5 WATER

Water scarcity and lack of clean drinking water is an international priority, and in recent years an increasing imperative in the Okanagan and for other parts of British Columbia. With climate change progressing, predictions are for more of the same, if not worse. There are opportunities for UBCO to look forward and work to implement water and reuse conservation solutions on campus while providing a learning experience for students and taking a leadership role in the region.

The overall water use plan presented provides a couple of directions that UBCO could take:

1. Use more efficient water fixtures and appliances, fine tune operating pressures and leakage issues, and continue with water efficient landscaping and irrigation systems.
2. Combine these efficient use of water systems with a reclaimed water system that provides reclaimed water for toilet flushing, landscape irrigation, wash-down, and cooling tower make-up.

Should the current water shortages in the region and along the West Coast continue, water conservation best practices will probably become code or regulation requirements over time. UBCO has an opportunity to take a leadership position on water use, and reclaimed water could form part of the approach as is done in many areas in North America.

UBCO can make provisions for water reuse by installing a purple piping grid (water reuse piping) along with other underground service installations. New buildings can be piped with purple pipe to be ready for when the new piping grid reaches them. The opportunity to coordinate a purple piping grid with campus expansion is a cost efficient strategy that minimizes disruption on campus while preparing the campus for future adoption of an on-site water reuse and treatment system.

Although there is currently not a favorable business case for a water reuse system, investment should be made in practicing leading sustainable practices that will become the norm in the future. It will be imperative for UBCO to monitor key performance indicators related to water usage and reuse opportunities.

This chapter summarizes existing conditions related to campus water consumption and identifies opportunities to meet the long-term sustainability goal of optimizing water quality and securing water supplies.

Goal

Optimize water quality, supply and security.

The opportunity for implementing best practices for water conservation is significant. Despite doubling the campus building area and population by 2030 compared to today, it is possible for the Campus to use less potable water and realize a net positive impact.

5.1 THE OPPORTUNITY

In review of the existing campus water systems, four key findings were made:

1. **Building Level Water Meters:** Currently, half the campus buildings have water meters, but only nine are connected to a direct digital control (DDC) system. And as such, there is a large opportunity to understand where water is being consumed in order to identify wastage and saving opportunities.
2. **On-site Water Reuse and Capture:** There is no reuse or water capture on campus. There is a large opportunity to save potable water by considering water reuse strategies.
3. **Cost of Water:** The low cost of water has in the past been a barrier to making the business case for water conservation and reuse measures. Future consideration of water scarcity and water cost escalation will be imperative in determining water conservation measures.
4. **Future Water Uncertainty:** Considering the future impacts of climate change and global water shortages, secure water supplies is a very important consideration for the Campus. Investing in best practices for water conservation and reuse would position UBCO as a thought leader in this arena.

5.2 SUMMARY OF EXISTING CONDITIONS

Campus Water Supply

The Glenmore Ellison Improvement District (GEID) supplies water for domestic, irrigation and fire suppression uses. This water enters through four revenue meters and is distributed across campus through a 450 mm pipe network dating 1992 to 2013 (see Figure 45 for campus water distribution layout).

When UBCO expanded in 2005, to address additional fire suppression and pressure capacity requirements, the domestic and fire water mains were connected and additional capacity was built in a water reservoir constructed in 2005/2006 located on the north side of campus. This reservoir has a capacity of 6,000 m^3. A maximum flow of 225 L/s is not to be exceeded for the available storage. There is an additional cell with capacity for 3,000 m^3 for future needs.

Currently, housing is located at the highest elevation of Discovery Avenue and at the elevation limits of the main pressure zone. Future development located above the existing buildings will be challenged to meet the fire suppression requirements, but high pressure mains are present north of campus and it is understood that the opportunity exists to connect.

If the conservation opportunities recommended in this plan are implemented, capacity should not be an issue by 2030. If potable water conservation measures are not implemented, this might trigger a GEID capacity upgrade at UBCO.

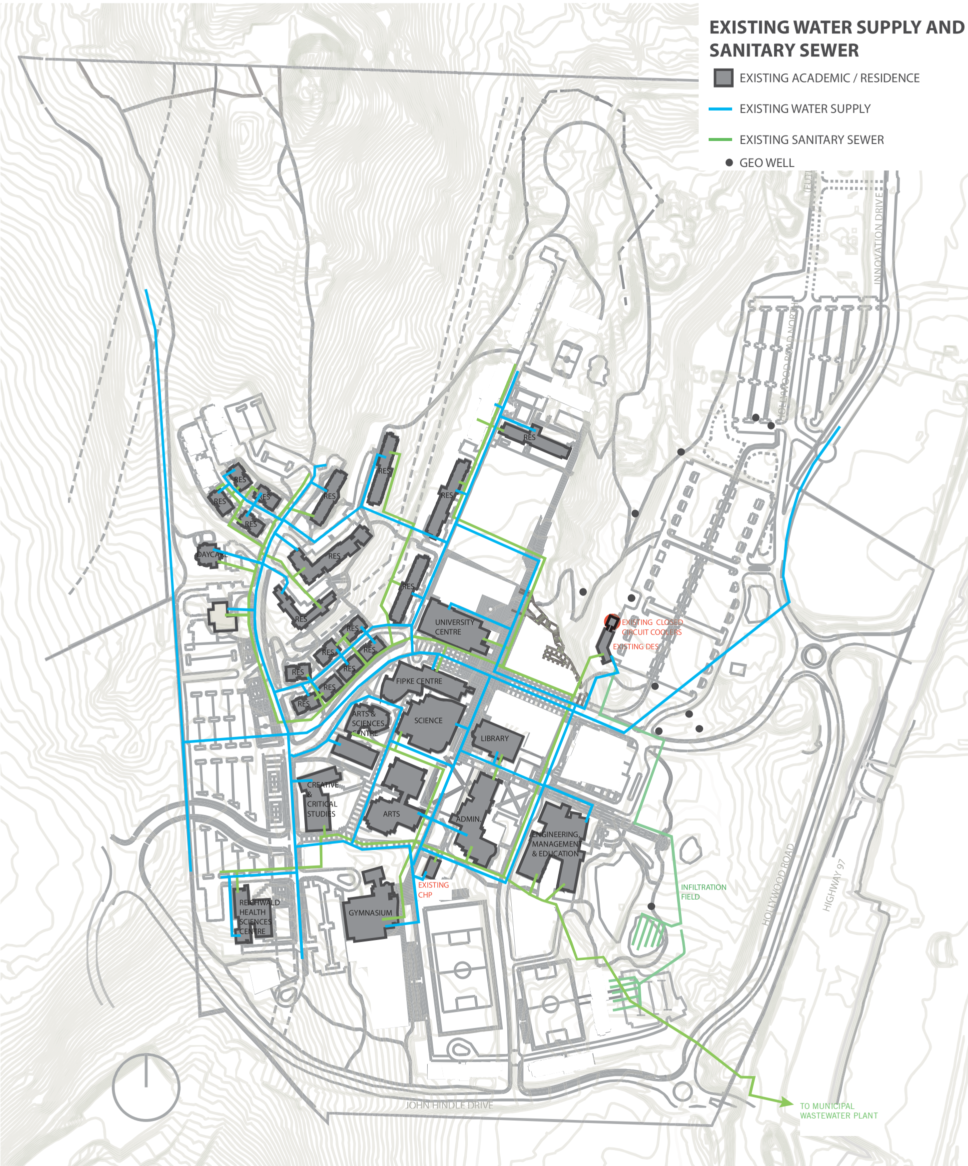

FIGURE 45: CONCEPTUAL LAYOUT OF EXISTING CAMPUS WATER AND SANITARY DISTRIBUTION

Campus Sanitary Distribution

The City of Kelowna provides sewer service to the campus (see Figure 45). The main campus is serviced by sanitary mains, while University House is served by septic tank/field. The Research Park (Curtis Pit) is serviced off Innovation Drive and service connections have been provided to the edge of Innovation Drive right of way. All internal sanitary mains are understood to have been sized and extended to the ends of roads to accommodate future buildings.

