RAPID RADICALS

IB TUG POJNIAM NYOB HAUV MILWAUKEE

THIAB NWS PAB NEEG TSIM TAU IB TXOJKEV LOS LIM DEJ SAI HEEV LI



TUS SUAM DUAB:
SARAH GAIL LUTHER

TUS SAU:
MICHAEL ALAN TIMM

Rapid Radicals

Ib tug pojniam nyob hauv
Milwaukee thiab nws pab neeg tsim
tau ib txojkev los lim dej sai heev li

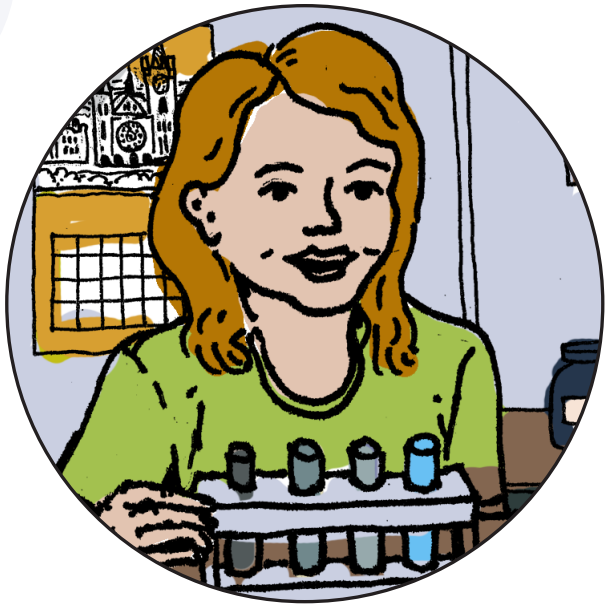
TUS SAU: MICHAEL ALAN TIMM

TUS SUAM DUAB: SARAH GAIL LUTHER

TXHAIS LOS NTAWM:
NATHAN HERR
CANDIE HERR

2024

Yog peb siv tau
Rapid Radicals los
lim cov dej
quav ua ntej peb tso
tawm mus rau tej
pab dej loj, nws ho
yuav zoo li cas?



Dr. Paige E. Peters

Rapid Radicals
Founder
Chief Technical Officer
&
Majority Owner

--Milwaukee, December 2024

Nyob zoo, Kuv lub npe hu ua Paige!

Kuv yog ib tug engineer nyob hauv Milwaukee, WI {Kuv yog ib tug tibneeg tiag tiag, tiamsis daim duab no los kuj zoo kawg}.

Kuv lub homphiaj yog los pab kom lub ntiajteb no muaj dej ntshiab siv. Thaum kuv tseem yau, kuv yeej tsis xav hais tias kuv yuav los tsim ib lub company. Tiamsis kuv kawm tau ntau yam tshaj li kuv xav.

Kuv tau kawm science thiab engineering. Science pab peb tsim tau ntau yam los pab tibneeg. Science ua rau kuv muaj lub tswvyim los tsim qhov technology no los pab lim dej.

Peb ntshaw kom tau ib txojkev tshiab los pab lim tej dej quav kom txhob ntws tawm mus

Kuv thiab kuv pab neeg muab lub company no hu ua Rapid Radicals. Peb tsim lub company no los pab lub ntiajteb. Peb pab neeg no zoo heev li.

Peb zaj lus no tsis tau tag. Thiab kuv tsis paub hais tias nws yuav xaus li cas, tiamsis nws pib los ntawm ib yam uas tsaus ntuj nti thiab kob nag ua loj heev.

MILWAUKEE, LUB 7 HLI, XYOO 2010

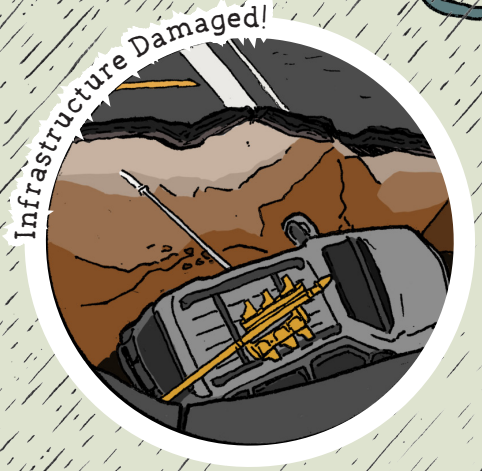
Kob Nag Los Tsuas peb lub zos

Lub 7 hlis, xyoo 2010, muaj ib kob nag loj heev los raug peb lub zos.

Tagnrho yog tshaj li 6 inches ntawm ib feeb. Deb nyab txhua lub qhov dej thiab txhua tus kwj deg.

Dej ntws rov los nyab tibneeg tej vajtsev tibsi thiab ua rau lawv poob nyiaj txiag txog laab los kho.









