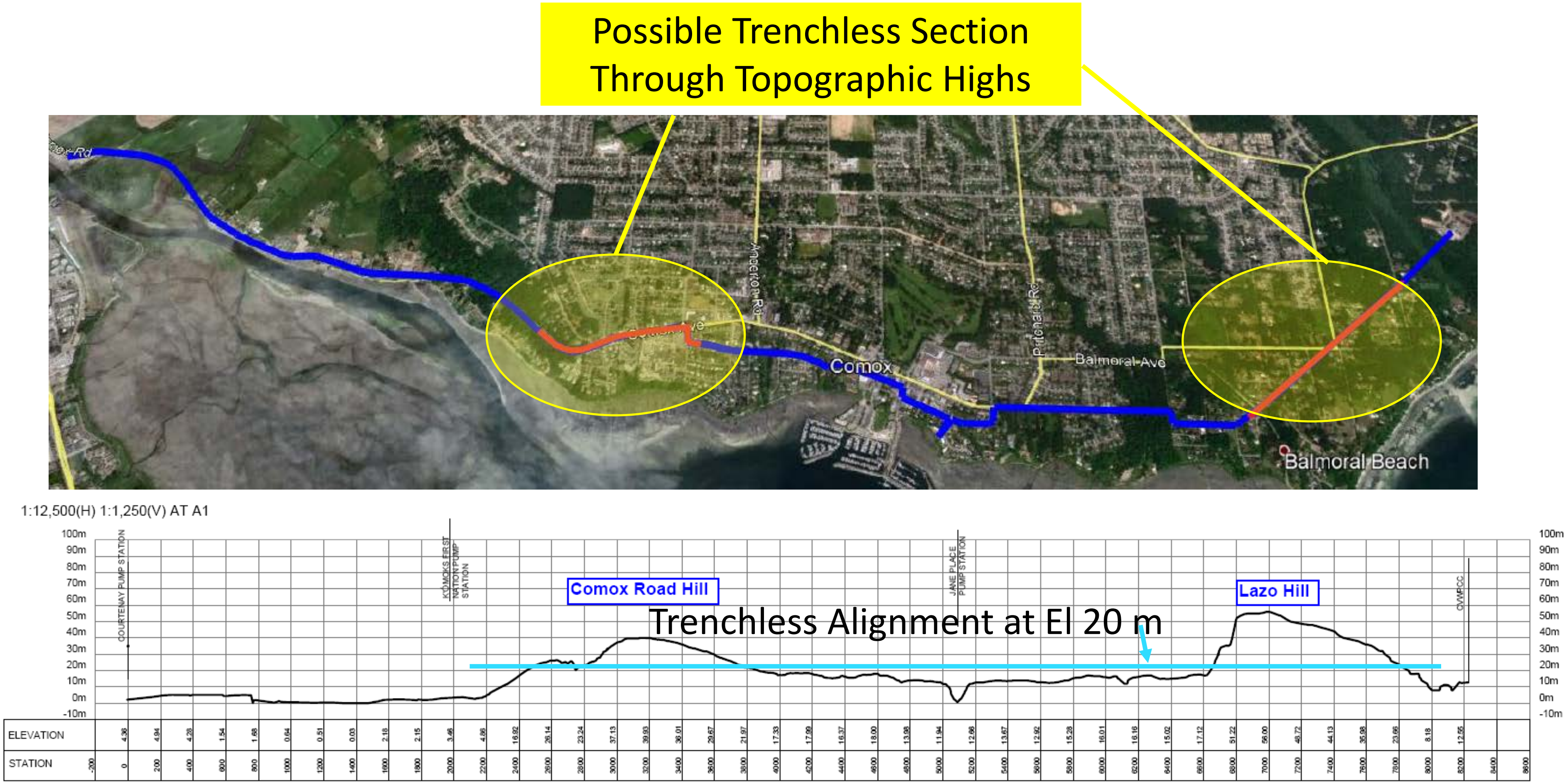
- Results of Conceptual Trenchless Study
- Trenchless Methodology Selection
- Order of Magnitude Cost
- Relevant examples

2019 Conceptual Trenchless Study

- Preferred alignment traverses two topographical highs - Lazo Hill and Comox Hill
- Hydraulic gradient significantly improved with trenchless approach compared to overland route
- MJA tasked with evaluating trenchless/tunnel options through the two topographic highs to improve the hydraulic gradient
- Assessment summarized in revised September 2019 Memo
- Conclusions: Generally favourable, and the alignment could be set as low as El 20 m

2019 Conceptual Trenchless Study

Alignment



McMILLEN JACOBS ASSOCIATES

2019 Conceptual Trenchless Study

Key Assumptions

- Ground conditions consist of cohesionless sand with intermittent silt and clay layers
- Perched groundwater with short duration flush flows may be encountered but in general the alignments are above the regional groundwater table
- Encountered groundwater is manageable and can be handled with gravity flow or sump pumps
- Cobbles and boulders cannot be ruled out given the depositional environment.
- The chosen trenchless approach will need to anticipate these and provide flexibility for removal

2019 Conceptual Trenchless Study

Design Criteria

- Minimize trenchless length to minimize cost
- Consider hydraulic requirements and associated pumping costs
- Straight and sloped trenchless alignments to simplify installation and optimize hydraulic performance
- Emphasis on work areas and portal/launch sites
- Flexible access and staging configurations preferred
- No consideration of property ownership or public right-of-way at this time (address this later)

Methodology Selection

Utility and Shield Tunnelling - TBMs

Techniques	Typical Applications	Tunnel Liner / Pipe Material	Excavation Method	Lengths Installed	Diameters Typically Installed	Line & Grade Accuracy
Utility Tunnelling[1]	Utilities with large diameters, typically shorter runs, curves capable	Ribs and lagging, steel or CMP liner plates,	Hand and small excavation tools	100 to 150 m (300 to 500 ft)	> 1370 mm (54 inches)	< 3% of tunnel diameter
Shield Tunnelling[1]	Utilities or large diameter pipe, longer runs, curves capable	Ribs and lagging, steel or CMP liner plates	Bucket or boom excavators	Unlimited	>2.2 m (84 inches) to accommodate equipment	< 3% of tunnel diameter
Tunnel Borings Methods (TBM) and MTBMs	TBMs are distance limited because it is a pipe jacking technique with limitations and the tunnel would have to be broken into shorter reaches necessitation additional and receiving shafts resulting in a costly approach. MTBMs are designed to operate below groundwater and is a very expensive method to deploy for an alignment above groundwater.					