There is one sewer meter on campus, which was installed in 2005 (for academic and residential buildings). Current flow range has been measured between 3 to 5 L/s. There is a discharge allowance of 21 L/s for the sanitary sewer. If levels are exceeded, this will trigger the City of Kelowna's requirement to upgrade the trunk main between UBCO and the treatment plant.

Campus Water Consumption

Water consumption, sewage and cost data for the existing campus was provided, analyzed and summarized. The data, used as a baseline, is based on utility data for the period April 2012 to March 2013. This time period was selected as a complete set of data. Table 47 provides a summary of the 2013 campus water performance metrics.

TABLE 47: UBCO WATER PERFORMANCE METRICS (2013)

DESCRIPTION	METRIC	COMMENTS
Campus Water Use Intensity (WUI):	1.3 m^3/m^2/year[1]	Average based on building areas
Campus Water Use Intensity (WUI):	23 l/FTE student/year[2]	Average based on FTE students
Campus Water Consumption[3]:	168,200 m^3 per year	Total Metered
Campus Water Cost[3]:	$30,702 per year	Total Invoice
Campus Sewer Meter[4]:	157,600 m^3 per year	Total Metered
Campus Sewer Cost:	$130,300 per year	Total Invoice

1. Based on total building area of 136,373 m^2
2. Based on student population of 7,439
3. Based on utility data for FY2013, GEID Meter
4. Based on utility data for FY2013, City of Kelowna Meter

Before recommending reduction strategies, it is imperative to understand where and how water is currently being used on campus. As there are a limited number of building level meters or separate metering of irrigation on campus, assumptions (based on industry experience) were made on estimating the end-uses.

Irrigation: 15,700 m^3 per year. Estimate given by UBC Hunter Wireless System for 2011.

Cooling: Cooling tower consumption peak is 100 m^3 per day depending on OAT with a max flow of 1.578 l/s. Total consumption by cooling towers is 7,000 m^3 per year.

Leakage: This study assumes a 13% leakage as confirmed with UBCO.

Occupancy: A split between 50% females and males respectively, with academic and offices being occupied 328 days per year (closed 10% of the year), and residences in use 10 months of the year.

During the course of developing this infrastructure plan, an audit of existing water fixtures in academic and residential buildings was completed by UBCO which enabled the team to include actual building fixture performance data in the

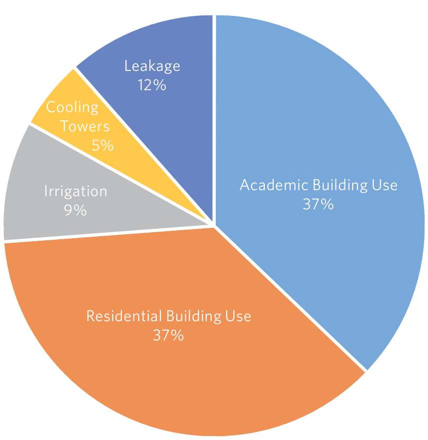

FIGURE 46: CAMPUS POTABLE WATER END-USES (2013 DATA)

analysis. A summary of existing fixtures and flowrates in campus buildings can be found in Appendix K.

The total measured campus water consumption, of 168,200 m^3 per year (2013 data), in combination with the assumptions on end-uses resulted in a breakdown of water uses, which is used as a baseline in this study, see Figure 46 and Table 48.

5.3 MEASURES FOR IMPROVEMENT

The general approach to achieve significant water consumption reductions is based on the following hierarchy of actions:

1. Meter, measure and monitor water consumption on campus;
2. Differentiate between potable and non-potable water demands on campus;
3. Achieve potable water usage reduction through conservation; and
4. Achieve potable water usage reduction through reuse.

Based on these opportunities for conservation and re-use, a number of water conservation measures (WCM) have been evaluated and are recommended to be implemented over time. The following section outlines recommended measures for each action.

TABLE 48: WATER CONSERVATION AND REUSE OPPORTUNITIES

WATER CONSUMPTION	POTABLE USE 2013 (M^3 PER YEAR)	REDUCTION STRATEGY	ANNUAL REDUCTION (M^3 PER YEAR)	ANNUAL REDUCTION (L/FTE/DAY)	REDUCTION OVER 2030 BASELINE (%)
Buildings (academic+ Residences)	124,522	Conservation: PRV Reduction	50,029	8.7	15%
		Conservation: High Efficiency Fixtures	73,942	12.8%	23%
		Reuse: Toilets & Urinals	39,028	6.8	12.3%
Irrigation	15,700	Conservation: Drip Irrigation	4,401	0.77	1.4%
		Reuse	13,205	2.3	4.2%
Cooling Tower	9,125	Reuse	22,079	3.9	6.9%
Leakage	19,415	n/a	n/a	n/a	n/a
Total Conservation			**128,374**	**22.4**	**40.4%**
Total Reuse			**74,314**	**12.9**	**23.4%**
Total Savings			**202,688**	**35.3**	**63.8%**

Water Conservation Measures (WCMs)

Strategies to conserve potable water include adjusting pressure reduction valves, installing high efficiency fixtures, switching to a drip irrigation system, and implementing a campus water reuse system.

Table 48 summarizes the water saving potential through conservation and re-use for the different end-uses. The potential savings compared to the 2030 baseline is 40% reduction due to conservation measures, and 24% reduction due to re-use strategies, resulting in a 64% total potable water reduction potential. These savings account for projected growth in student and faculty population, and are further illustrated in Figure 51 and 52.

The individual WCM measures are described below.

Water Audits and Water Meters

In order to understand where water consumption occurs, identify water wastage, and determine opportunities for savings, it is recommended that water meters are installed for each building and a detailed water audit is completed for the campus. This is imperative in order to ascertain a breakdown between different end-uses on campus. This measure is considered a low hanging fruit and an important action that should be initiated in year 1.

The UBCO Whole Systems Infrastructure Systems and Economic Modelling Report's Appendix E contain capital cost estimates to install water meters in existing buildings on campus. Water meter cost estimates range between $6,600 to $8,600 depending on the buildings.

Water Audits and Water Meters	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

WCM 1—Operating Pressure Reduction (Adjust PRV's)

Current operating pressure setting is between 70 and 80 psi. Adjust building pressure reducing valves (PRVs) to operate at 40 psi for academic buildings and 60 psi for residential buildings to reduce flowrate. A change in operating pressure could result in a potential potable water savings of 15%.

