

# CONTINUING EVALUATION OF HDPE PIPE FOR MARINE OUTFALLS

Prepared by:

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Phillips, Tim O'Leary & Baker McCullough



**King County**

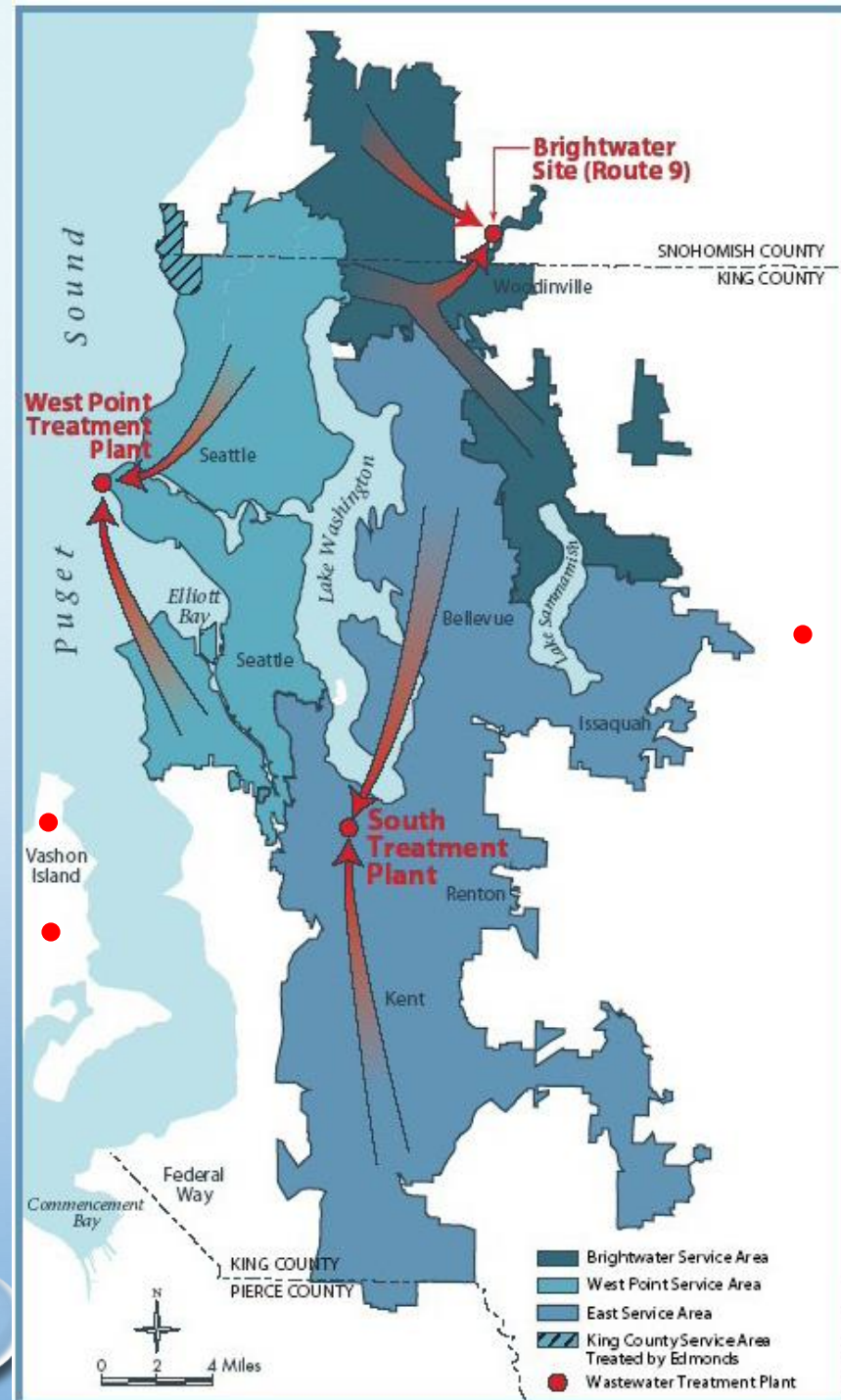
Department of  
Natural Resources and Parks  
**Wastewater Treatment Division**