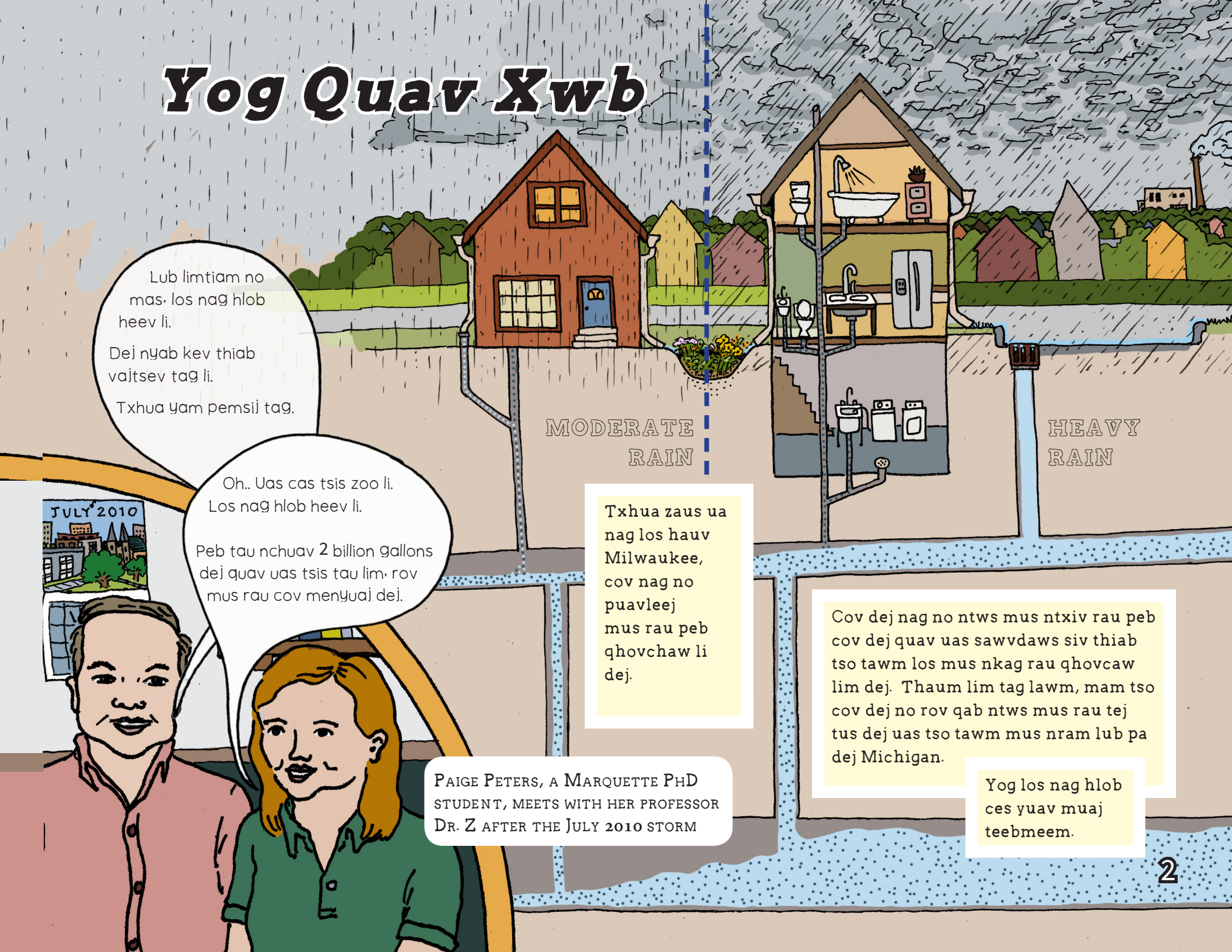
MILWAUKEE RIVER

LAKE MICHIGAN

MENOMONEE RIVER

KINNICKINNIC RIVER

Yog Quav Xwb



Paige Peters, a Marquette PhD student, meets with her professor Dr. Z after the July 2010 storm

Nyob hauv chav lim dej quav

COMBINED SEWER AREA

SEPARATED SEWER AREA

OVERFLOW PIPES

STORM SEWER PIPES

RIVERS

DEEP TUNNEL

Av nqus cov dej nkag los mus rau Jones Island.

Thaum los nag hlob los yog te yaj, dej nkag los rau hauv qhov chaw lim dej ceev heev. Yuav kom dej txhob nyab vajtse, yuav tsum tso dej tawm ntws mus rau hauv pub pa dej Michigan.

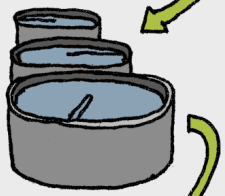
Thaum dej nyab thiab ntau tshaj li tej kav dej thiab qhovchaw lim dej ntim tau, yuav tau tav thiab cug mus rau ib lub dab dej txais. Thaum qhovchaw lim dej muaj chaw, mam rov nqus cov dej no mus lim.

Txij thaum li 1920 los, Kev lim dej raws li no puavleej ua tau haujlwm zoo.

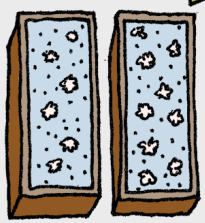
MILWAUKEE CHAV LIM DEJ



Tshaus tej thooj tawm



Cia cov Thooj me tog



Cia cob kab los noj quav

Tom qab ntawd dej yog tshuaj tua kab mob thiab tso tawm mus rau Lake Michigan.

Tig Los Saib kom Meej

Koj tso dej viv...

Cov dej viv no nkag mus koom nrog cov dej nag uas los saum ru tsev, tej kev thiab av ntws tibsis mus rau qhovchaw lim dej.

Los nag hauv zos...

Qhovchaw lim dej yeej zoo heev, tiamsis thaum nag los hlob, nws tauv tsis tag.

Paige Peters

Cov vaj uas teev dej thiab qhov dej pab cug kom dej tsis txhob los nyab ze zos.

Txawm yog muaj tej qhov dej thiab vaj teev dej los tseem muaj ntau zaug uas dej los nyab zej zos thiab. Yog thaum twg los nag hlob ces dej tseem tauv thiab nyab tau vajtse. Peb yuav tsum tav kom tau cov dej no.

Thaum los nag hlob, thiab huabcua hloov, yuav tsum muaj kev los tav tau cov dej.

Ua li cas peb los txog qhov no?

Potawatomi, Ojibwe, Odawa (Ottawa), Fox, Ho-Chunk, Menominee, Sauk, and Oneida peoples call this area "Good Earth" or "The Gathering Place by the Waters" for generations.

Tig Rov Saib Qab

1833

Treaty of Chicago -ua rau cov qhab rhais chaw.



1846

City of Milwaukee tsim los ntawm Juneautown, Kilbourntown and Walker's Point.



1869 - 1893

Milwaukee los tsim cov chaw lim dej thiab xa dej mus rau Lake Michigan.



1874

Milwaukee nqus dej tawm hauv lub pas dej Michigan los rau pejxeem siv.



1888

Milwaukee's E.P. Allis Co. Los ua ciav dej [mile) tso dej hauv Milwaukee River mus rau nram lub pasdej Michigan.



MKE Water Innovation

Peb Yuav Mus Qhovtwg Rau Yav Tom Ntej?

Peb yeej mus deb heev li lawm hais txog kev lim dej txij thaum xyoo 1920's. Milorganite muaj dej quav los ua chiv siv. Tej qhov dej no yeej zoo heev tiamsis puas muaj lwm txojkev ua zoo dua?

Paige Peters

1914

Milwaukee tau tsim muaj kev lim dej quav (Jones Island) kom raws li European methods.



1925 - 1926

Qhovchaw lim dej nyob Jones Island lim 85 million gallons of dej quav txhua hnub. Qhov no tsim tau cov chiv Milorganite los muag.



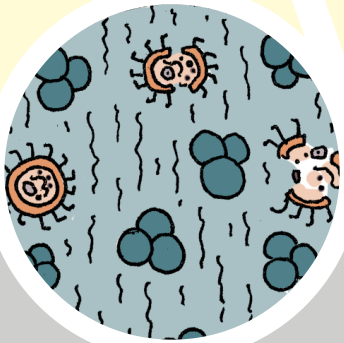
1939

Qhib qhovchaw lim dej (Linnwood Treatment) los pab nqus dej tawm hauv lub pas dej Michigan los lim haus.



1994

Thaum cov kabmob Crytosporidium outbreak of 1993, Milwaukee Water Works tau los tsim ozone treatment los pab lim dej kom huvsi thiaj haus tau.