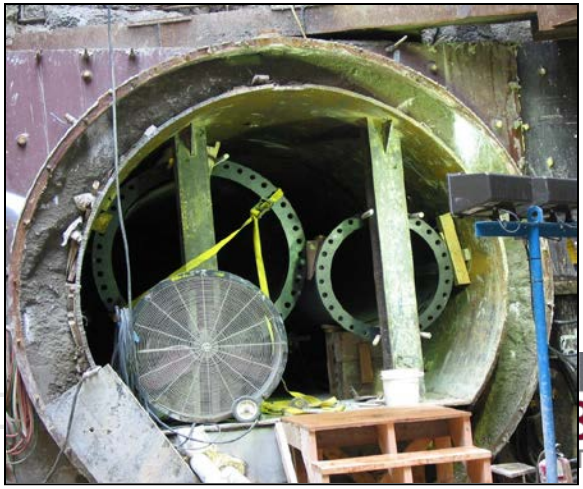
[1] Two Pass Installation

MILLEN JACOBS ASSOCIATES

Methodology Selection

Utility and Shield Tunnelling

- Shield advances by hydraulic jacks pushing off the initial ground support system as tunnel progresses
- Excavation with hand or mechanical tools (bucket excavator, cutter boom)
- Spoils are mucked out by carts
- Ground obstructions accessible for removal
- Two pass method for installation of carrier pipe that is grouted in place



Methodology Selection

HDD and Direct Pipe Methods

Techniques	Typical Applications	Tunnel Liner / Pipe Material	Excavation Method	Lengths Installed	Diameters Typically Installed	Line & Grade Accuracy
Horizontal Directional Drilling (HDD)[1]	Waterways, water bodies, urban corridors, natural barriers	High density polyethylene (HDPE) and steel pipe used most often	Bit and tooling excavation using slurry for transport	Typical routine installations in the 1000 to 1,500 m (3,300 to 5,000 ft) range	Currently up to 1370 mm (54 inches)	Dependent on guidance system, but typically within 1 m (3+ feet) vertical/horizontal
Direct Pipe[2]	Waterway/water body crossings, outfalls	Steel pipe	Microtunnel Boring Machine (MTBM)	1000 m (3,300 feet) range routine, 1,500 m (5,000) accomplished	900 to 1,500 mm (24 to 60 inches)	< 3% of the pipe diameter.

[1] One Pass Installation

[2] Direct pipe is very difficult to implement in an urban environment due to high demand for unencumbered urban space – discussed for completeness

McMILLEN JACOBS ASSOCIATES

Methodology Selection

Narrowing Methodology Selection

Trenchless Method	Limitations	Project Applicability
Utility Tunneling	Typically used for smaller diameter and shorter tunnels	No practical for long tunnels proposed
Shield Tunneling	Typically used for tunnels > 1,500 mm (60 inches, diameter increases with distance, two pass installation	Not practical for tunnel diameter < 2.2 m (84 inches) for the tunnel length required for the project but considered a feasible method.
TBM Methods	Pipe jacking method limited by distance and that would require additional jacking and receiving shafts along the alignment	Not considered practical where really deep shafts would be required beneath the two topographic highs
Horizonal Directional Drilling (HDD)	Requires drilling fluid in the borehole at all times to maintain borehole stability. Can be overcome with fluid reservoir at downstream end or shallow arcuate profile. Requires long laydown area for the pipe.	Force main can be installed without casing or oversized tunnel greatly reducing the tunnel diameter that has to be excavated for pipe installation. Method considered feasible assuming that an appropriate laydown area can be found.
Microtunneling	Needlessly using a method designed for below-groundwater conditions in an above-groundwater condition.	Not considered cost effective for the two tunnels but carried forward as a viable trenchless method.
Direct Pipe	All of pipe and machine umbilicals threaded through built up pipe on the surface for thrusting forward, high demand work space for an urban footprint, can only install steel pipe, two pass method for HDPE pipe	Urban demands for space to layout pipe and thrust pit not considered practical for the urban setting
Considered the more feasible methods with HDD being the most cost effective		

Summary of Advantages/Limitations

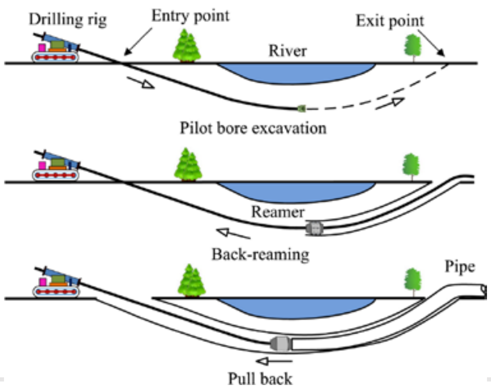
Trenchless comparisons for selected categories

Category	Trenchless Method		
	Shield Tunneling	Microtunneling	Horizontal Directional Drilling
Staging Area Requirements	Method is compact, has small surface footprint	Larger area required for staging due to supporting equipment (e.g. slurry plant), shafts required.	Larger area required for HDD equipment and long linear pipe laydown area. Surface to surface method with shallow pits.
Shaft and Pits	Requires surface portal for ground ingress and egress, otherwise shafts may be necessary.	Requires jacking shaft to accommodate equipment. Requires receiving shaft. May require ground improvement for jacking force development and at launch and receipt portals.	Requires small surface pits at both bore ends or a shallow shaft on the downstream end to maintain a fluid-filled borehole.
Settlement and Risk to Stakeholders	Casing provides ground support, face control variable, depth of alignment note likely to produce measurable surface settlement.	Machine/Pipe and engineered drilling fluids provides continuous ground support and hydrostatic counterbalancing.	Slurry provides continuous ground support and hydrostatic counterbalancing prior to pipe installation. Surface casing may be used for shallow section. Borehole slurry reverts to weak clay over time.
Typical Diameters Installed	2.2 m or larger	0.5 m to 2.7 m	0.1 m to 1.5 m
Typical Length Installed	No limitations	Installed lengths are typically in the range of 600 m, however 1100 m has been installed before	Less than 1,500 m
Impact/Mitigation if boulder encountered	Small time impact primarily reduction in advance rate for removal of boulder	Moderate to significant time impact, even if planned for tunnel diameter affords limited access to face for removal, advance could be stopped days to a week or two	Low to moderate time impact to either drill through boulder or drill around it, hours to a day or two time impact, significant impact if frequent or nested