# PRESENTATION OUTLINE

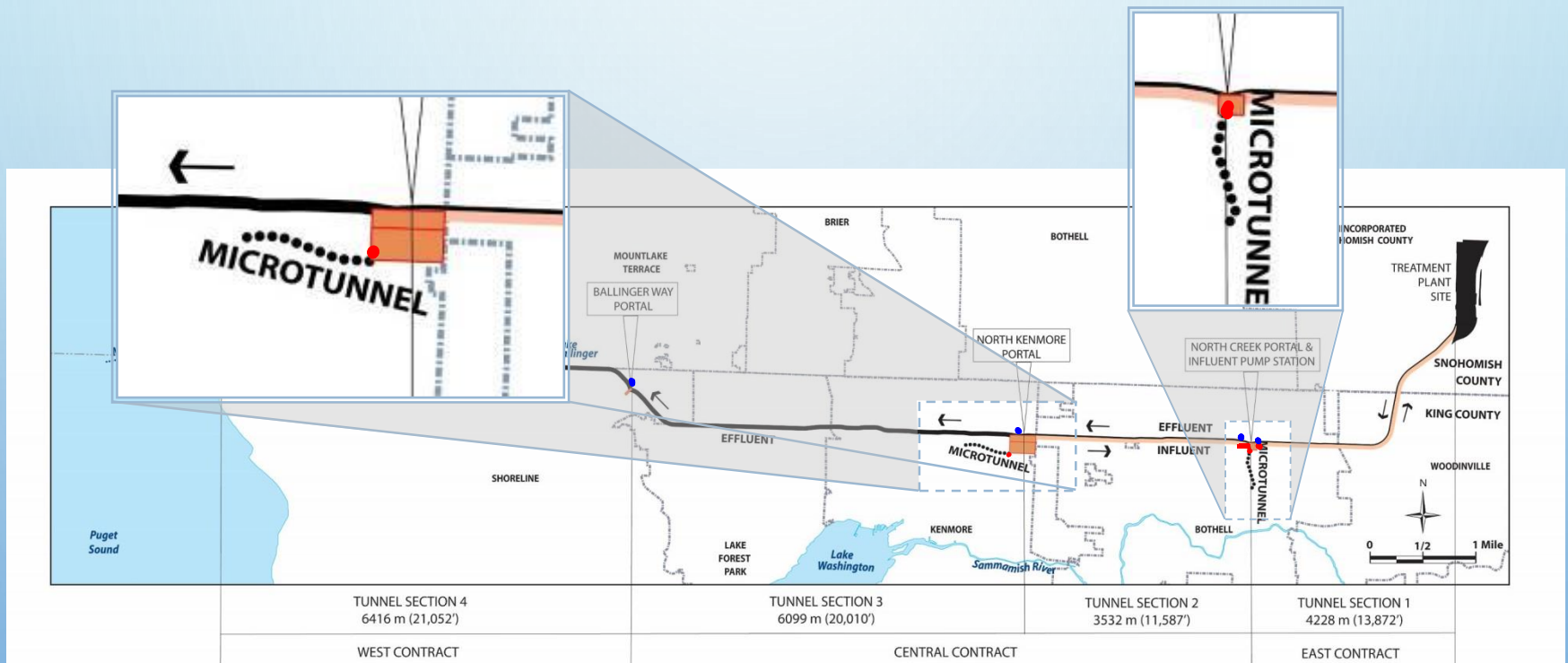
- Brightwater Outfall Description
- Outfall Inspections
- Material & Habitat Study
- Habitat Results
- Material Results
- Where do we go from here?

# KING COUNTY WASTEWATER TREATMENT DIVISION

- 5 WWTPs
  - West Point
  - South
  - Brightwater
  - Carnation
  - Vashon (2)
- 47 Pump stations
- 26 Regulators
- 38 Overflows
- 4 CSO treatment plants
- 391 Miles of sewers



# BRIGHTWATER TREATMENT & CONVEYANCE SYSTEM





How many utilities  
have marine  
outfalls?

River outfalls?

How many are using  
HDPE for the outfall  
pipe?