Although this measure will lead to potable water savings, it will need to be coupled with a water behaviour change program to educate student residents about water conservation benefits. A common concern with reductions in water pressure is user complaints regarding low kitchen sink and shower pressure flows. Additionally, based on UBC Point Grey's experience in undertaking such a measure, it will be important to consult the GEID, the local water provider, in case they intend to make similar operating pressure reductions. If so, the savings may not be as great as anticipated.

WCM 1: Operating Pressure Reduction (Adjust PRV's)	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

WCM 2—High Efficiency Fixtures

It is noted that many buildings on campus have already been upgraded to house low flow fixtures. It is recommended to replace all existing standard fixtures and low flow fixtures with high efficiency fixtures. Table 49 provides a summary of flowrates for different types of fixtures and recommended high efficiency fixtures. These fixture performance rates and a policy mandate should be integrated into UBCO's *Design Guidelines* to provide direction for when future building upgrades or new construction projects come online. Upgrading the campus over time to high efficiency fixtures could result in a potential potable water savings of 23%.

TABLE 49: FIXTURE EFFICIENCY DEFINITIONS

DEFINITION	TOILETS	URINALS	FAUCETS		SHOWERS
			LAVATORY	KITCHEN	
Standard	>6.0 lpf	>3.8 lpf	>0.138 l/s	0.138 l/s	>0.14 l/s
Low Flow	6 lpf	1.9 lpf	0.063 l/s	0.095 l/s	0.1 l/s
High Efficiency	4.8[1] / 3.8[2] lpf	0.5 lpf	0.031 l/s	0.063 l/s	0.03 l/s[3]

1. Academic Buildings: 4.8 lpf Dual Flush Flushometer Toilet
2. Residential Buildings: 3.8 lpf High Efficiency Dual Flush Toilet
3. Shower heads providing less than 0.1 l/s may increase duration of usage

WCM 2: High Efficiency Fixtures	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

WCM 3—Switch to Drip Irrigation and Use Non-Potable Water

Continue with efforts to switch to drip irrigation systems as a conservation strategy as well using non-potable water sources for irrigation once an on-site waste water treatment and reuse system is installed on campus (WCM 4). It is noted that UBCO has already started to switch to a drip irrigation system on campus and this effort is encouraged to continue with this approach as the campus grows. The benefit of drip irrigation is to reduce water loss due to evaporation vs. spray systems. Use of treated non-potable water to offset potable irrigation water is a very viable strategy.

The UBCO maintenance staff provided background information on the irrigation system being implemented. An overall 25% water use reduction for switching to drip irrigation and reuse of non-potable water was used for the estimate that results in a total of 5% water savings based on all campus potable water uses.

WCM 3: Switch to Drip Irrigation and use non-potable water	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

WCM 4—Implement Campus Scale Wastewater and Reclaimed Water Treatment System for Reuse

In order to realize deep performance results in potable water conservation and to prepare the campus for anticipated water shortages, it is proposed that a

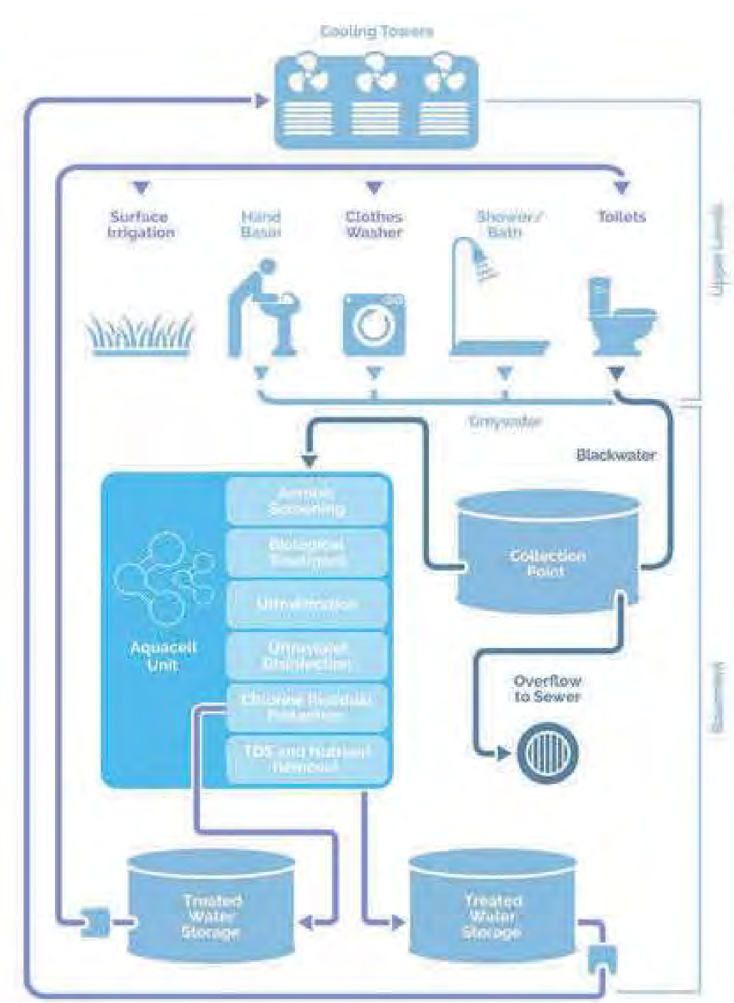

FIGURE 47: EXAMPLE OF WASTEWATER COLLECTION, TREATMENT AND REUSE PROCESS

campus-wide treatment system of grey and blackwater is installed to offset all non-potable water end uses. The proposed system for treatment and reuse would collect all wastewater (grey+blackwater) on campus. Potential non-potable water end use applications include toilet flushing, irrigation for landscape grounds and possibly green roofs, cooling tower make up, possibly some site wash-down and if required, wetland top-up in dry weather (with phosphorus/nitrogen removal to avoid slime). Figure 47 illustrates an example of wastewater collection, treatment and reuse processes.

A recommended treatment system is a Magellan-Wetland Hybrid System (MBBR). This treatment system is a unique configuration of well-proven treatment processes and consists of a primary screening system followed by a multistage moving bed biofilm reactor (MBBR), a secondary clarifier and finally a polishing wetland system. Note, this type of MBBR plant was developed for decentralized (small scale) operations, such as the flows estimated for the UBCO Campus, and is considered a preferred option. It is a good cost-effective system for this scale of plant and has lower operations and maintenance costs as compared to some of the other water reuse technology examples. Therefore, this system was used in the cost analysis for this study.

Options were considered for both the neighbourhood and campus scale. A wastewater and reclaimed water treatment plant sized for 42,000 liters per day (11,000 gallons per day) of reclaimed water production is estimated to meet the non-potable demands for the campus scale system. To use reclaimed water safely from the proposed wastewater and reclaimed water treatment facilities, additional treatment would be required including micro-filtration and chlorine residual protection as part of the overall reclaimed water treatment process.

Savings of 24% could be realized through the use of a MBBR system to offset all non-potable campus water usages.