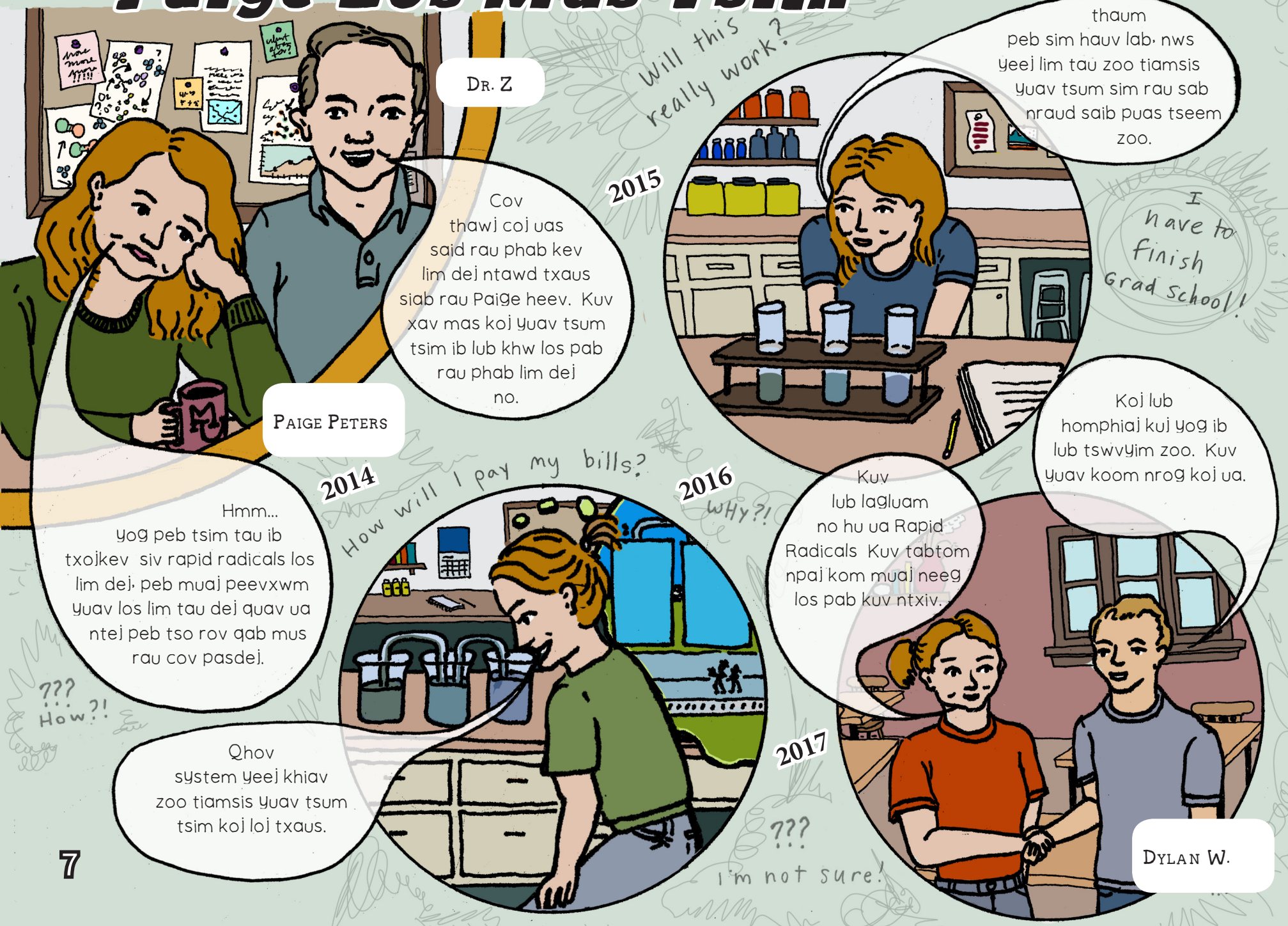


1993-2010

MMSD tau khawb ib cov qhov tob thiab pab kom dej tsis txhob nyab tau lawm. Cov qhov dej no cug tau 521 million gallons.



Paige Los Mus Tsim



Coj Neeg Los sis Pab



2018

Cia peb los sis tham: nyob tod MMSD, peb xav nrhiav kev los daws cov teebmeem uas dej nyab thiab?

The Water Council's BREW accelerator xav los pab koj pib koj lub khw thiab?

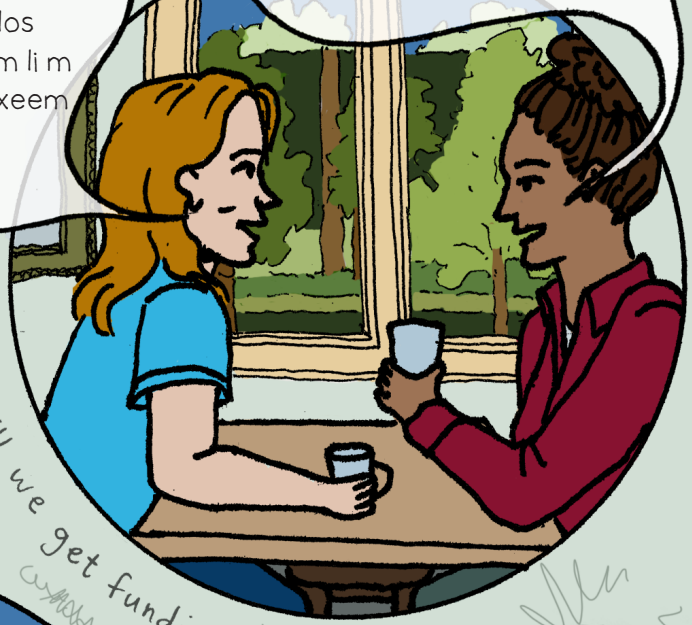
Marquette University xav los koom tes pab koj thiab.

Peb muaj ib lub tswvyim loj thiab zoo heev tiamsis peb xav tau tswvyim thiab kev koom tes ntxiv. Cov neeg txawjntse ntuas kom kuv nug saib peb cov pejxeem ntshaw dabtsi thiab xav tau kev pab dabtsi?

2019

Muaj ntau yam uas yuav tau kawm thiab coj los uas kom lub lagluam li m dej no pab tau pejxeem sawvdaws.

Koj pab tau pejxeem dabtsi los yog, koj tshem tau pejxeem tej kev nyuaj siab dabtsi?



A PANDEMIC?!?!

How will we get funding?

???

2020

Will it be too expensive?!



Wow. Twb yog xyoo 2022. Peb npaj txhij lawm yuav los sim Rapid Radicals hauv ib lub shipping container nyob rau MMSD's South Shore Wastewater Treatment Plant.

Tsw dabtsi?