Methodology Selection

Horizontal Directional Drilling (HDD)

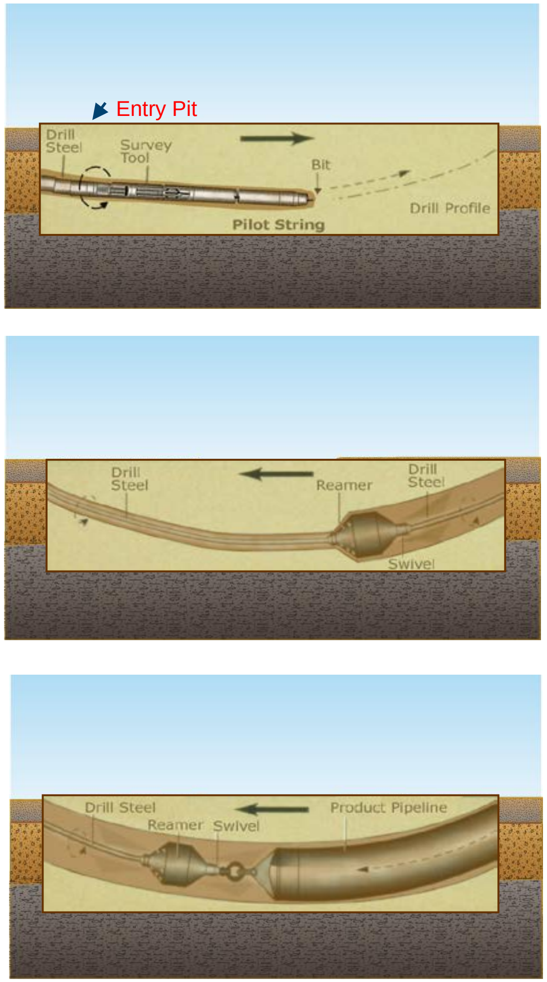
- Surface to surface method to construct inverted-U profile
- Can drill a straight and sloped alignment through hill
  - Would require a fluid control pit on downstream side to maintain borehole stability
- Drill pilot bore to design line and grade
- Ream hole 300 mm greater than pipe OD (~1.5 m for 1.2 m OD pipe)
- Build up and layout pipe on surface in one or two sections for pullback into reamed hole
- Pull pipe into reamed hole



McMILLEN JACOBS ASSOCIATES

Methodology Selection

HDD Continued



Order of Magnitude Cost

			Digger Shield	Microtunnel	HDD
Item	Qty	Unit	Base Cost ($)	Base Cost ($)	Base Cost ($)
Portal/Site Development	4	ea	1.6	1.6	0.8
Comox Hill Excavation and Lining	1000	m	11.5	9.5	5.0
Lazo Hill Excavation and Lining	1000	m	11.5	9.5	5.0
Mobilization and Site Work	1	ea	2.0	2.0	0.5
Total Base Cost			26.0	22.6	11.3
Total Cost Range			13.3 to 34.6	11.3 to 29.4	5.7 to 14.7

- Note: All values in CAD$, 2019 Canadian currency, rates and exclusive of contingency, engineering, pipe, and Owner's costs
- Duration: Digger Shield, ~18 months 1 heading, Microtunneling, ~10 – 12 months, HDD, 6 – 7 months
- Minimum Tunnel Diameter used for base costs.

Relevant examples of HDD technology

HDD Projects in Vancouver Island and Lower Mainland

- CRD Victoria Harbour Crossing
  - Owner: Capital Region District.
  - Engineers/Contractors: Harbour Resource Partners (AECOM/Graham/Michels)
  - 940 m long, 42 in diameter, 108 megaliter a day capacity sanitary sewer
  - Years: 2017-2020
- Golden Ears Forcemain and River Crossing (Maple Ridge to Langley)
  - Owner: Metro Vancouver
  - Engineers: McMillen Jacobs Associates
  - 1,600 m long, twin 914 mm diameter sanitary sewer
  - Years: 2018-2021
- Fraser River South Arm Crossing (Richmond to Delta)
  - Owner: FortisBC
  - Contractor: North American Pipelines
  - 1,400 long, twin bore at 508 mm and 610 mm. Natural gas pipelines. Final cost: $13.9 million
  - Years: 2009-2001
- Vancouver City Central Transmission Project
  - Owner: BC Hydro
  - Contractor: Michels Pipeline
  - 850 m long, 864 mm diameter conduit for high voltage electical lines, HDD cost approx, $8.1 million.
  - Years: 2003

Order of Magnitude Cost

			Digger Shield	Microtunnel	HDD
		Minimum Tunnel Diameter	2.2 m	1.2 m	1.6 m
Item	**Qty**	**Unit**	**Base Cost ($)**	**Base Cost ($)**	**Base Cost ($)**
Portal/Site Development	4	ea	1.6	1.6	0.8
Comox Hill Excavation and Lining	1000	m	11.5	9.5	5.0
Lazo Hill Excavation and Lining	1000	m	11.5	9.5	5.0
Mobilization and Site Work	1	ea	2.0	2.0	0.5
Total Base Cost			26.0	22.6	11.3
Total Cost Range			$13.3 to $34.6	$11.3 to $29.4	$5.7 to $14.7

- Note: All values in CAD$, 2019 Canadian currency, rates and exclusive of contingency, engineering, pipe, and Owner's costs
- Duration: Digger Shield, ~18 months 1 heading, Microtunneling, ~10 – 12 months, HDD, 6 – 7 months
- Minimum Tunnel Diameter used for base costs.

Recommendations

The key data gaps identified are:

- Preliminary and detailed information on the geotechnical and groundwater conditions along the alignment, especially Comox Hill
- Availability of land and temporary right-of-way for staging and construction areas – crucial for HDD in order to provide a laydown area for the pipe welding and testing
- Availability of permanent right-of-way

Questions?