It is recommended that UBCO complete a detailed economic and feasibility study for implementing a wastewater and reclaimed water treatment facility on campus. This study could further examine costs and trade-offs of implementing a full scale system versus a system sized to provide just reclaimed water needed for campus operations.

WCM 4: Implement Campus Scale wastewater and reclaimed water treatment system for reuse	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

Purple Piping

The non-potable water supply (reclaimed water) must be conveyed in piping systems (pipes, valves and fixtures) that are specially marked to indicate that the water source inside the pipes are non-potable (not safe to drink). Example signs and labels to mark reclaimed water pipes and fixtures such as toilets, urinals and irrigation connections are clearly showing what features use reclaimed (non-potable) water, as per examples in Figure 48.

Buried reclaimed "purple" water pipes must also be labelled to indicate they carry non-potable water, and warning tape is used in reclaimed water pipe trenches to warn that the pipe below carries non-potable water.

The installation of purple piping is recommended to be phased in with the expansions of the CHP and DES piping to put the pipe in the ground even if it will not come online until a later date. It is also recommended that future buildings include purple piping and water reuse connections, making them "future ready". If a treatment plant is not available initially, potable water could be fed through the purple pipe network until the plant is ready.

Section 5.6 Costing Analysis and Appendix E *UBCO Whole Systems Infrastructure Systems and Economic Modeling* report summarizes unit rates for retrofitting existing buildings and constructing new buildings with purple piping, and the capital costs associated with phasing in purple pipe with the DES and CHP expansion.

Potential Location on Campus

A potential location for a wastewater treatment facility has been identified on the new Campus Plan. The suggested location is in the southeast part of campus between the existing ponds and proposed building and play field where the sanitary conveyance line exits. The existing sanitary sewer line may need to be rerouted to reach the location of the wastewater and reclaimed water treatment plant. The potential location of the plant should be evaluated further as part of a detailed feasibility study. Figure 49 shows the potential expansion of the purple pipe network as well as the supply and sanitary distribution network, and that full completion of implementing a wastewater treatment facility would be realized in Phase 3.

Options for treatment systems

The size of treatment plant studied in this infrastructure plan is based on the total campus and the projected aggressive growth. The anticipated total sewage flows and the demand for reclaimed water per day should be analyzed in more detail. An option for a smaller treatment plant or multiple systems could potentially be a viable option should the campus growth differ from assumptions in this *Plan*.

FIGURE 48: SAMPLE SIGNAGE FOR PURPLE PIPING AND NON-POTABLE WATER SUPPLIES.

Buried reclaimed "purple" water pipes must also be labelled to indicate they carry non-potable water, and warning tape is used in reclaimed water pipe trenches to warn that the pipe below carries non-potable water.

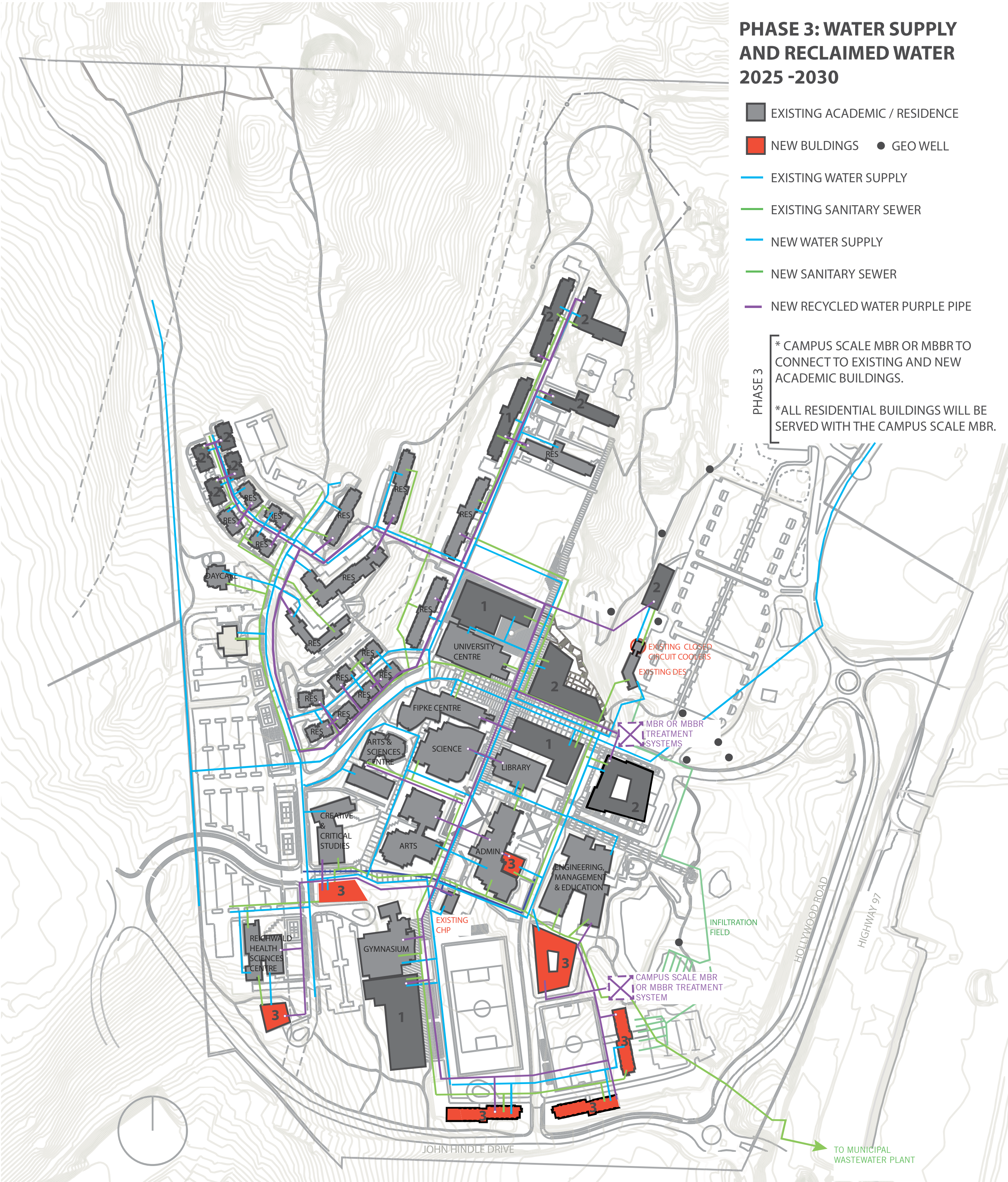

FIGURE 49: CONCEPTUAL LAYOUT OF PURPLE PIPE NETWORK AND LOCATION OF MBBR TREATMENT SYSTEM (PHASE 3).

Other water reuse technology that could be considered in a more detailed feasibility study may include:

- **Membrane Bioreactor (MBR):** Typical MBR treatment facilities for wastewater treatment consists of grit removal, fine screening, and equalization, followed by an anoxic basin, an aeration basin, and a membrane basin.
- **Orenco AdvanTex® System:** This system utilizes a recirculating biological filter that cycles primary treated effluent through textile media filters enclosed in a fiberglass containers.
- **Living Machine® System:** This system introduces the wastewater to a dense, diverse micro-ecosystem contained in a series of cells. The cells fill with water allowing microorganisms to begin consuming the nutrients. Alternating anaerobic and aerobic cycles use nature, including wetland plants, for reuse applications.
- **Constructed Wetland:** Constructed wetlands are engineered systems that use natural functions of vegetation, soil, and organisms to treat wastewater in a low energy manner.