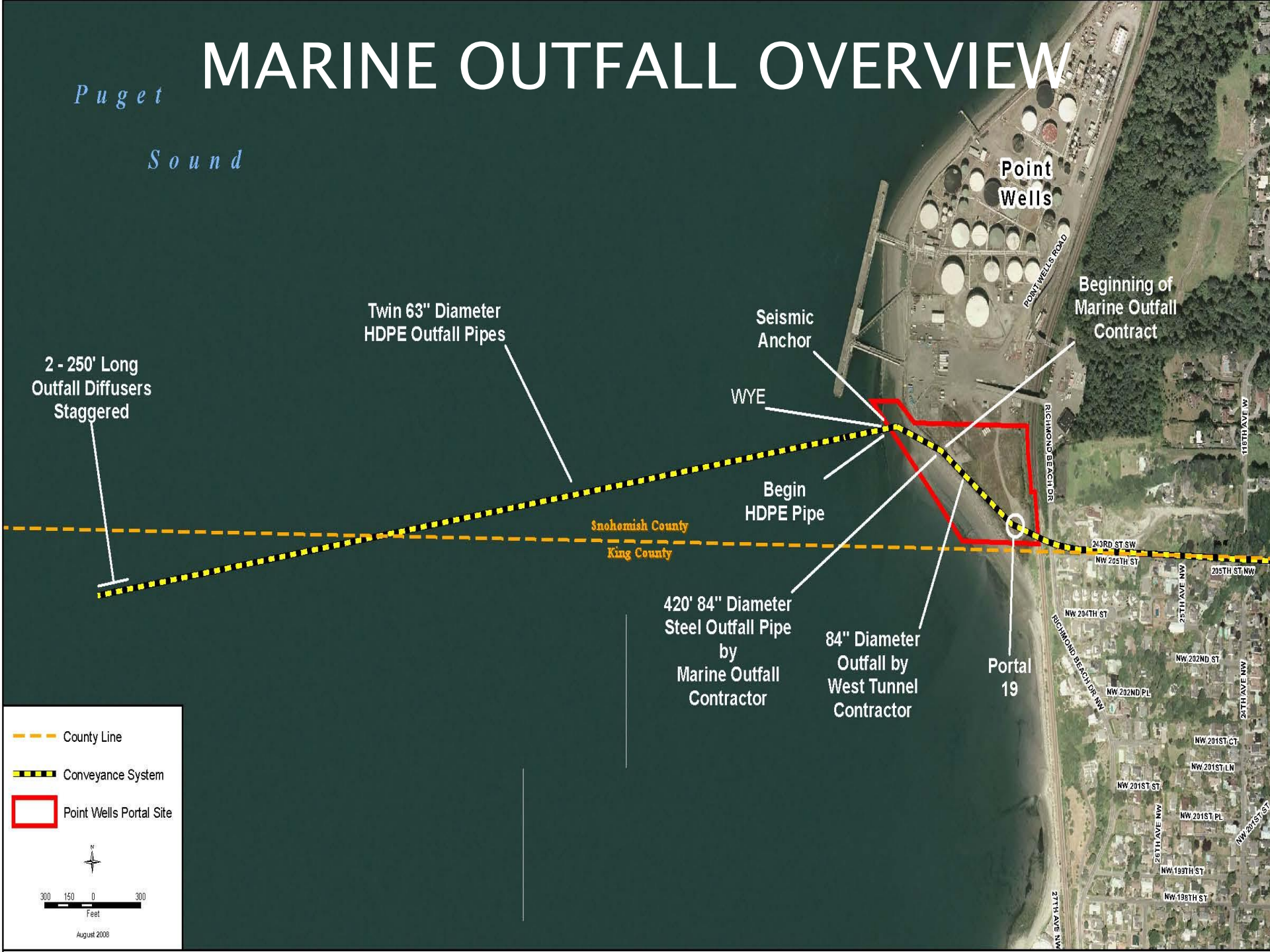


# BWMO CHARACTERISTICS

- 420 feet 84" polyurethane lined/coated steel pipe w/ICCP
- Sheet pile & concrete seismic anchor
- Wye transition
- 2 – 63-inch OD HDPE pipes 5,018 & 4,768 feet long (DR 21 & 26)
- 494 feet buried, remaining bottom laid pipe
- 250 foot long diffuser on each, staggered
- Flow range is 8 MGD low flow – 170 MGD peak