Doug Grimes, P. Geo

grimes@mcmjac.com

604-336-8639

Liquid Waste Management Plan - Stages 1 & 2

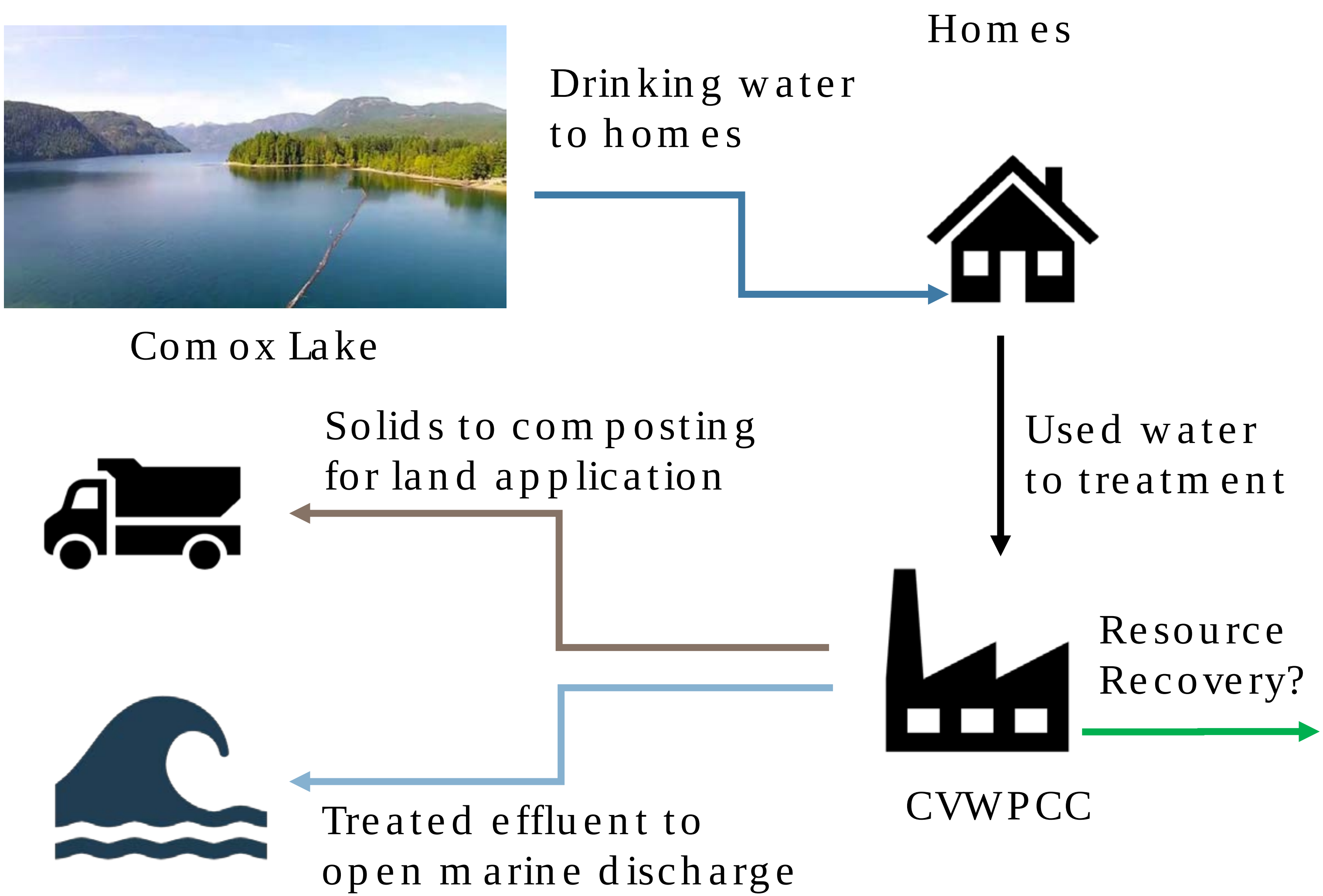
An Overview of Microplastics, Emerging Contaminants and Viruses in Wastewater

September 30th, 2019

Why are we talking about microplastics, emerging contaminants and viruses?

- Emerging issues in wastewater treatment
- Generally, there are potential risks to human and environmental health from microplastics and emerging contaminants, but the magnitude of the risks are uncertain and not quantified. The human health risk due to viruses is well understood.
- Generally, there are no regulatory requirements in Canada for these contaminants, but this could be changing
- Generally, treatment technologies to address these issues are still being researched

The system we're talking about



Scope of the LWMP for wastewater treatment

- Important to remember that WWTPs do not generate these contaminants – they are generated by the users of the sewerage system, and the WWTP is at the downstream end of that system
- In the LWMP we focus on environmental standards, effluent quality and in some cases resource recovery
- The LWMP provides an over-arching framework for working towards the community's goals
- The commitments and recommendations in the LWMP will guide future upgrades to the District's treatment facilities
- Selection or recommendation of specific treatment processes or technologies is not addressed at the LWMP level
- It is the goals/objectives of treatment that are important at this stage
  - *i.e., does the community want to meet the letter of the effluent discharge regulations or go beyond that? How far beyond?*

Effluent Discharge Regulations

	Provincial Regulations for Discharges to a **Marine** Environment	Provincial Regulations for Discharges to a **Freshwater** Environment	Federal Regulations
Total Suspended Solids (TSS)	Maximum 45 mg/L	Maximum 45 mg/L	Average 25 mg/L
Biochemical Oxygen Demand (BOD)	Maximum 45 mg/L	Maximum 45 mg/L	Average 25 mg/L
Disinfection	Shellfish: 14 Fecal Coliforms/100 mL Recreation: 200 Fecal Coliforms/100 mL		N/A
Ammonia Toxicity	Chronic: non-toxic outside Initial Dilution Zone Acute: non-toxic in undiluted effluent		
Advanced or Tertiary Treatment	Additional requirements may be imposed depending on results of an EIS	Total Phosphorus < 1 mg/L Phosphate <0.5 mg/L	N/A