5.4 BENEFITS AND CHALLENGES

In summary there are number of benefits and challenges regarding the water conservation measures and these should inform the overall decision making process as it relates to UBCO's goals to optimize water quality, supply and security (see Table 50).

TABLE 50: BENEFITS AND CHALLENGES—WATER MEASURE

WATER MEASURES	BENEFITS	CHALLENGES
Conduct Water Audit and Install Water Meters	• Easy to implement from a cost and operational standpoint • Identify water consumption usage and wastage on campus • Identify saving opportunities	• Lack of funding to initiate measure
WCM 1: Operating Pressure Reduction (Adjust PRV's)	• Lower water bills • Easy to implement • Very low capital cost • Reduced DHW heating due to lower water use • Water savings of 15%	• Potential user complaints from kitchen sinks and lower shower pressure flows • Consider impact if City of Kelowna or GEID decides to reduce its operating pressure
WCM 2: High Efficiency Fixtures	• Lower water and sewer bills • Can be performed without interrupting water supply • Reduced DHW heating energy due to lower water use • Water savings of 23%	• Capital cost, but phase in and coordinate as building retrofits occur • Residential user complaints.

WATER MEASURES	BENEFITS	CHALLENGES
WCM 3: Switch to Drip Irrigation and use non-potable water	• Lower water bills • Initiative already underway on campus, setting best practice for future campus expansion • Water savings of 1.4%	• Capital cost • Maintenance
WCM 4: Implement Campus Scale MBR treatment system for reuse	• Lower water and sewer bills • Long-term water security • Position UBC campus as thought leaders in water conservation • Ability to phase in purple pipe grid with CHP/DES expansion to save on capital costs • Opportunity to pilot purple piping at a building level to determine increment cost increase • Water savings of 24%	• Capital cost investment • Maintenance

5.5 NEW CONSTRUCTION—MEASURES FOR IMPROVEMENT

It is recommended that UBCO's *Design Guidelines* and project design briefs for new construction projects clearly articulate the aspiration and mandate for new buildings relative to the sustainability targets and long-term vision of water quality, supply and security. New buildings are proposed to follow previously mentioned water conservation measure as they are built:

- Install water meters;
- Modify PRV settings, as per WCM 1;
- Install high efficiency fixtures, as per Table 50 in WCM 2;
- Consider biodiversity strategies for landscaping and use of efficient irrigation systems, as per WCM 3; and
- Plumb buildings with purple pipes (as a pilot starting in Phase 1) to test the incremental cost and to make the campus ready to connect with an on-site wastewater treatment and reuse system, as per WCM 4, when it is economically viable.

As noted in the energy chapter, two residential buildings are due for mid-life upgrades and others will follow. It is recommended that the UBCO *Design Guidelines* be updated to reflect water conservation best practices for New Construction, building upgrades and major retrofits.

Campus Water Consumption Projections with Growth

Figures 50,51 and 52 show the projected water consumption and sewage generation on campus and savings associated with existing building upgrades and water efficient new developments as campus grows compared to a Business As Usual (BAU) case.

Business As Usual Case Definition

The Business As Usual (BAU) case includes the following assumptions in addition to the overall project assumptions outlined in Part 2, Approach + Methodology:

- Existing campus buildings: included and based on today's performance—no water conservation upgrades done (BAU existing buildings)
- New construction building: Today's PRV rate of 70-80 psi and low flow fixtures
- Existing and New Construction buildings: sewage to City main
- Standard spray irrigation
- No reuse system on-site

Figure 50 and 51 show the phasing of the recommended water conservation measures, milestone savings and sewage reduction between now and 2030, while accounting for projected growth. Through implementation of multi-pronged approach, UBCO could realize the following milestone targets:

- by 2020 achieve 29% water use reduction as compared to BAU;
- by 2025 achieve 40% water use reduction as compared to BAU; and
- by 2030 achieve 64% water use reduction as compared to BAU.

Figure 50 summarizes the potable water reduction potential through the suggested WCMs compared to the 2030 baseline consumption. Note that this is taking student and faculty population growth into account, as such the overall savings are 64% compared to the BAU case.