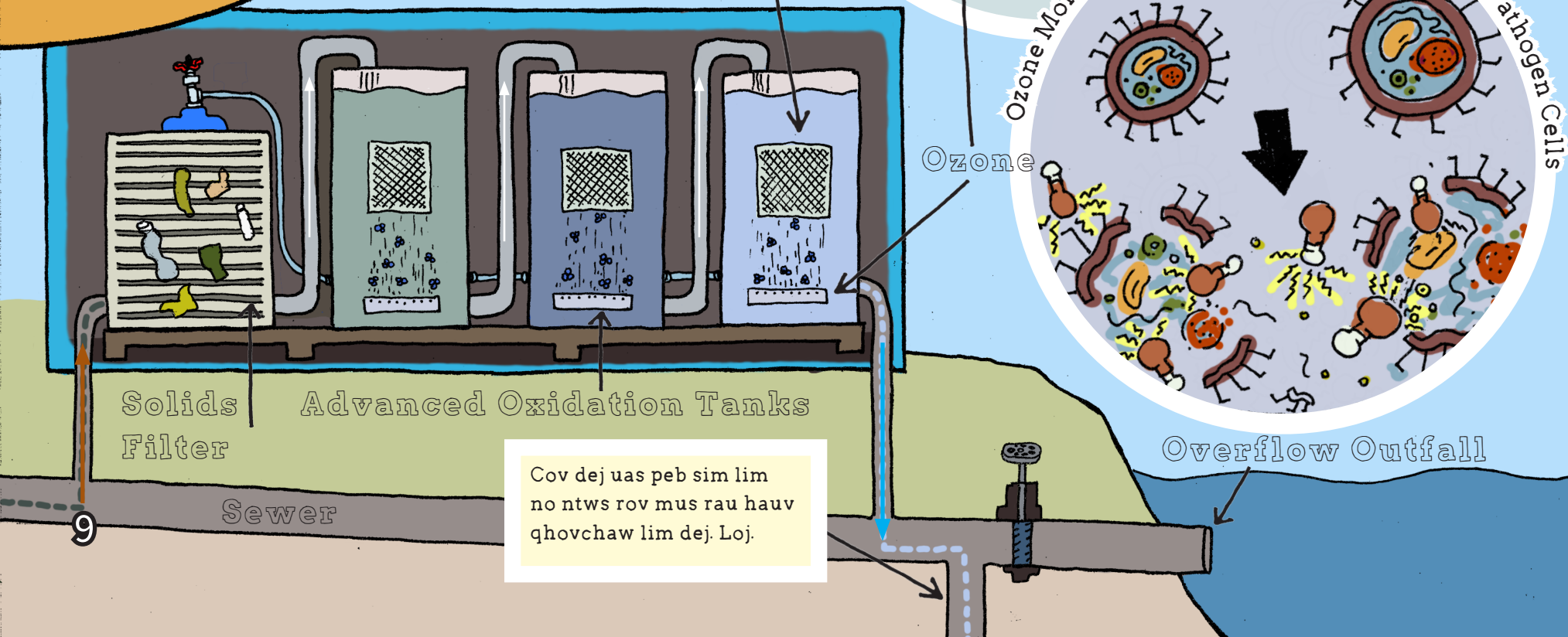
Sim Qhov Project



Peb npaj tau ntau xyoo lawm, txog sijhawm los mus sim thiab siv. Peb coj los sim rau hauv ib lub shipping container tod MMSD's South Shore Wastewater Treatment Plant!

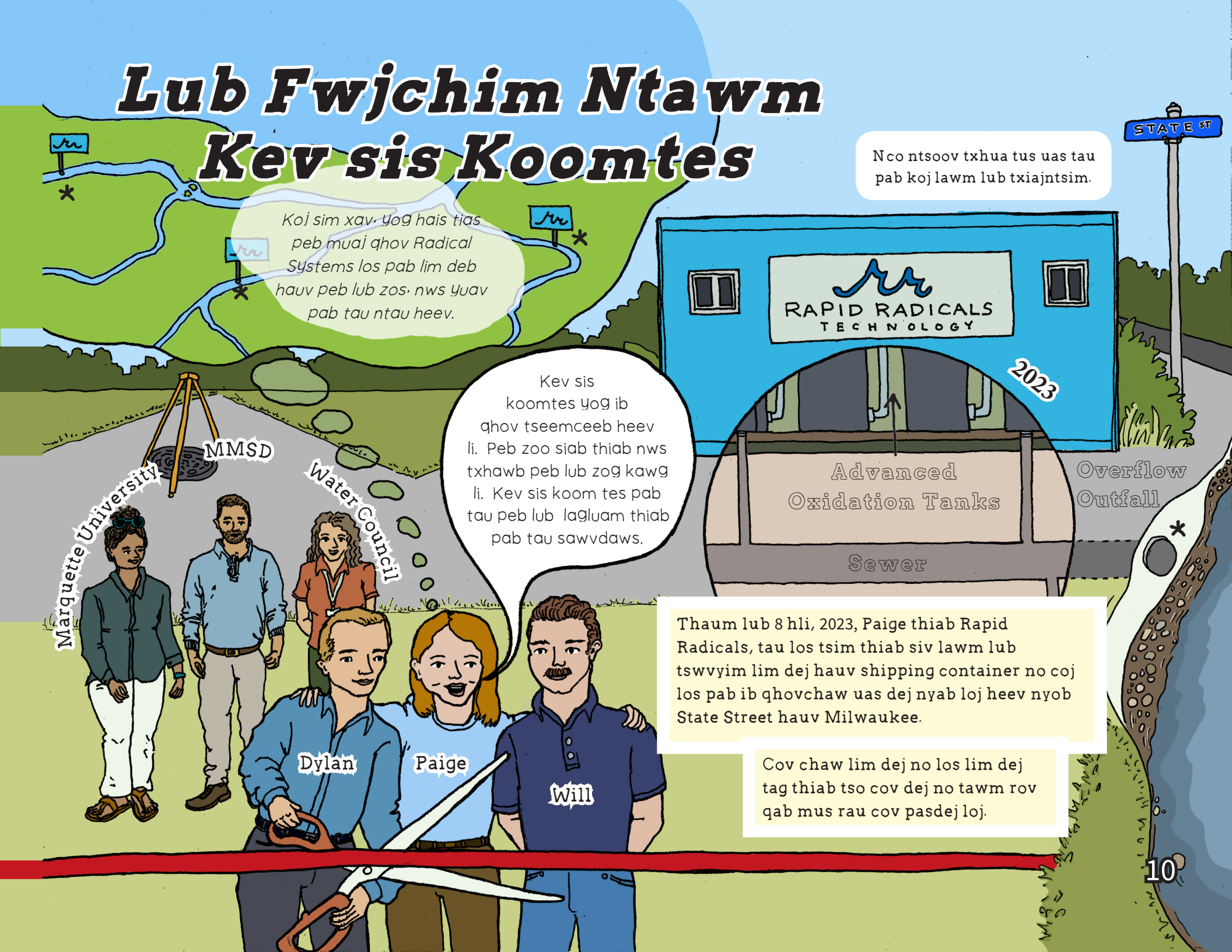
Nws ua haujlwm li no: Peb tso ozone rau hauv cov thoob thiab siv catalyst los ua radical formation.