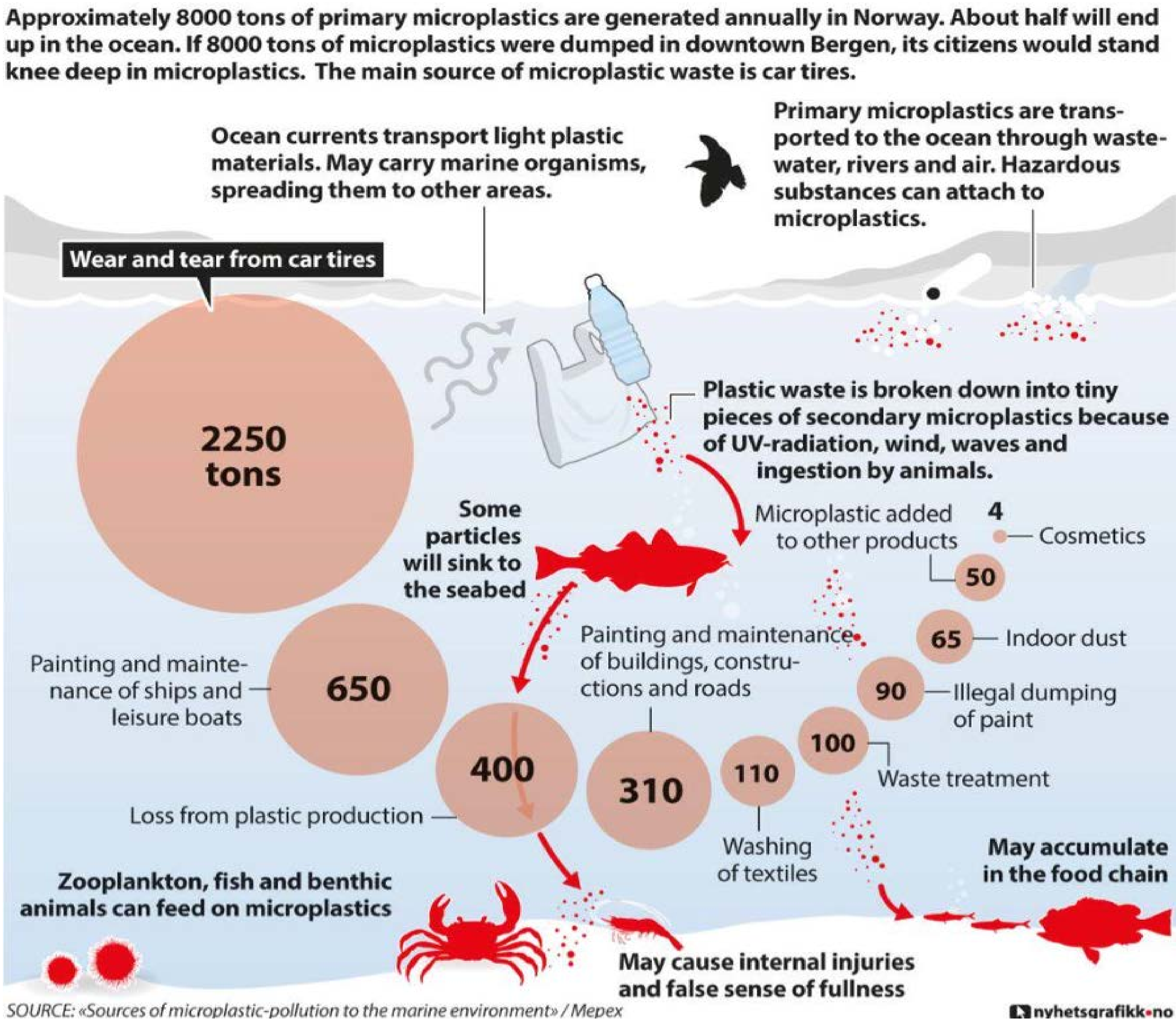
Reclaimed Water Regulations

	Indirect Potable Reuse	Greater Exposure	Moderate Exposure	Lower Exposure
Uses	Replenishing a potable water source, like an aquifer	Public might be directly exposed Eg. irrigating a golf course	Public probably won't be exposed Eg. irrigating a silviculture operation	Industrial uses, public not at risk of exposure Eg. use at treatment plant
Total Suspended Solids, TSS (mg/L)	5	10	25	45
5-Day Biochemical Oxygen Demand, BOD_5 (mg/L)	5	10	25	45
Turbidity (NTU)	<1	2	n/a	n/a
Disinfection	Fecal coliforms <1 100 mL Chlorine residual required	Fecal coliforms <1 /100 mL Chlorine residual required	Fecal coliforms <100 /100mL Chlorine residual required	Fecal coliforms <200 / 100mL Chlorine residual required

Before trying to solve a problem, it's important that we understand what the problem is.

Microplastics (MPs)

Where do microplastics come from?