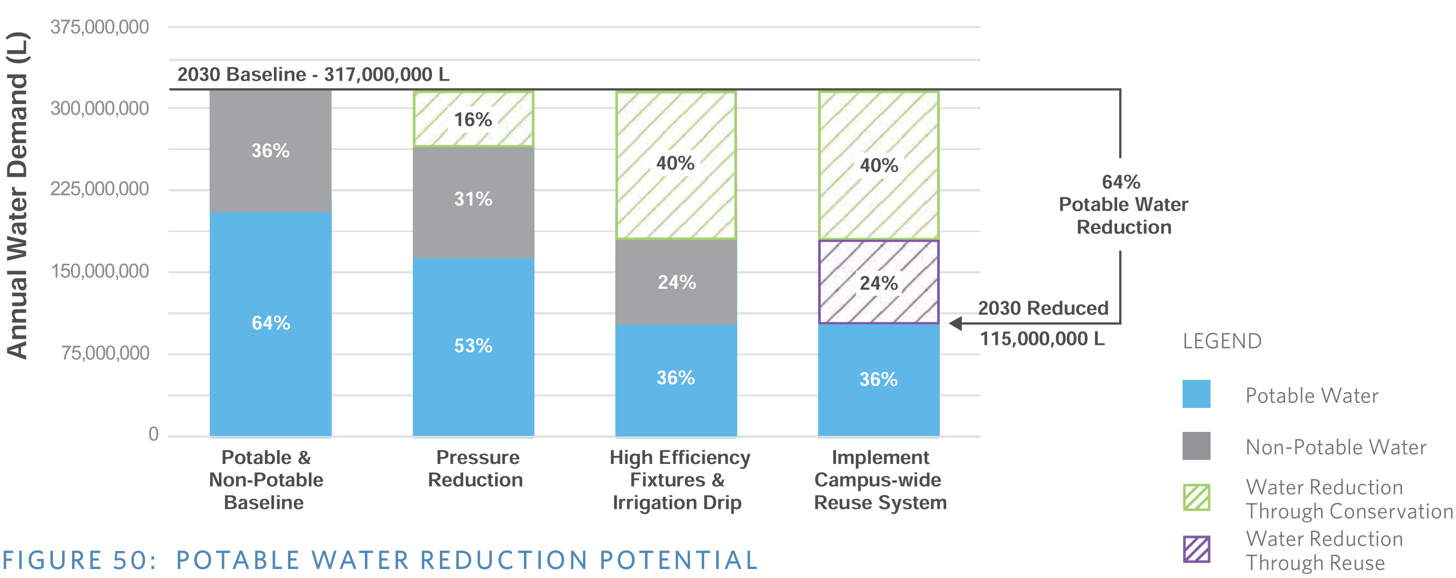

FIGURE 50: POTABLE WATER REDUCTION POTENTIAL

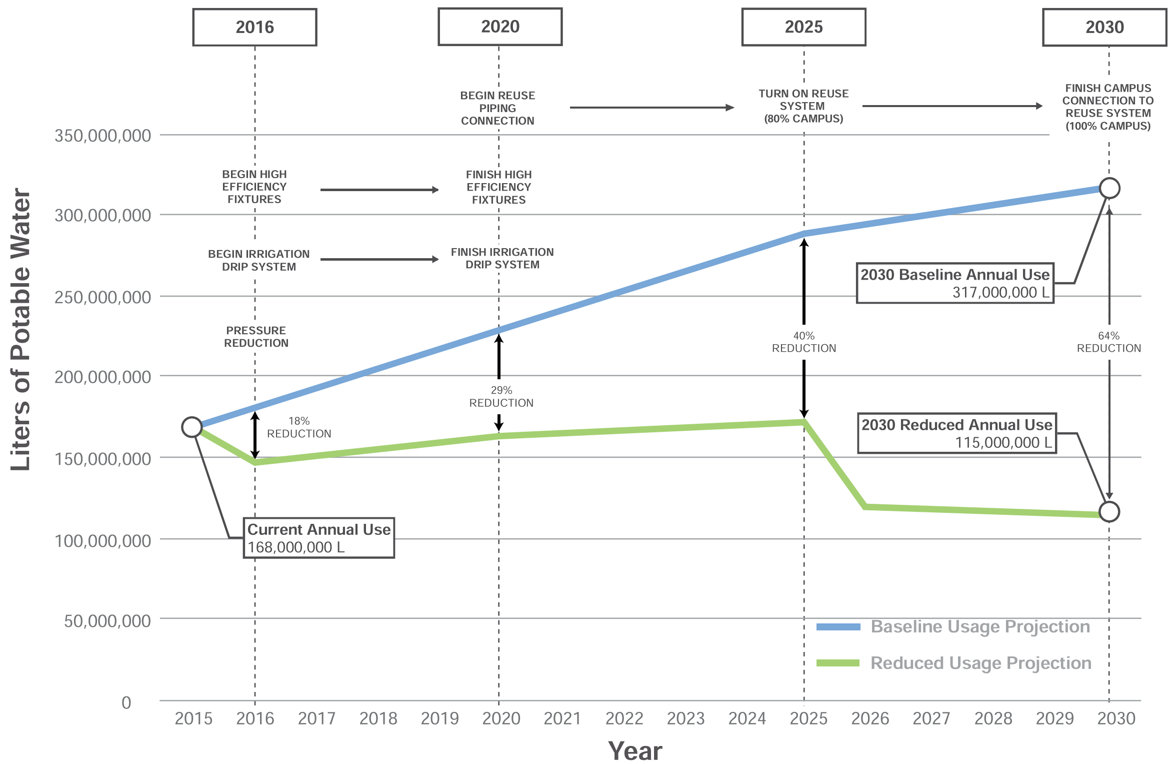

FIGURE 51: PROJECTED POTABLE WATER CONSUMPTION WITH GROWTH AND REDUCTION POTENTIAL COMPARED TO BAU

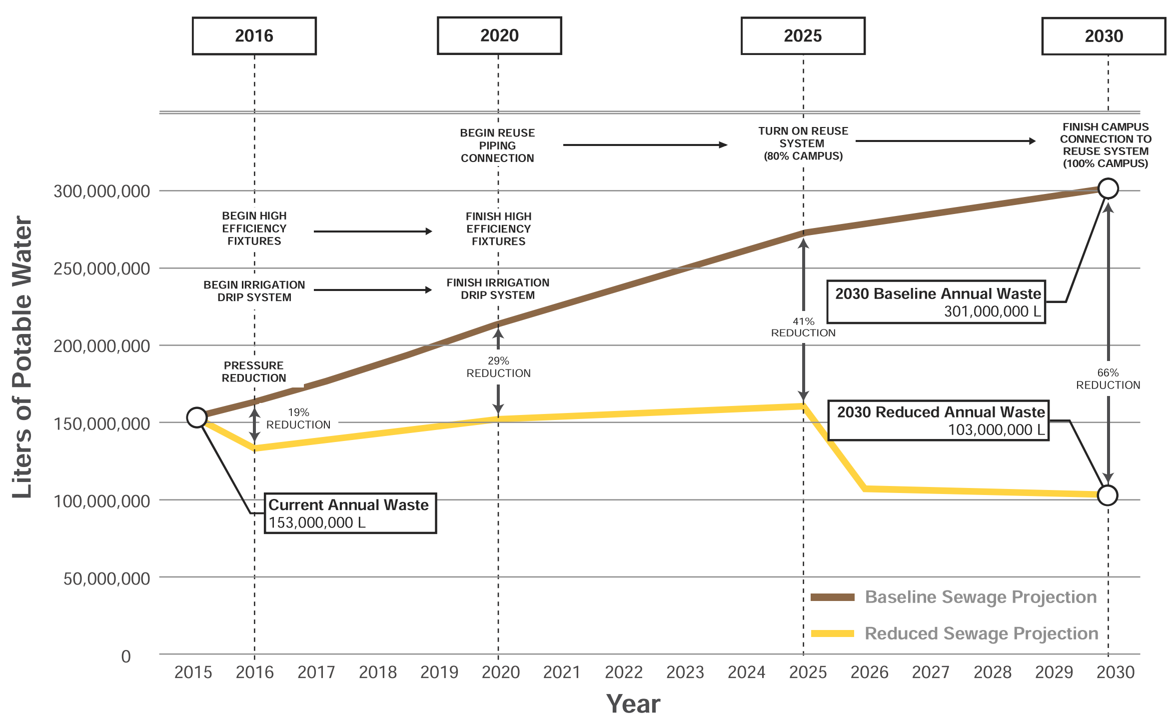

FIGURE 52: PROJECTED SEWAGE GENERATION WITH GROWTH AND REDUCTION POTENTIAL COMPARED TO BAU

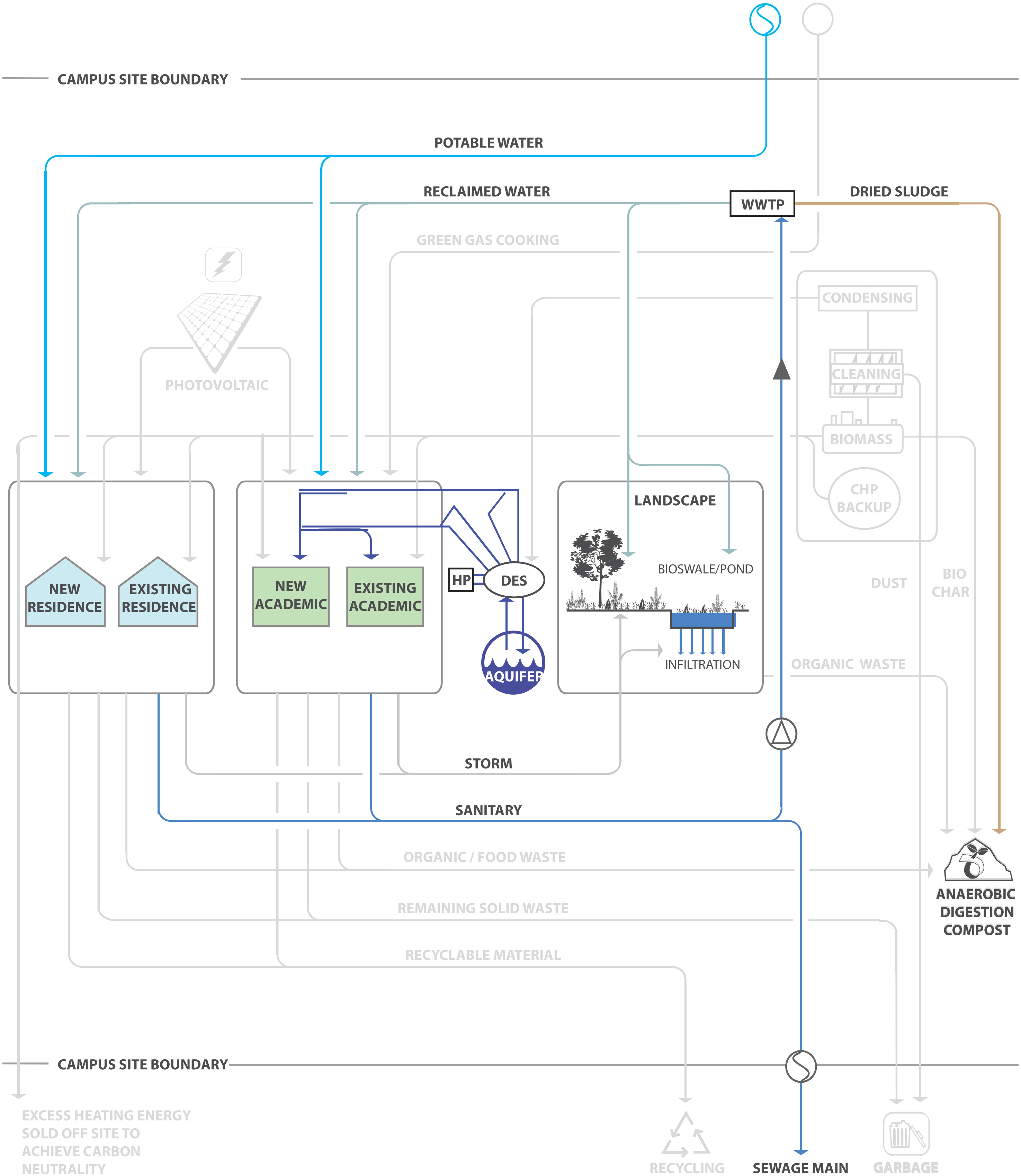

FIGURE 53: WATER SYSTEMS MAP

Figure 53 illustrates the potable and sanitary systems on campus, and the possibility of introducing a wastewater treatment plant (WWTP) to provide reclaimed water to service academic and residential buildings, and landscape irrigation. The systems maps shows the interactions between water, waste, stormwater and landscape systems, and the future potential of managing these resource flows on campus (i.e., diverting sewage sludge to anaerobic digestion compost system).

Performance Metrics

Table 51 summarizes the milestone metrics possible based on the measures implemented over time to 2030.

TABLE 51: UBCO WATER PERFORMANCE METRICS BY 2030

METRIC		CURRENT PRACTICE	2030 BUSINESS AS USUAL	2030 PROPOSED MEASURES	REDUCTION (COMPARED TO CURRENT)	REDUCTION (COMPARED TO 2030 BAU)
Campus Water Use Intensity (WUI)	m^3/m^2/year	1.3	1.1	0.4	68%	64%
	l/FTE student/year	23	20	7	68%	64%

5.6 COSTING ANALYSIS

The following summarizes the costing analysis for the WCMs on an individual basis. It should be noted that the savings from WCM 1 to WCM 4 are incremental as they get implemented over time. Details on the costing analysis, capital cost outlines, detailed assumptions, and cash flow analysis can be found in Appendix E *UBCO Whole Systems Infrastructure Systems and Economic Modelling* report.

Cost estimates and unit rates for retrofitting existing buildings are listed in Appendix E, along with a unit rate for installing purple piping as part of new construction projects:

- Purple piping for building retrofits $196/lm
- Purple piping for new construction $146/lm

In addition, the capital costs associated with installing a purple pipe distribution network as part of the CHP and DES expansion, and connecting residential and academic buildings to the grid is summarized below and included in Appendix E:

- Distribution of purple piping (sharing DES/CHP tunnel) $1,378/lm
- New recycled water pipe HDPE 6" to connect residential and academic buildings $1,740/lm

Table 52 summarizes the capital costs anticipated per phase and the estimated savings for the water conservation measures.

TABLE 52: CAPITAL COST SUMMARY AND ESTIMATED SAVINGS FOR WATER CONSERVATION MEASURES

CAPITAL COST		PHASE 1 2015-2020	PHASE 2 2020-2025	PHASE 3 2025-2030	SUB-TOTAL UP TO 2030	2030-2065	TOTAL	SIMPLE PAYBACK (YEARS)	DISCOUNTED PAYBACK (YEARS)	NPC TO 2030 $
WCM1	Operating Pressure Reduction	$0	$0	$0	$0	$0	$0	1	1	(476,900)
WCM2	Water Efficient Fixtures	$1,778,900	$0	$0	$1,778,900	$0	$1,778,900	19	45	881,400
WCM3	Irrigation	$1,116,300	$0	$0	$1,116,300	$0	$1,116,300	37	After 50 years	901,100
WCM4	Greywater/ Blackwater Systems	$140,700	$12,671,200	$2,886,300	$15,698,200	$0	$15,696,200	After 50 years	After 50 years	9,487,400
Total Capital Cost		**$3,035,900**	**$12,671,200**	**$2,886,300**	**$18,593,400**	**$0**	**$18,593,400**			

SAVINGS (ESCALATED $)		PHASE 1 2015-2020	PHASE 2 2020-2025	PHASE 3 2025-2030	SUB-TOTAL UP TO 2030	2030-2065	TOTAL
WCM1	Operating Pressure Reduction	($237,100)	($232,300)	($269,300)	($738,700)	$0	($738,700)
WCM2	Water Efficient Fixtures	($438,900)	($437,600)	($503,300)	($1,379,800)	($6,823,500)	($8,203,300)
WCM3	Irrigation	($107,000)	($104,800)	($121,500)	($333,300)	($1,604,400)	($1,937,700)
WCM4	Greywater/ Blackwater Systems	$0		($273,000)	($273,000)	($3,603,800)	($3,876,800)
Total Savings (Future Values)		**($783,000)**	**($774,700)**	**($1,167,100)**	**($2,724,800)**	**($12,031,700)**	**($14,828,000)**
Savings NPC		**($676.400)**	**($486,000)**	**($547,300)**	**($1,709,700)**		

Note: Ongoing maintenance (FM) savings excluded

Sensitivity analysis has been completed for WCMs 2, and 3. It has not been prepared for WCM 1 as no capital cost was included for this measure. Similarly, WCM 4 showed payback beyond 50 years which is the maximum timeframe considered in this analysis and as such a sensitivity analysis on this measure was not possible.