Xyoo 2022, Rapid Radicals los sim thiab siv cov shipping container nyob tod MMSD's Southshore Wastewater Treatment Plant.



Cov dej uas peb sim lim no ntws rov mus rau hauv qhovchaw lim dej. Loj.

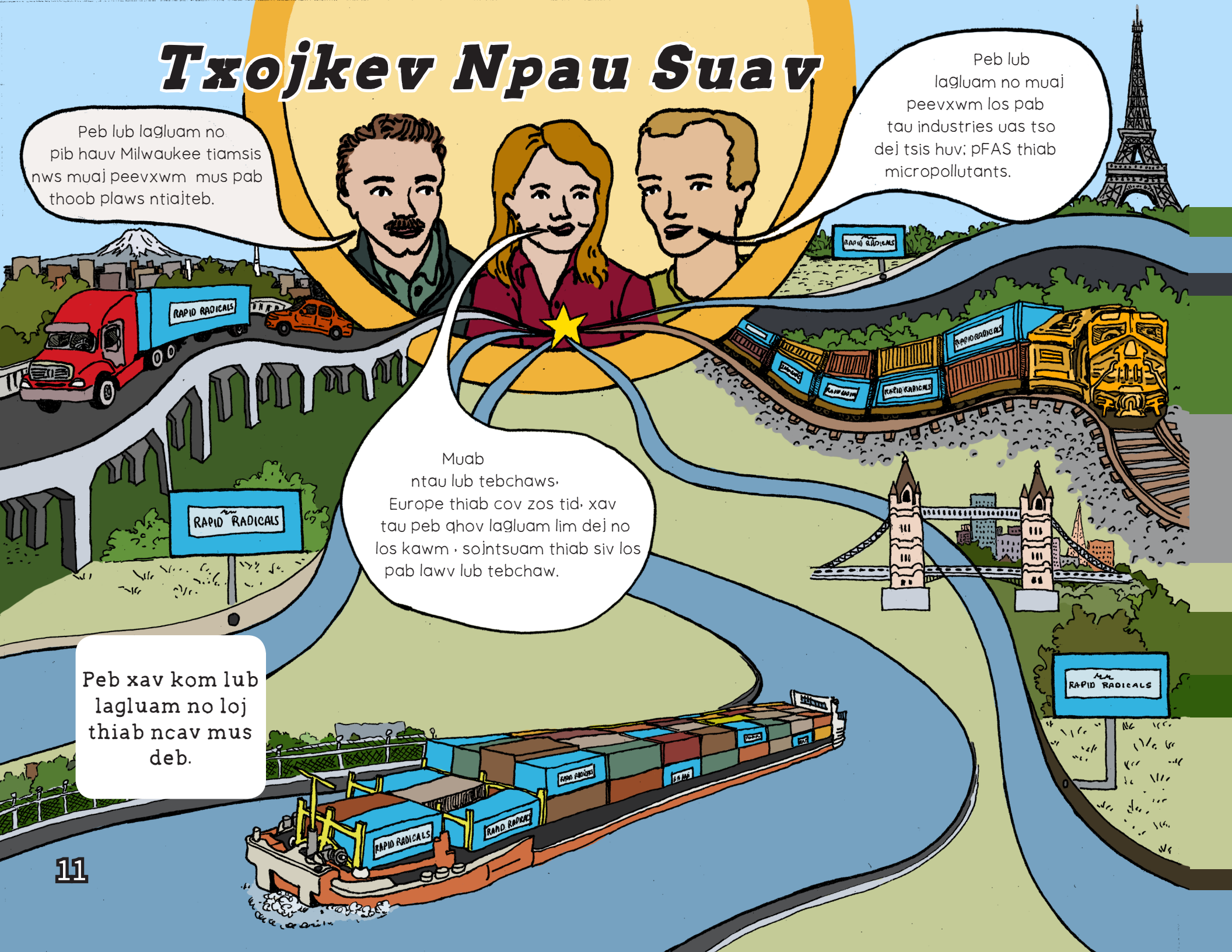
Lub Fwjchim Ntawm Kev sis Koomtes



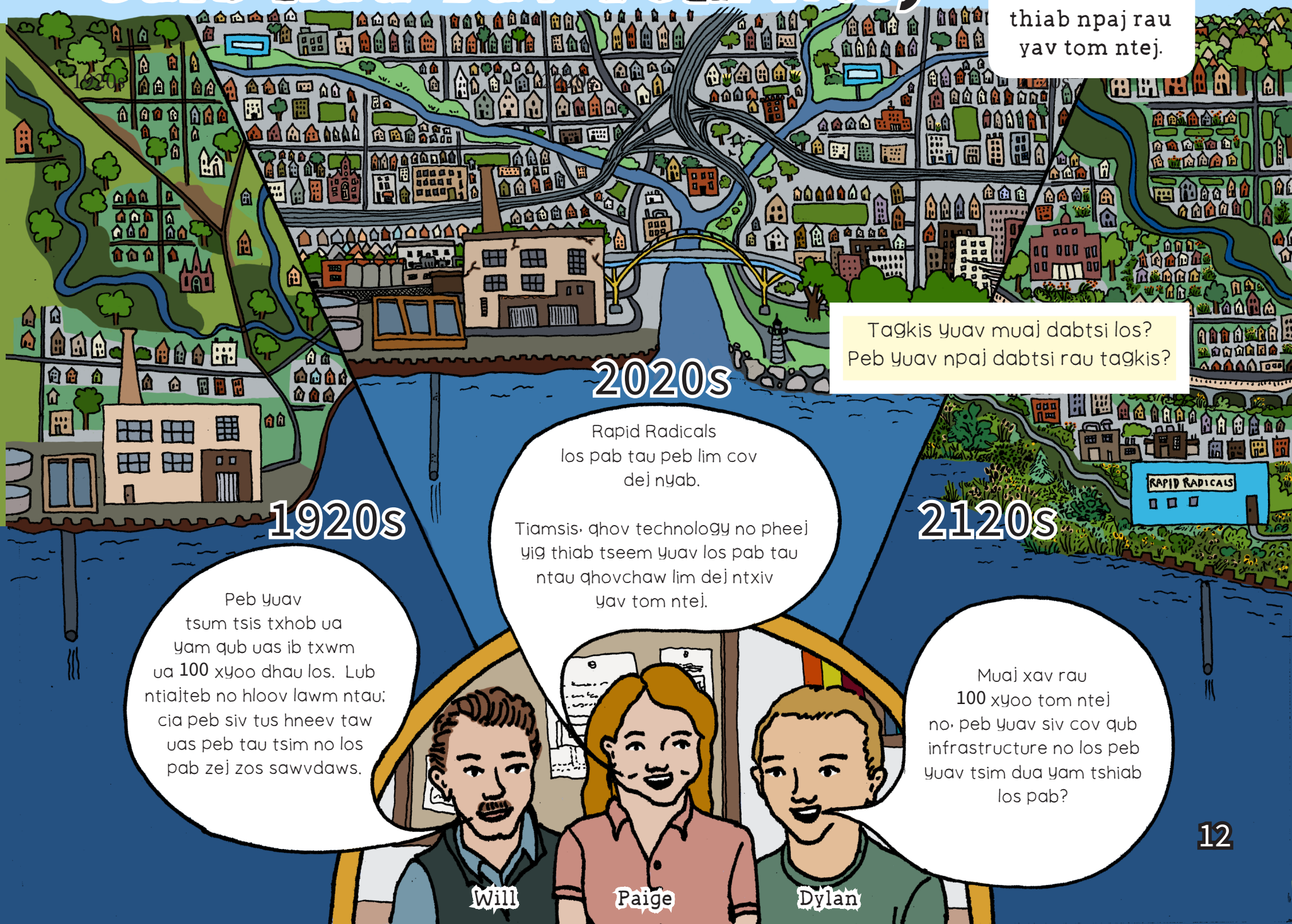
Thaum lub 8 hli, 2023, Paige thiab Rapid Radicals, tau los tsim thiab siv lawm lub tswvyim lim dej hauv shipping container no coj los pab ib qhovchaw uas dej nyab loj heev nyob State Street hauv Milwaukee.