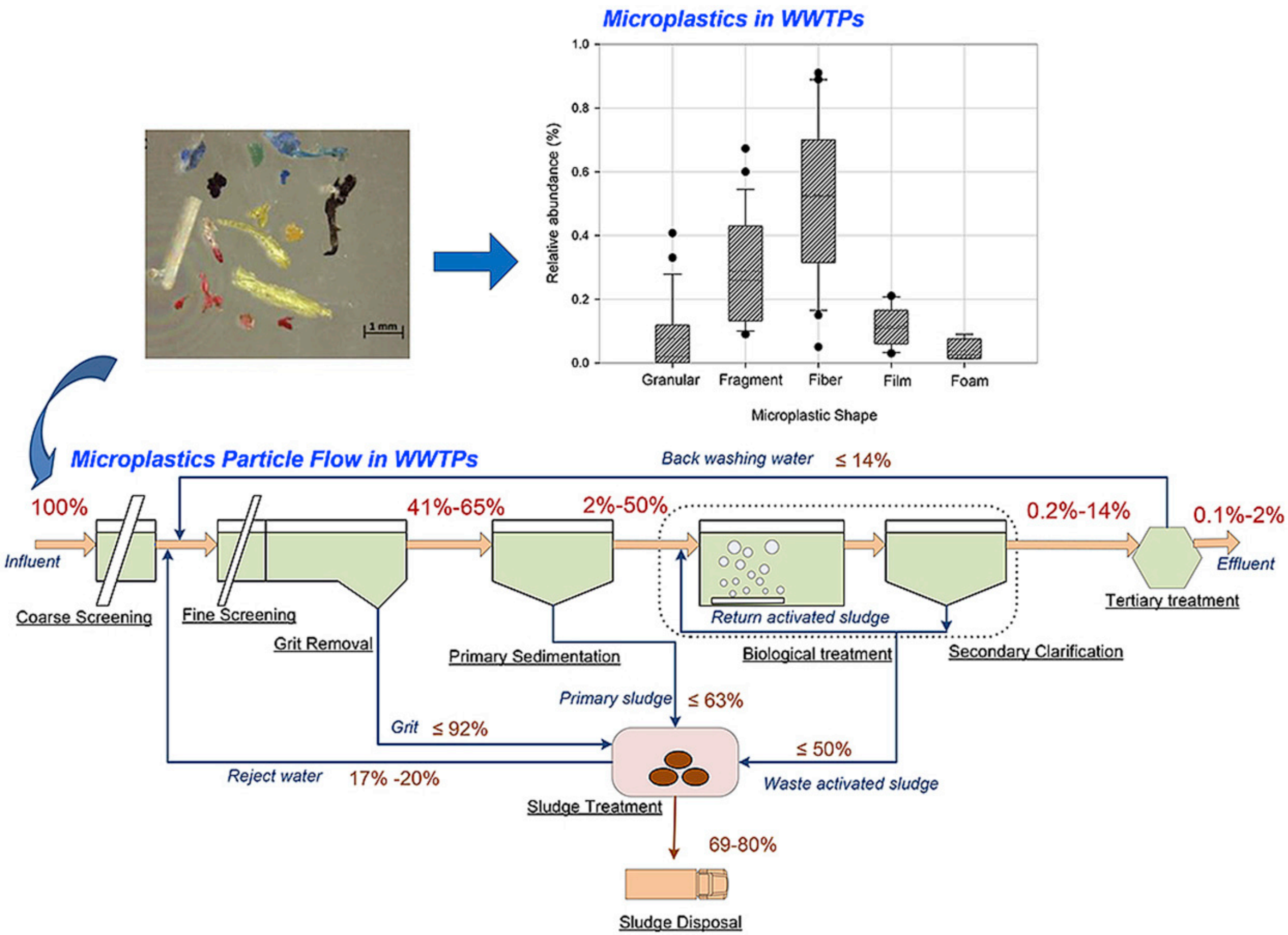


9

What are the effects of microplastics on human and environmental health?

- 2019 report by WHO: MPs so far have been found to pose low concern for human health but there are potential negative effects:
  - *Physical: impede breathing, intestinal damage*
  - *Chemical: leaching of toxic compounds, EDCs*
  - *Carriers: microorganisms, persistent organic pollutants*
- Wide diversity in chemical and physical properties of MPs makes them difficult to characterize
- Effects not well understood and research is ongoing

Secondary Treatment at WWTPs Typically Captures 80% to 95% of MPs



Estimated Average Microplastics Removal Rate Through Wastewater Treatment Plant with Primary, Secondary, and Tertiary Treatment Processes (Sun et al., 2019).

11

Capture of Microplastics

— Secondary treatment captures between 80-95% of MPs
— Tertiary filtration can increase MP capture to 97%
— Capture effectiveness depends on size and shape
— The uncaptured fraction still represents a significant load to the receiving environment (e.g. Vancouver area WWTPs capture an estimated 1.8 trillion plastic particles/year but still release 30 billion particles/year)
— Enhanced capture of MPs may improve effectiveness of effluent disinfection
— Captured MPs are incorporated into the waste solids (they do not disappear!)
— MPs captured at the CVWPCC will be diverted from the marine environment to the waste solids stream sent to the compost facility

Regulatory framework

- Canada: no regulation currently in place for removal of MPs in wastewater treatment plants
- Microbeads in toiletries were banned effective July 1, 2018. Though microbeads represent a small portion of MPs overall, this is a first step and could be representative of further steps.

So what next for Microplastics?

- Analysis of MPs is difficult and the effects are not well defined – this complicates mapping out an action plan
- Some source control measures can be undertaken, for example:
  - *product bans (microbeads, single use plastic products, etc.)*
  - *alternative materials for textiles such as polyester fleece garments*
  - *in-home filter on washing machine discharge*
  - *education and public outreach*
- Recognize that captured MPs will end up in the waste solids (in this case Skyrocket Compost)

Contaminants of Emerging Concern (CECs)

What are CECs and what is their effect on human and environmental health?

— Wide range of compounds with different origins (persistent organics, pharmaceuticals, personal care products, prescribed drugs and medicines, endocrine disruptors)

— Some are soluble in water, some are not soluble, they may be biodegradable or persistent

— May be transformed into other compounds in the wastewater mixture

— Risks to environmental and human health have been identified, but effects of many of these compounds is not well understood and research is ongoing

wsp

Regulatory framework

— Canada: no regulation currently in place but likely that guidelines and possibly regulations will be forthcoming at some point

— European Union: member states must monitor substances on Watch List (8 compounds)

— Switzerland:

  ✓ *removal of CECs mandatory, driving forces are downstream water use, ecotoxicology, protection of drinking water*

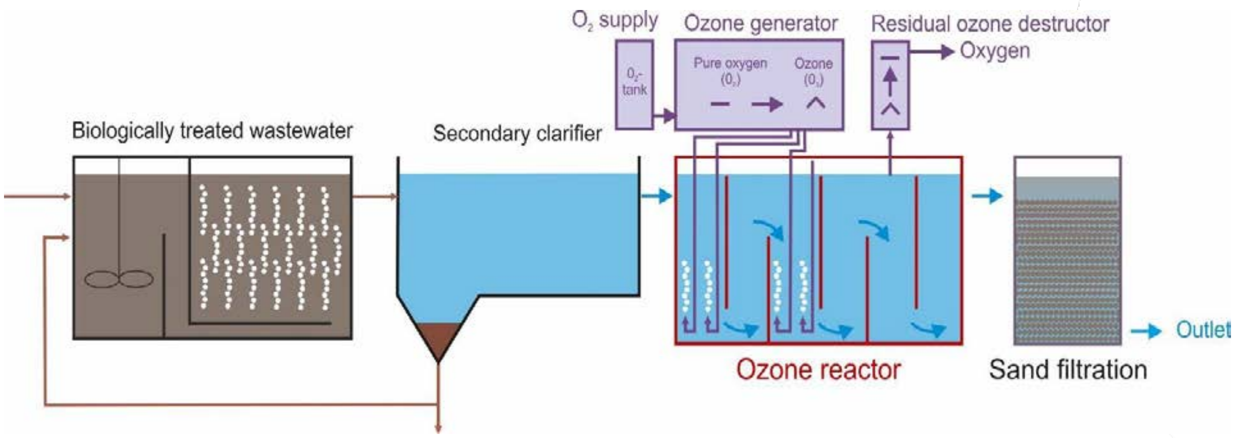
  ✓ *12 indicator compounds that must be monitored*