The sensitivity analysis shows that the payback can be significantly reduced only if a very high water price escalation of 15% to 20% occurs:

- For WCM 2, this would reduce the simple payback from 19 years to 13 years with a 20% escalation.
- For WCM 3, this would reduce the simple payback from 36 years to 26 years with a 10% escalation and 18 years with a 20% escalation .

An on-site wastewater and reclaimed water treatment system will require a significant capital investment as highlighted above. Consideration should be given to future savings realized from the implementation of WCMs 1-3, totaling approximately $2.5 million, and the opportunity to use these savings to fund either a water reuse system sized to provide reclaimed water or a campus scale waste water treatment system when the business case for it becomes more viable.

Given the effects of climate change are already being felt in the region, a long-term perspective should be taken when considering this measure. An on-site water reuse system will make the campus more resilient to regional water shortages and possible escalation of water rates. It will also provide water security for campus day-to-day operations and a water secure source for fire suppression.

Evaluation Criteria

Based on the four evaluation criteria established for the project, the water conservation measures studied are supportive or highly supportive of:

1. Contributing to meeting the following whole systems infrastructure study goals by 2050;
2. Minimizing life cycle costs;
3. Being relatively easy to implement and maintain; and
4. Contributing to the long-term adaptability and resiliency of the campus.

These measures are further prioritized below in terms of when they should be implemented. As discussed above, certain WCM measures are easily implemented and can result in immediate water savings, whereas the water reuse system is a long-term strategy with higher capital cost investment that would help position UBCO in securing future water supplies. A summary of the evaluation is presented in Figure 54 Evaluation of Water Conservation Measures Evaluation and a detailed summary is provided in Appendix F.

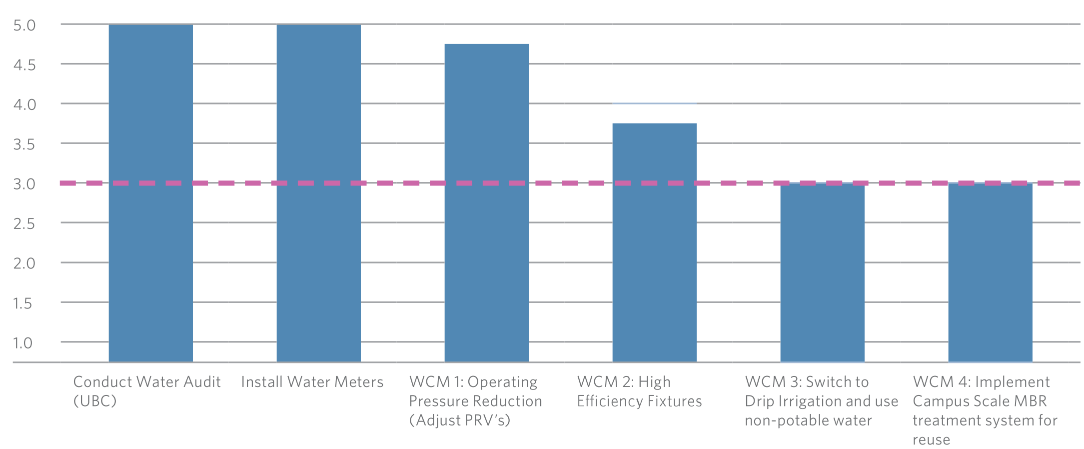

FIGURE 54: EVALUATION OF WATER CONSERVATION MEASURES

5.7 IMPLEMENTATION PLAN

A bold shift and commitment by UBCO is required to take a regional leadership position in implementing water conservation, on-site wastewater and reuse best practices that are necessary for preparing the campus for anticipated long-term water shortages in the Okanagan region. This leadership position will require taking a long-term vision to overcome near-term financial obstacles for the proposed water conservation and reuse plan. UBC's newly formed Energy and Water Services Advisory Board will support UBCO leadership and will play an important role in peer reviewing the technical and financial feasibility of proposed large scale infrastructure projects, such as, an on-site wastewater treatment and reuse system.

A multi-pronged approach should be undertaken for implementing water conservation measures at UBCO:

1. Implement low hanging fruit measures to establish a strong baseline, identify wastage, and result in some immediate potable water savings;
2. Update and adopt new policies and guidelines that mandate adoption of water conservation and reuse best practices for all building retrofits and new construction; and
3. Adopt future-oriented measures overtime, thereby making the campus more resilient to future water shortages.

Table 53 summarizes the recommended actions that can be implemented within the first five years, those that can be piloted and evaluated or considered as part of cyclical maintenance programs, and those measures that will require long-term planning.

TABLE 53: IMPLEMENTATION PLAN FOR WATER CONSERVATION MEASURES

Water Conservation Measures	<5 Years	5-10 Years	10-20 Years
Low Hanging Fruit Actions			
Establish campus wide monitoring strategy and water metering program (for each building, cooling and irrigation) to develop an accurate water use baseline for campus operations through the implementation of a water audit program and installation of water meters in all existing and new buildings.	⊙		
Engage summer student to assist with establishing baseline water performance and audit of buildings	⊙		
Develop a long-term water management plan for the campus that establishes a policy for auditing, monitoring and tracking overall water performance, and for overcoming short-term focus on capital cost vs. long-term imperative to plan for water shortages.	⊙		
Develop a campus wide Behaviour Change and Engagement Strategy to promote and support campus resource conservation and DSM strategies required for the whole systems plan implementation.	⊙	⊙	⊙
Update UBCO's *Design Guidelines*, *Technical Guidelines*, and *UBC LEED v4 Implementation Guide* for expected water performance of new construction and existing building upgrades	⊙		
Update Project Design Brief for new capital project to include performance requirements to install high efficiency fixtures, adjust PRVs, for landscaping use LID and high efficiency irrigation, make purple pipe ready	⊙		

Water Conservation Measures	<5 Years	5-10 Years	10-20 Years
WCM 1—Operating Pressure Reduction (Adjust PRV's)			
Lower academic buildings pressures to 40 psi and Residence buildings to 60 psi (could be completed in a single year; or less)	●		
WCM 2—High Efficiency Fixtures			
Begin water efficient fixture replacement program of buildings as building upgrades are due (i.e., Monashee, Similkameen)	●		
Complete water efficient fixture replacement program for existing buildings		●	
WCM 3—Switch to Drip Irrigation and use non-potable water			
Continue to phase in planned drip irrigation program (FM 5-year. plan); include recommendation for Xeriscaping in landscape vision document.	●		
Complete drip irrigation program		●	
WCM 4—Implement Campus Scale MBR treatment system for reuse			
Pilot purple pipe installation in a new construction and a retrofit project on campus to determine the incremental cost and viability of preparing the campus for an on-site water treatment facility	●		
Phase in purple pipe distribution as DES and CHP expansion occurs on campus in order to minimize site disturbance, maximize construction cost efficiency of infrastructure.	●	●	
Monitor the key performance indicators for broader adoption of purple pipe ready buildings and campus wide infrastructure.		●	
As business case becomes more viable, phase in an on-site water reuse system.			●
Complete a detailed feasibility study for campus reuse system integration (WCM 4)	●		