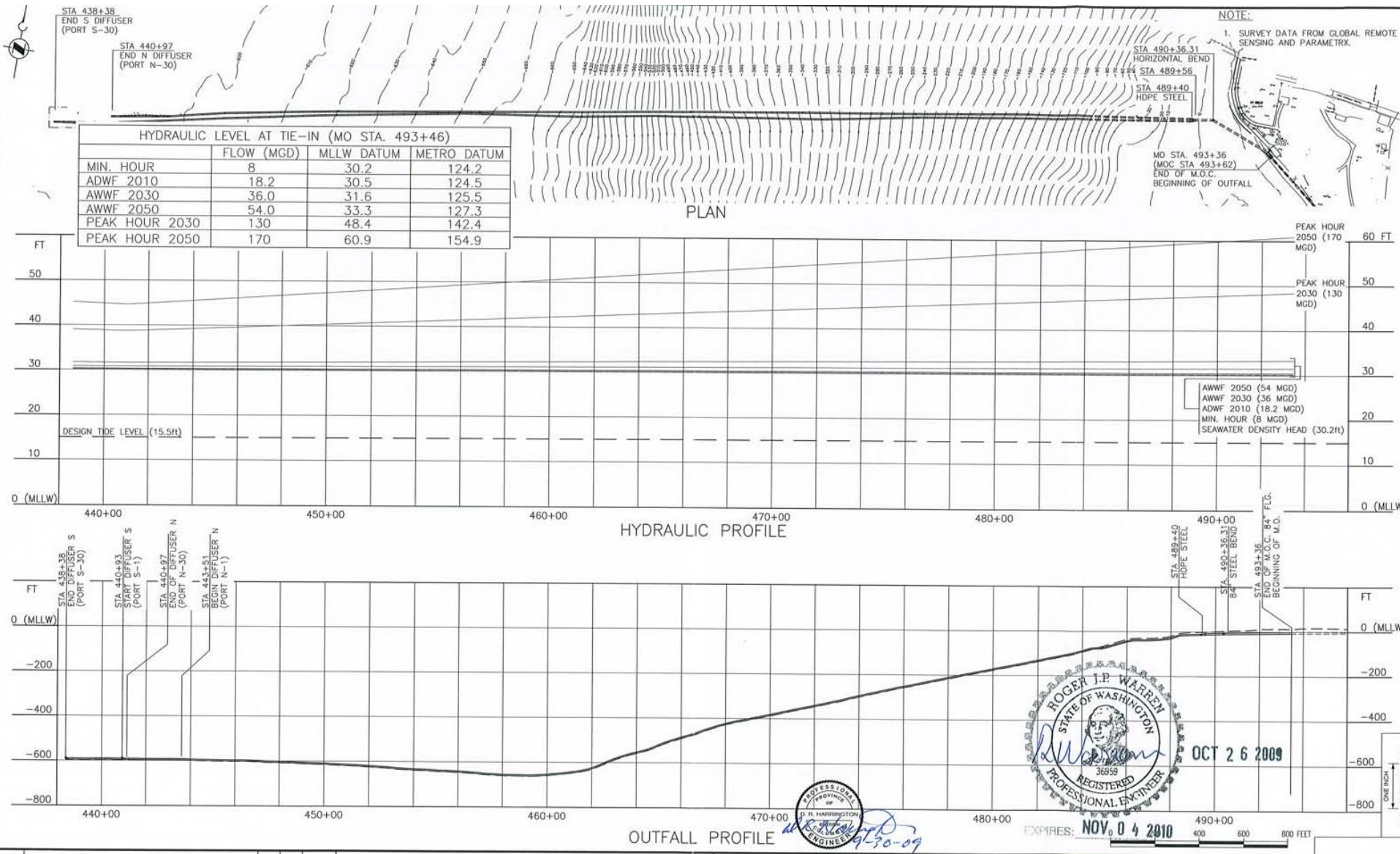
*P u g e t*

## Sound





# MARINE OUTFALL PLAN/PROFILE

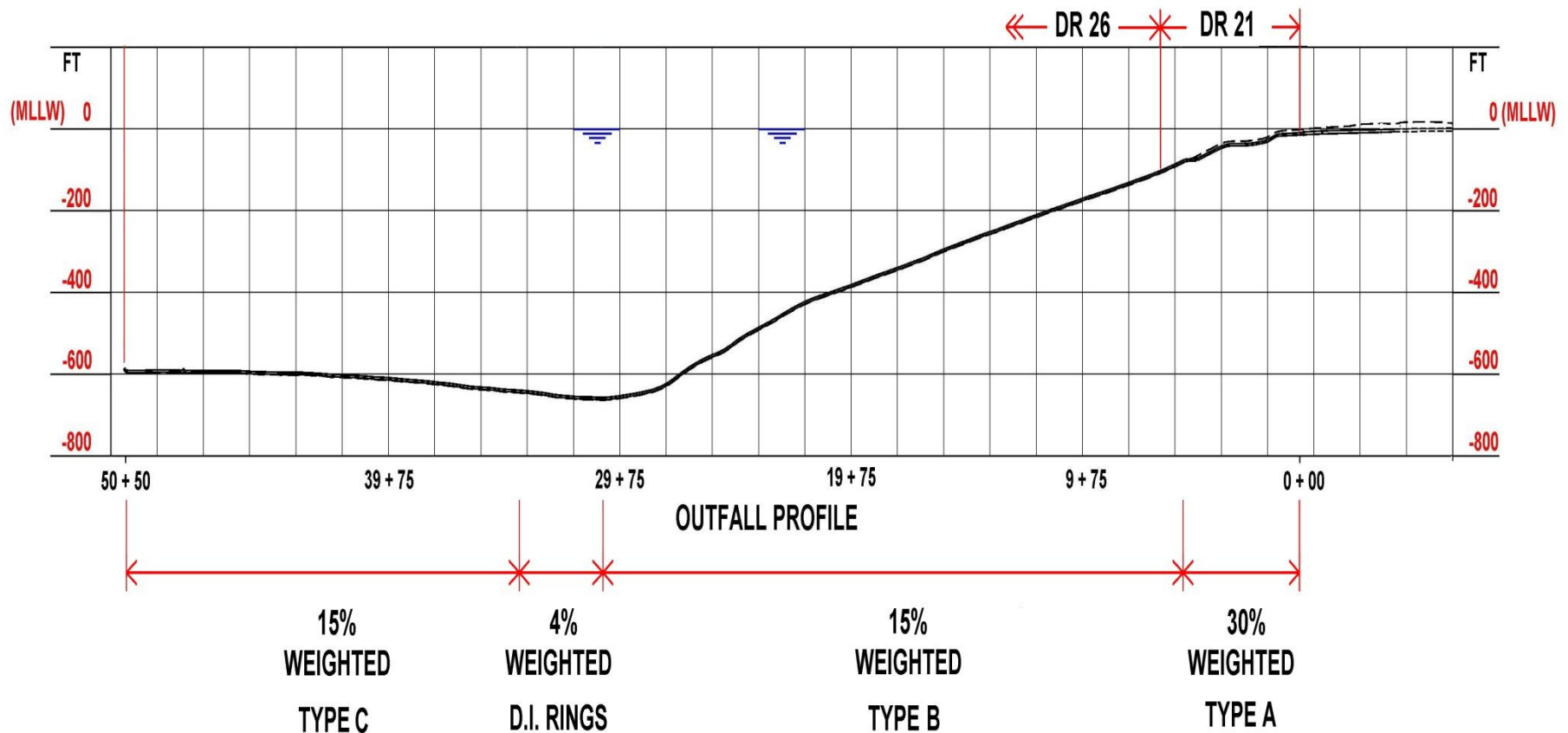




# BRIGHTWATER MARINE OUTFALL PROFILE

END OF DIFFUSERS

START OF TWIN  
63" DIA. PIPELINES







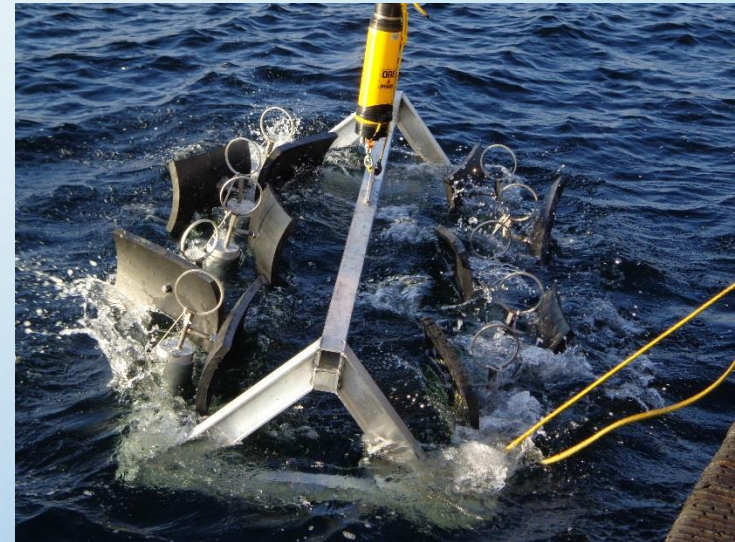






# OPERATION & INSPECTION OVERVIEW

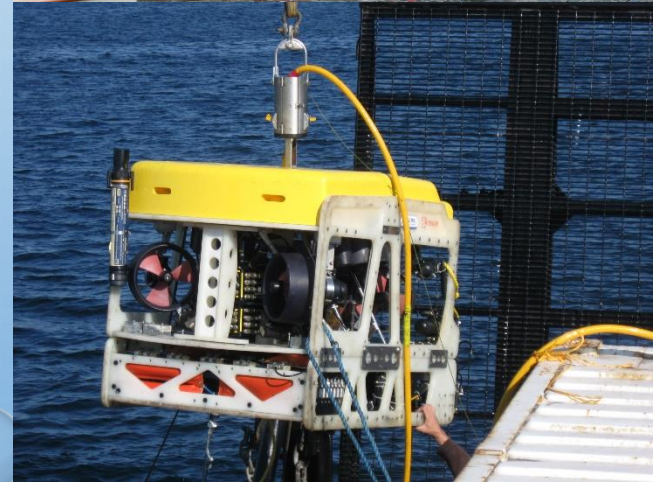
- Outfall built in 2008
- Operational in 2012