  ✓ *required to achieve average 80% removal at WWTPs*

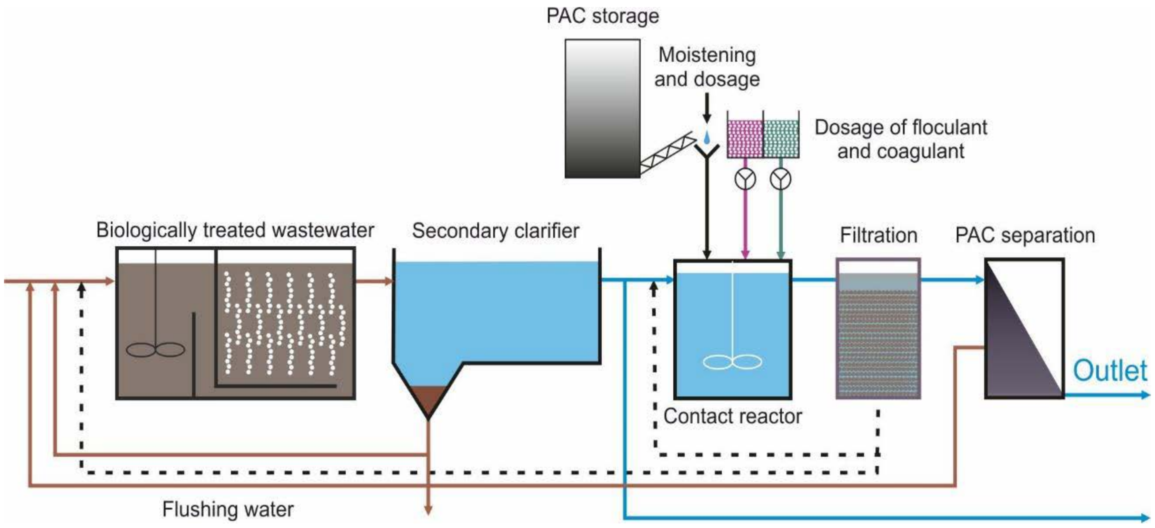
— Advanced treatment for CEC removal is becoming more common in Europe – no operating facilities identified in North America but one is under construction in Montreal

Advanced Treatment Processes to Remove CECs

- Removal at WWTPs depends on many factors, and very difficult or impossible to quantify removal rates
- Many CECs may pass through conventional WWTP treatment processes without being removed
- **Activated Carbon:** high cost, requires disposal or regeneration of spent carbon (which contains the captured CECs)
  - ✓ *Powdered Activated Carbon (GAC): dosed to biological treatment or secondary effluent, incorporated along with captured compounds into waste solids - low capital cost, high operating cost*
  - ✓ *Granular Activated Carbon (GAC): fixed-bed absorbers, media will eventually be saturated and require regeneration at a specialized facility (typically using high heat to oxidize capture compounds) – low capital cost, high operating cost*
- **Membrane Technology (nanofiltration, reverse osmosis):** high energy demand, membrane fouling, disposal of brine (which contains the captured compounds)
- **Advanced Oxidation (ozone):** high energy demand, potential formation of toxic by-products which may require additional downstream treatment (e.g., filtration or activated carbon)



Example of Full -Scale Ozone System (Dubendorf , Switzerland)



Example of Full -Scale Powdered Activated Carbon (PAC) System (Dulmen , Germay)

Operating CEC Removal Facilities

So what next for CECs?

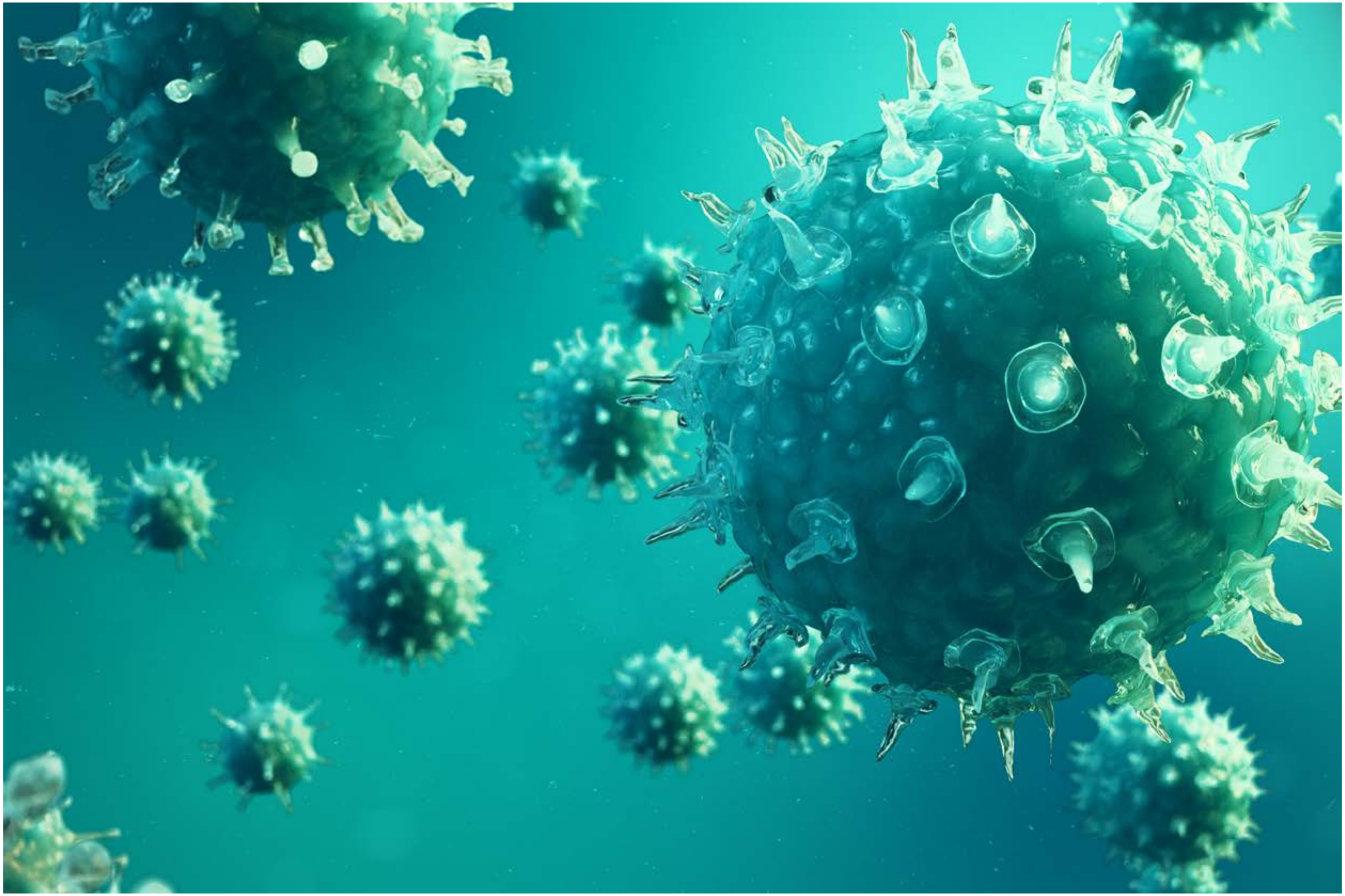
— Wide range of compounds and characteristics