Cov chaw lim dej no los lim dej tag thiab tso cov dej no tawm rov qab mus rau cov pasdej loj.

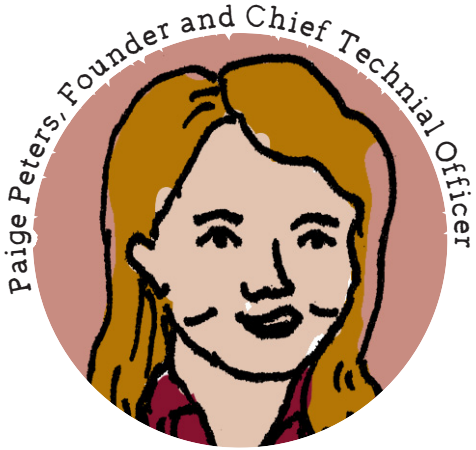
Txojkev Npau Suav



Saib Rau Yav Tom Ntej



Cov Phaj-Ej thiab Nas-Ej



Favorite Book:
The Ghost Map by Steven Johnson

Favorite Song:
Light On by Maggie Rogers

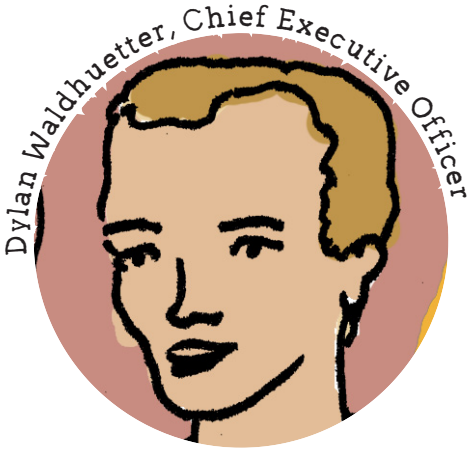
Favorite Food:
campfire nachos

Hero Growing Up:
My parents, Toby & Patti

Born: Cancer, 1988

"Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."

- Margaret Mead



Favorite Book:
Harry Potter and the Half-Blood Prince

Favorite Song:
That's the Way That the World Goes 'Round by John Prine

Favorite Food:
My friend Sam's smash burger

Hero Growing Up:
My parents

Born: Libra, 1990

"Just that you do the right thing. The rest doesn't matter"

- Marcus Aurelius, Meditations



Favorite Book:
The Old Man And The Sea
by Ernest Hemmingway

Favorite Song:
Good Riddance by Green Day

Favorite Food:
My mother's beef stroganoff

Hero Growing Up:
Great-grandpa William Frank Schanen Jr.

Born: Sagittarius, 1997

"Live in the sunshine, swim the sea, drink the wild air's salubrity."

- Ralph Waldo Emerson, Merlin's Song

Cov Kws Coj-Ua



Dr. Dan Zitomer has over 25 years of experience in the environmental engineering industry. Dr. Zitomer joined Marquette University in 1995 where he is currently a civil and environmental engineering professor. He serves as the Director of the Water Quality Center and is the Marquette Site Director for the NSF WEP IUCRC.

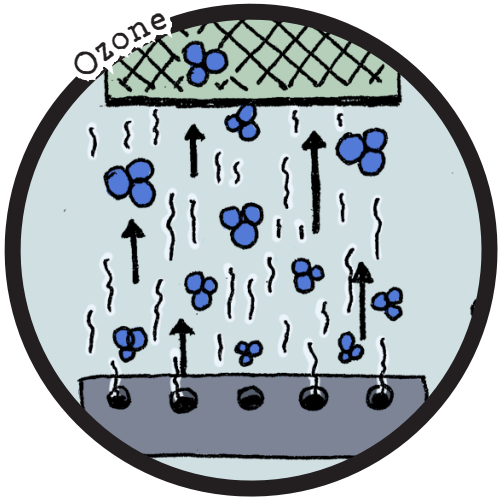


Matt Magruder at MMSD (the Milwaukee Metropolitan Sewerage District) has been a partner and advocate whose curiosity doesn't quit. Matt helpd Rapid Radicals test its pilot system at South Shore Wastewater Treatment Plant in 2020 and also in the field at State Street in 2023.



Dr. Kalpa Vithalani is executive director of Tech Transfer at Marquette University. She believes in the importance of collaborative applied research, "We can't keep our incredible academic discoveries within academic walls... How do we turn them into products and services that really help the public and benefit society and save our world?"

Lub Neej – Tseeb nrog Science

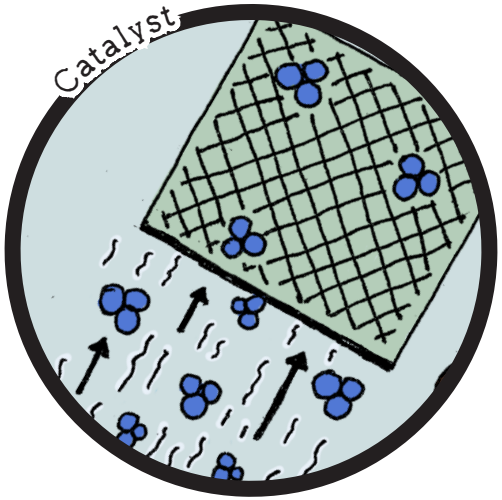


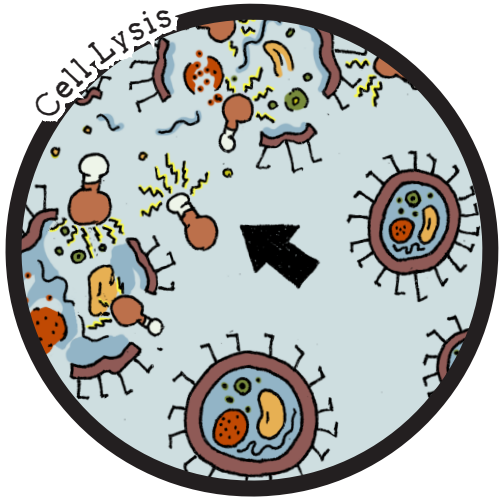
Ozone yog peb lub oxygen atoms nyoj ua ke thaum diatomic oxygen (zoo li peb ua pa huab cua) yog energized los ntawm ultra violet hluav taws xob.