- High degree of biological colonization noticed early
- 10 Year study created





# BWMO MONITORING

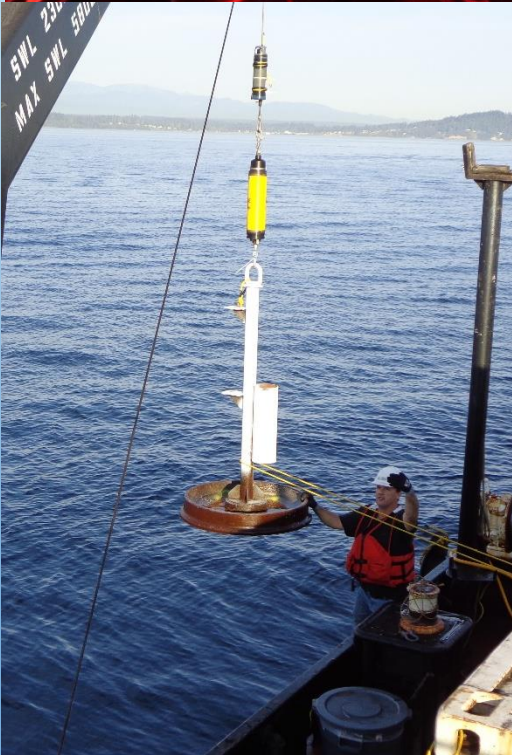
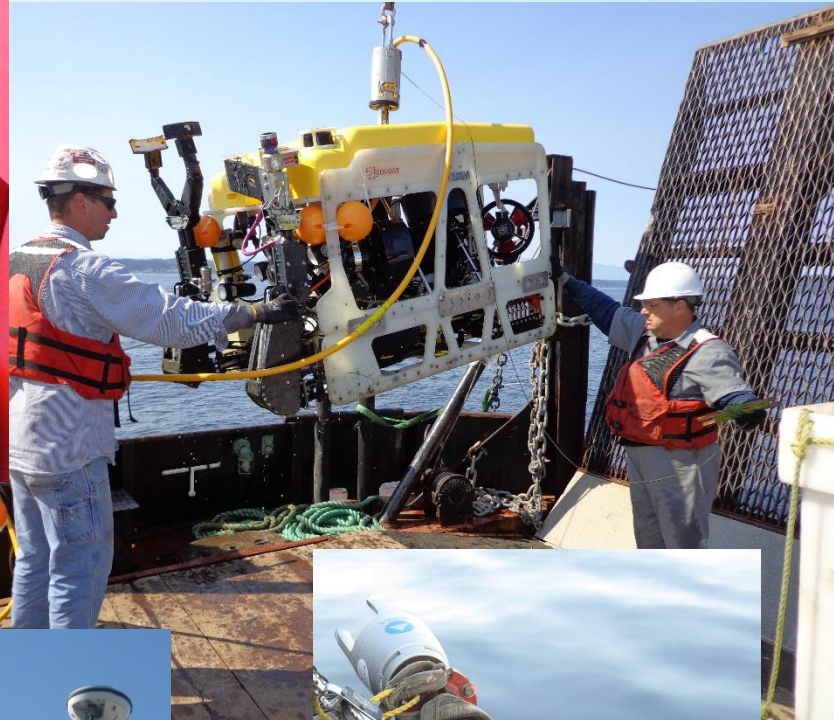
- Annual visual inspection with Remote Operated Vehicle (ROV)
  - King County research vessels Liberty or Sound Guardian with small ROV
  - In year 2, 5 & 10 using work class ROV and salvage contractor barge
- 5 year diffuser elevation