— Source control measures for many CECs not very practical (e.g., prescription drugs, birth control pills)

— CEC removal technology has been developed and implemented. Advanced treatment for CECs will add cost (capital, O&M) and operating complexity

— Consider waste solids handling – waste sludge is normally incinerated in Europe vs end use as soil conditioner in Canada (e.g., Skyrocket Compost)

— Monitor development of technologies, and when upgrading the CVWPCC, allow future incorporation of advanced processes (e.g., ozone, activated carbon)



Viruses in Wastewater

Viruses of concern and their effects

- Wide variety of viruses in wastewater pose risks to human health and the receiving environment ecology
- Some have not been characterized or placed into specific taxa
- Enteric viruses transmitted via fecal-oral route can cause illnesses ranging from gastroenteritis (stomach flu) to hepatitis
- Viruses can adapt to new hosts and environments and can survive up to 130 days in seawater
- *Norovirus* is one of the most researched – leading cause of gastroenteritis and foodborne infection (leafy greens, shellfish)

Regulatory Framework

— Viruses are not a standard measurement for wastewater effluents and not incorporated into current regulations

— Current regulations are based on organisms that indicate sewage contamination of water (*fecal coliforms* and *E.coli*, which are relatively easy to measure)

— Little correlation between fecal indicator organisms and viruses

— Measurement of viruses has advanced in recent years

  — *Male-specific coliphages have been suggested as an indicator for norovirus (MSCs are commonly found in wastewater, are similar in size and shape to norovirus, and are relatively easy to measure)*

Treatment to remove viruses

— Viruses are frequently entrained in solids, which are removed to some degree in several of the stages of a typical WWTP

— Disinfection of treated effluent before discharge will enhance removal of bacteria and viruses:

- ✓ ***Chlorination*** *(gas or sodium hypochlorite, which is essentially concentrated household bleach): toxic to fish (so requires dechlorination), potential formation of carcinogenic disinfection byproducts (DPBs)*
- ✓ ***Ultraviolet (UV) light****: non-toxic, no chemical addition, no DBPs, preferred over chlorine by regulatory agencies and in common use for new and retro-fitted WWTPs in North America*
- ✓ ***Peracetic acid (PAA)*** *– combination of acetic acid and hydrogen peroxide reacts in water to form a strong oxidant, no DPBs, lower aquatic toxicity than chlorine*
- ✓ ***Ozone****: very reactive and more effective for virus removal than chlorine, UV or PAA, but also corrosive, produces DPBs, health risk to operators, requires on-site ozone generator, not common in North America but widely used in Europe*

So what next for virus inactivation?

- Wide diversity of viruses in wastewater
- Future regulatory updates may incorporate virus indicators (e.g., MSCs) in future
- Focus on *norovirus* since it is linked to consumption of shellfish and has caused local outbreaks of gastroenteritius
- Await outcome of UV pilot testing for virus inactivation (MSC reduction) planned at a nearby municipality before implementing disinfection at the CVWPCC
- Pilot testing at the CVWPCC in advance of disinfection process selection may be advisable

Connecting the dots

- Implementing advanced effluent treatment for MPs or CECs and enhancing removal of solids at the CVWPCC:
  - *can be expected to reduce concentrations of microplastics (MPs) and contaminants of emerging concern (CECs) in the liquid effluent discharge but difficult to quantify by how much*
  - *can also be expected to enhance the effectiveness of disinfection due to reduced shielding of target organisms and viruses by solid particles*
  - *can be expected to increase the amount of MPs and CECs in Skyrocket Compost which may cause other unintended consequences*

Potential recommendations for incorporation into the LWMP for MPs, CECs and viruses

— Investigate locally feasible source control and public education approaches (particularly for MPs)

— Recommend that enhanced treatment approaches be evaluated at the pre-design stage when upgrading the CVWPCC:

  —allow for addition of effluent filtration for enhanced solids removal (more removal of MPs, CECs, better disinfection), recognizing consequent effects on waste solids quality

  —incorporate consideration of enhanced MP capture into process selection (long retention time processes, chemical flocculants)

  —allow for future incorporation of advanced treatment processes (e.g., ozone, activated carbon)

  —allow space on the site to upgrade processes to meet more stringent effluent standards in future

— Consider pilot testing of disinfection for inactivation of *norovirus* at the CVWPCC