Thaum ozone los nrog dej, nws hloov mus ua hydrxyl radicals. Cov no yog reactive molecules uas rub thiab dua cov electrons rhuav tshem daim celluar membrane, thiab rupturing cell machinery.

Paige thiab nws tus Marquette university advisor Dr. Dan Zitomer paub hais tias siv tau Ozone los mus lim dej thiab tua tau cob kab mob (ua rau neeg muaj mob).

Qhov tseeb, xyoo 1993, lub zos Milwaukee tau siv ozonation los mus lim dej. Xyoo ntawd, tus kab Cryptosporidium tau los kim mob rau 400,000 leej tibneeg; yog ib tug kab mob kis uas loj kawg li hauv tebchaws U. S.





Thaum pib 21 xyoo pua, neeg tsis siv ozonation los lim dej vim hais tias qeeb thiab kim heev.

Paige thiab Dr. Z tau tshawb kawm chemistry—thiab siv tau catalysts los pab kom cov chemical reactions mus nrawm thiab hloov, ozone mus rau hydroxyl radicals.

Lub Neej-Tseeb ua Lag Luam

Cov kev cai feem ntau tsis yuam kom yuav tsum lim wastewter kom huv si raws li cov dej haus, yog li ntawd, thiaj tsis muaj lagluam ntau uas los pab rau sab lim dej quav li no.

Tiamsis thaum twg uas muaj nag hlob los nyab li xyoo 2010, Dr. Z lub qab daus tsev uas rau nws lub tsev tsis huv. Txawm yog yuav cog paj ntoos thiab lwm yam los pab nqus dej los yeej tsis txaus. Thaum muaj dej nyab lawm ces, muaj kab mob ntau yam tsis zoo los txuam nrog dej. Vim tej huabcua pheej hloov, tsuas yuav muaj nag hlob ntxiv xwb.

Thaum los nag hlob thiab cov dej quav no nyab tuaj, yuav tsum muaj tej yam uas los pab lim kom tau cov dej no ko huv sai. Cov pa (oxygen) thiab cov tshuaj tua kab no yeej ua dejnum nyhav heev tiamsis li cas los yeej tsis txaus lim kom sai.

Vim li no, Paige cov “Rapid Radicals” catalyst thiab cov kev lim dej no thiaj li yog ib txojkev uas pab tau lim dej sai rau zej zos. Qhov lagluam no yog tsim los pab pejxeem daws cov teebmeem dej nyab no ntag. Muaj coob pab tibneeg hauv no yeej ntseeg hais tias lub lagluam no zoo.

Puas yuav mus tau?

Real Numbers

Rapid Radicals chemical treatment
$0.10/m³
ozone generation energy cost for COD removal to regulatory standard

Conventional activated sludge biological treatment
$0.20/m³
conventional activated sludge and ***$0.03/m³*** *for chlorination and dechlorination*

> ***$9,900***
> *nominal chemical cost for Rapid Radicals treatment for 12-hr, 36 MGD storm*

Quotations & figures sourced from Paige Peters' PhD dissertation, Feasibility of Sewer Overflow Treatment Using Chemical Oxidation After Rapid Solids Removal, published in May 2023, Marquette University



August 2023 ribbon cutting at State Street

Thaum peb tshawbfawb txhua yam tag lawm, peb pom tau hais tias lub lagluam lim dej no yeej lim tau dej zoo thiab yog ib yam uas tsis kim heev. Peb yuav tau tsim kom qhov PSS no loj, thiab yuav tsum nyob ze ib qhovchaw uas cov dej quav/zis no ntws mus rau hauv Milwaukee, WI. Yuav tau los sojntsuam thiab saib kom meej kom txhua yam khiav zoo raws li (automation and solids handling) los mus lim cov dej nyab no (more variable influent conditions).

Cov sijhawm ua Lagluam

2010	Dejnag los nyab Milwaukee thiab Dr. Dan Zitomer's lub qab daus
2014	Marquette University los tshawbfawb; NSF Water & Equipment Policy IURC los pab nyiaj.
2016	Paige Peters pib lub lagluam Rapid Radicals LLC
2017	Paige ntiav Dylan Waldhuetter los pab chiv lub lagluam no.
2018	NNSF Innovation Corps los tshawb nrhiav cov neeg siv qhov lag luam no thiab los pib qhov lagluam no.
2019	Technology Transfer | The Water Council's BREW Accelerator | gBeta gener8tor | Imagine H2O
2020	Tus kabmob Coronavirus thoob ntiajteb/Ntiav Will Schanen los ua haujlwm full time.
2022	Dylan los ua tus full time CEO/ Yeej Governor's Business Plan Contest
2023	Paige Peters kawm tiav nws daim PHD/Nruab tiav rau tom MMSD State Street/Hloov Rapid Radicals mus rau Delaware C Corp
2024	Rapid Radicals thov tau 4 pob nyiaj los tsim lub lagluam no ntxiv.
2025	???

Rapid Radicals thov tau nyiaj los pab pib lub lagluam no lawm. Peb yuav tsim thiab nrhiav txoj hauv kev los pab kom tes haujlwm no loj thiab nthuav dav mus ntxiv lawm yav tom ntej.

Learn More

ABOUT OUR SEWER SYSTEM

History of Milwaukee Metropolitan Sewerage District (MMSD)
https://www.mmsd.com/about-us/history

About MMSD's Deep Tunnel
https://www.mmsd.com/what-we-do/wastewater-treatment/deep-tunnel

ABOUT OUR WATER SYSTEM

How Milwaukee Water Works Treats Drinking Water
https://city.milwaukee.gov/water/customer/FAQs/qualityandhealth/Water-treatment-process.htm

History of Milwaukee Water Works
https://city.milwaukee.gov/water/customer/FAQs/additionalinfo/History-of-the-Milwaukee-Water-Works.htm

OTHER RESOURCES

A look inside Milwaukee Water Works
https://onmilwaukee.com/articles/linnwood-water-treatment-facility

Timeline video of 30 years of key water story headlines, 1993-2019
https://vimeo.com/382211134

It was not easy, and the knowledge and insight I gathered along the way has made me a better and more curious leader, researcher, and engineer, and a stronger version of myself.