# ANNUAL VISUAL INSPECTIONS

# TOOLS OF THE TRADE





# 100 FEET





# 300 FEET

03-NOV-10  
13:26:21

2010

D: 305.2F  
H: 105

King County

RACK-B  
2012

18/09/12

Time 17:38:13  
STATION 478+28.5  
E: 1254739.2  
N: 288059.1

222  
+00



TERRASOUND



GLOBAL



-0209F

177 +10P 100.9m

+0 +OR -22

2016

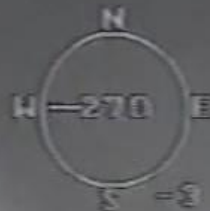
DEC 04 16  
12:55:19  
Brightwater

\$CPGCA,125509.74,4746.72744,N,12224.2393  
S,W,-1.00,0.0,0.0,M,,,\*0F6,N,12237.6150

# 600 FEET

2008

Depth 216.8K  
Tilt 18.00deg  
Vector -44.10deg  
Pitch -0.09/13/2008  
Roll HDD 100% 017:34:13



King County

2012

08/09/12

Time 09:51:27  
DX -2.9  
STA 458+63.98

229  
+00



-8804F

TERRASOUND



ANCHOR  
OEA 0000

191 -17P 177.8m

-2 -8R -38

2015

MAR 18 15  
09:43:45  
Brightwa\_

3.W -1.00.0.0.0.0.M.,,\*0A.,\*120000.0000  
\$CPCGA,094342.74,4746.69364,N,12224.4680

# 100 FEET VIDEOS



2008

Depth 035.2M  
Tilt -16.6Deg  
Vector -44.1Deg  
Pitch -0.89713/2008  
Roll HDD 100% 0.15517/13



25-JUN-15  
12:23:17

2015

D:097.7F  
H:344

107 -30P 34.9m  
-1 -17R -37  
2016

+47.779200° N  
-122.400300° W  
GPS: 08:31:28

Bightwater  
09/28/2016  
08:31:38

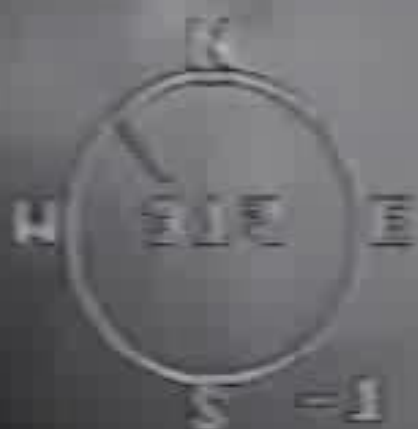




# 300 FEET VIDEOS

2008

Depth 097.7M  
Tilt -7.6Deg  
Vector -44.2Deg  
Pitch -0.89743/2008  
Roll HDD 100% 04:55:38:14