It is my hope that other budding, go-getter, entrepreneurial-minded graduate students may see this and know they can make their own dream a reality, too.

Key Terms

Basement Backup
During heavy storms or melting snow, so much water enters the sewer system so rapidly that it can be overwhelming. When the system cannot hold or treat the water it must go somewhere. That water can "back up" from the sewer system into people's basements.

Biological Water Treatment
Using microbes to digest wastewater is known as biological treatment because microbes are alive. Sometimes they are given extra oxygen to speed up their digestion.

Catalyst
A substance that speeds up a chemical reaction but does not itself get used up. Enzymes are examples in the human body. Reactions in the presence of a catalyst happen faster.

Chemical Water Treatment
Using materials like chlorine, ozone, or sodium hypochlorite to kill organisms in water, sometimes forming byproducts. Ozone is useful in that it does not create harmful byproducts.

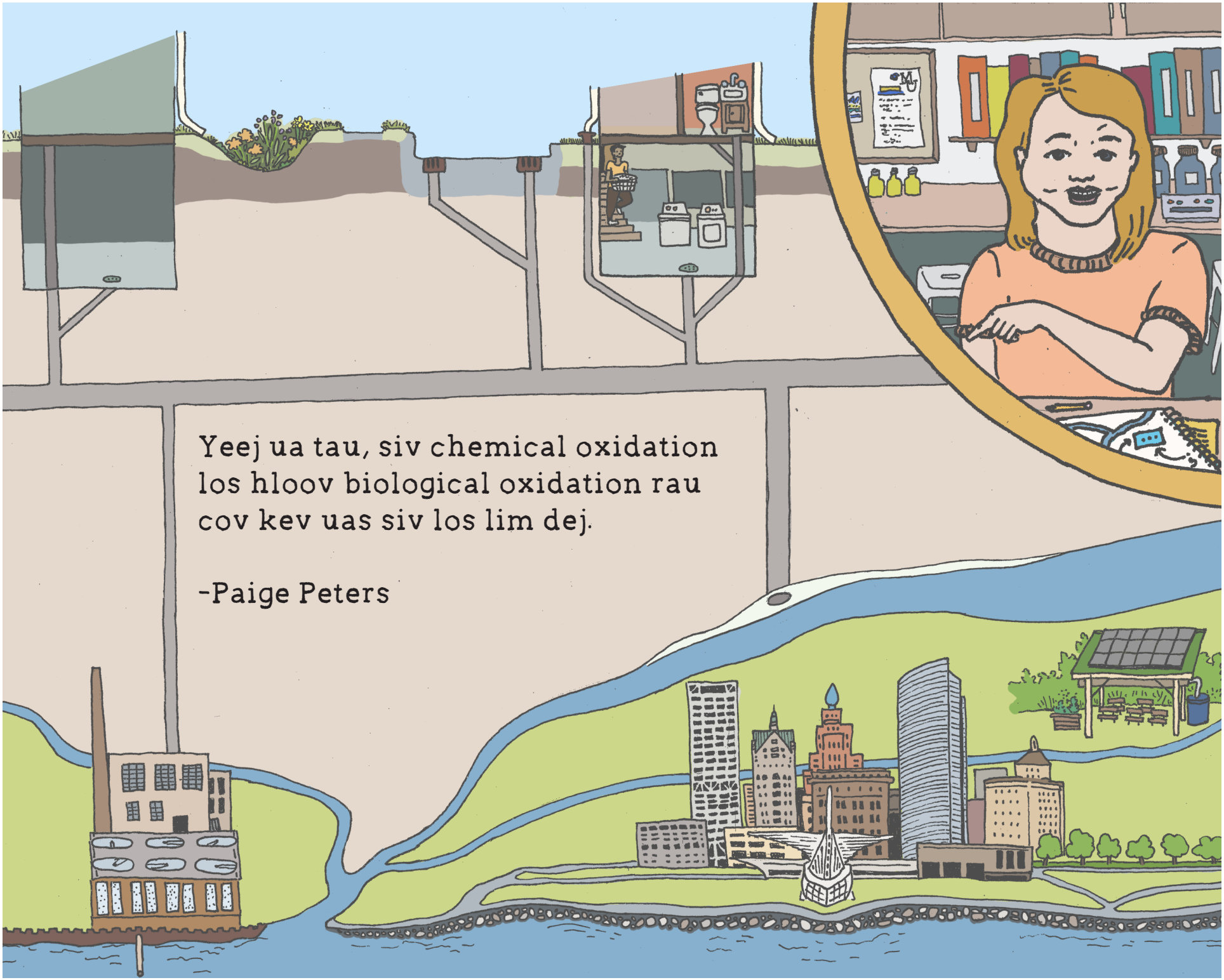
Combined Sewer
The area of cities where what you flush down the toilet goes into the same pipes as what washes off the street. Outside that area, the separated sewer area contributes wastewater to the same system, but stormwater flows directly into rivers.

Deep Tunnel
In Milwaukee, a massive engineering project that burrowed a giant tunnel network beneath the city able to hold 521 million gallons of water during heavy storms so it can be pumped up later for treatment. Did you know the rock from excavating the Deep Tunnel was used to form Lakeshore State Park?

Green Infrastructure
Nature-inspired practices like rain gardens, bioswales, rain barrels, cisterns, native plantings, or porous pavers that store water or help it soak into the ground rather than going right into "gray infrastructure" pipes.

Overflow
Initiated to prevent basement backups when the sewer system gets overwhelmed with too much water too fast, overflows occur at outfall pipes discharging into Milwaukee's three rivers.

Ozone
Three oxygen atoms fused together, which can be harmful to life. When injected into water as a bubbling gas, ozone forms hydroxyl radicals, which are used to kill pathogens to clean the water.


Yeej ua tau, siv chemical oxidation
los hloov biological oxidation rau
cov kev uas siv los lim dej.
-Paige Peters



Favorite Book
Any Golden Press field guide!

Favorite Food
Thai Curries

Zodiac Sign
Aries

I love playing music! I have a flute, guitar, ukulele, cello, harp, trombone, accordion, concertina, kalimba, and a keyboard! I can't play all of them well, but I like practicing and experimenting.



Favorite Book
The Hitchhiker's Guide to the Galaxy
by Douglas Adams

Hero Growing Up
Captain Kirk

Zodiac Sign / Year of Birth
Pisces / 1982

"Nature is a living whole."
--Alexander von Humboldt

Qhov dlej num nuav yog them nyaj lug ntawm Wisconsin Department of Administration, Wisconsin Coastal Management Program hab the National Oceanic and Atmospheric Administration nyob rua huv qaab kev tswj fwm pum zoo ntawm Wisconsin Coastal Management Program No. AD239125 – 024.21 Tau nyaj lug ntawm the Wisconsin Coastal Management Program hab National Oceanic and Atmospheric Administration, Office for Coastal Management huv qaab the Coastal Zone Management Act, Grant # NA22N055190085.

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