RACK-8  
2012

18/09/12

Time 17:37:47  
STATION 478+60.6  
E: 1254770.9  
N: 288064.1



-0203F

TERRASOUND GLOBAL



075 +17P 67.8m  
-2 -8R -36 2015

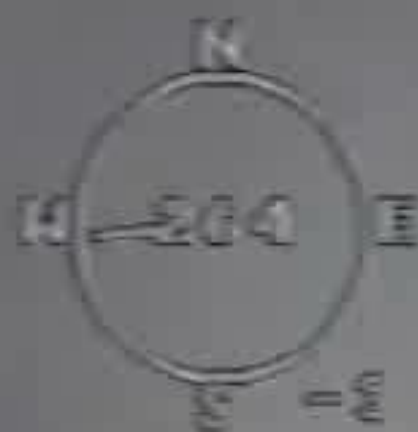
MAR 18 15  
09:09:28  
Brightwa\_

4,W,-1,00,0.0,0.0,M,,,\*,05,,\*120000.0000  
\$GPGGA,090926.68,4746.73886,N,12224.1314

# 600 FEET VIDEO

2008

Depth 216.3M  
Yoff 18.0Deg  
Vector -44.1Deg  
Pitch -009.13/2008  
Roll HDD 100% 0417:34:11





# POST DEPLOYMENT STUDY

- No previous long term information
- Three primary goals
  - Determine if marine life had an affect on the HDPE
  - What colonizes on the HDPE
  - Determine what effect the pipeline has on marine habitat – Pipe good? Pipe Bad?



# STUDY DESIGN

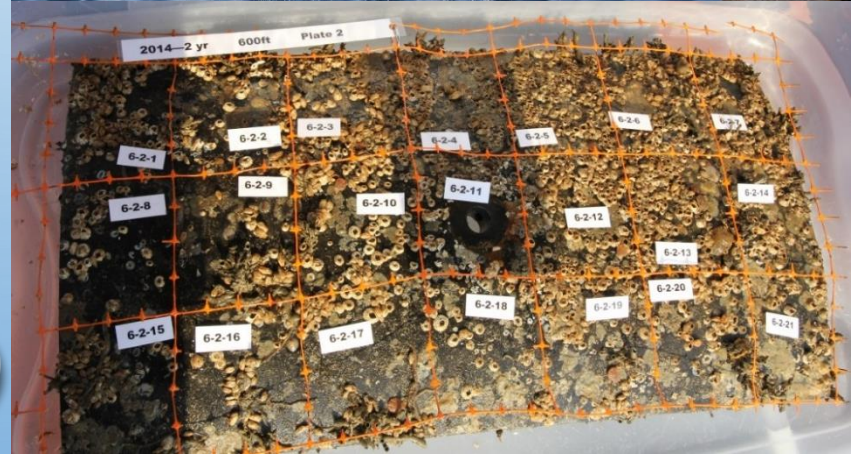
- 2 ft x 1 ft sections of pipe deployed in 2012
  - -100, -300, -600 ft MLLW
  - Reference site (-600 ft)
- 10 “settlement plates” for each site
- 3 replicates to be collected at each depth year 2 & 5 and 4 in year 10





- ROV collection
- Samples assessed for % cover
- Flexible mesh grid aids in estimation – 21 cells
- Macroscopic biota identified in the field
- Photographs of each cell
  - Future identification
  - Better estimate of % cover

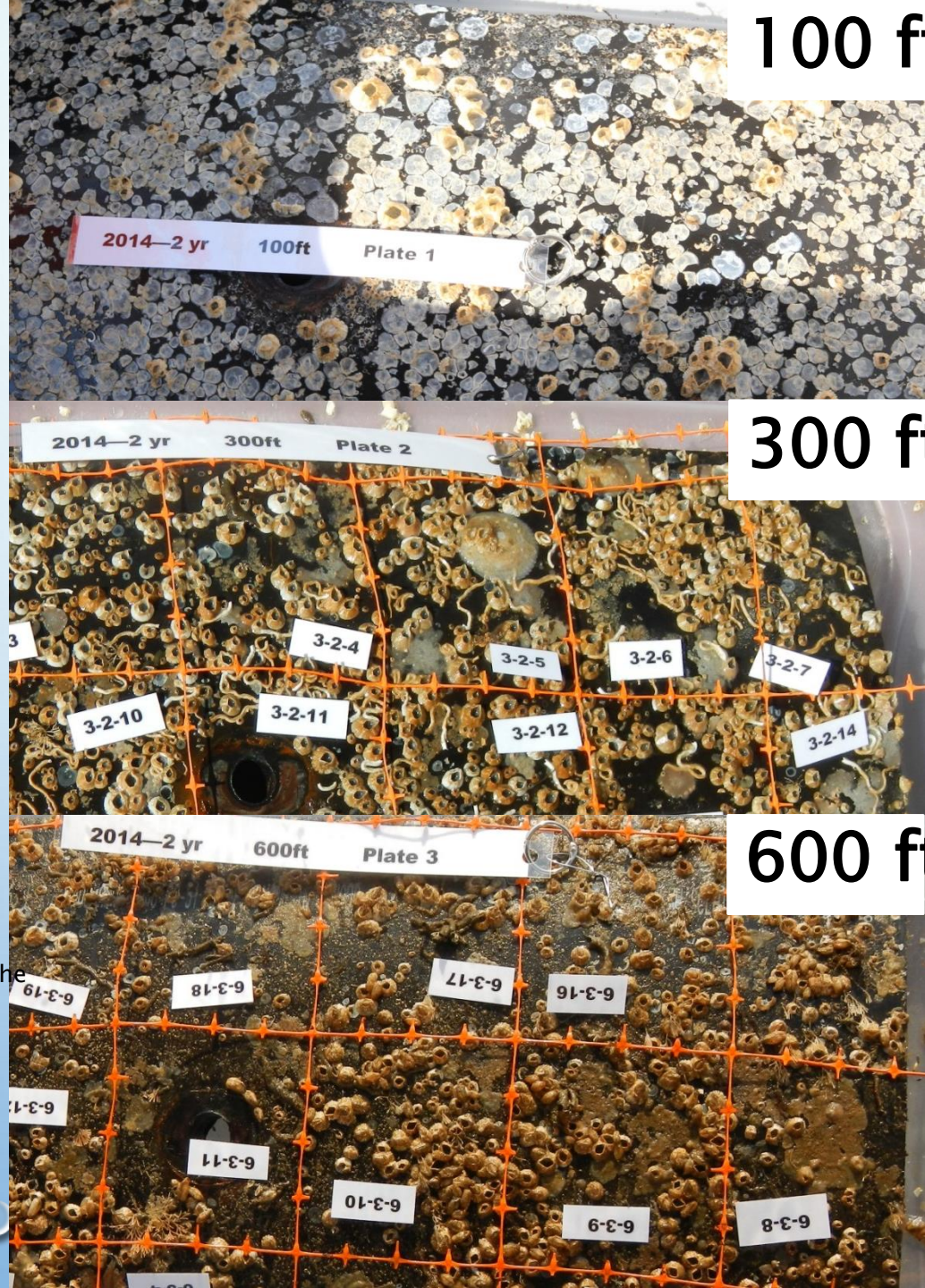
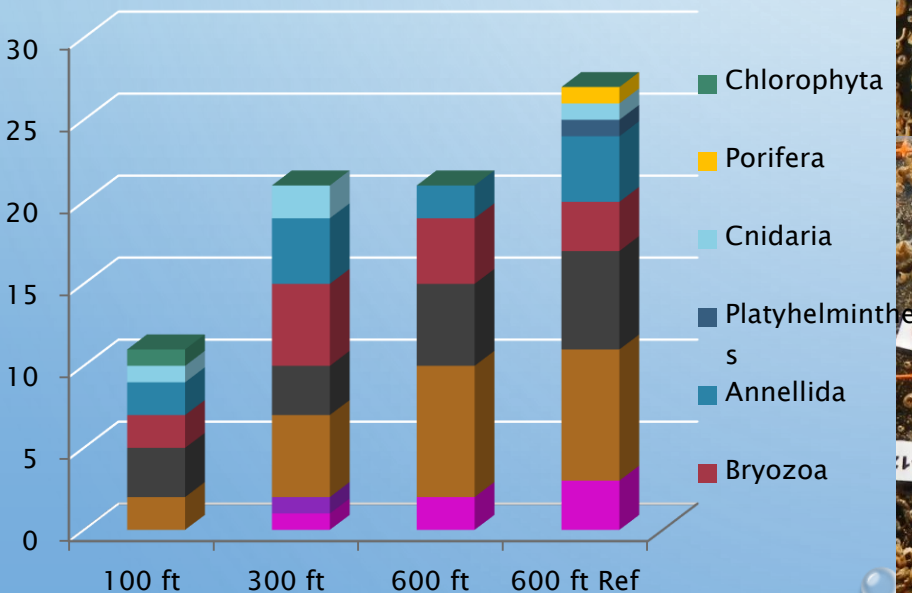
## SAMPLE RETRIEVAL





# PRELIMINARY RESULTS 2014

- Diversity increased past 100 ft







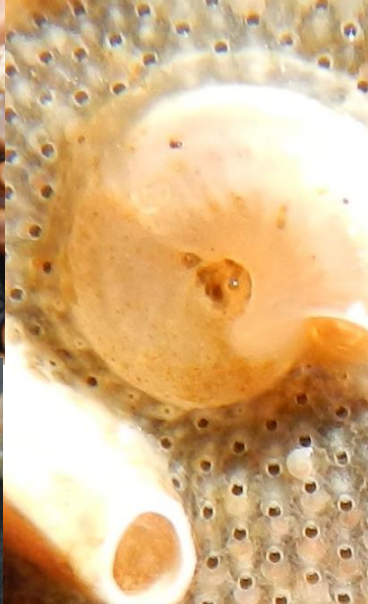
*Pododesmus  
macrochisma*



*Serpulidae*



*Delectopecte  
n*



*Schizoporella  
sp.  
&  
Spirorbis sp.*



*Tubulipora  
sp.*



*Trichotropsis  
cancellata*



*Chlamys  
hasta*



*Chelyosoma  
sp.*



*Urticina crassicornis*



*Crisia sp.*



*Chlamys  
rubida*



*Hiatella*



*Harmothoe  
sp.*

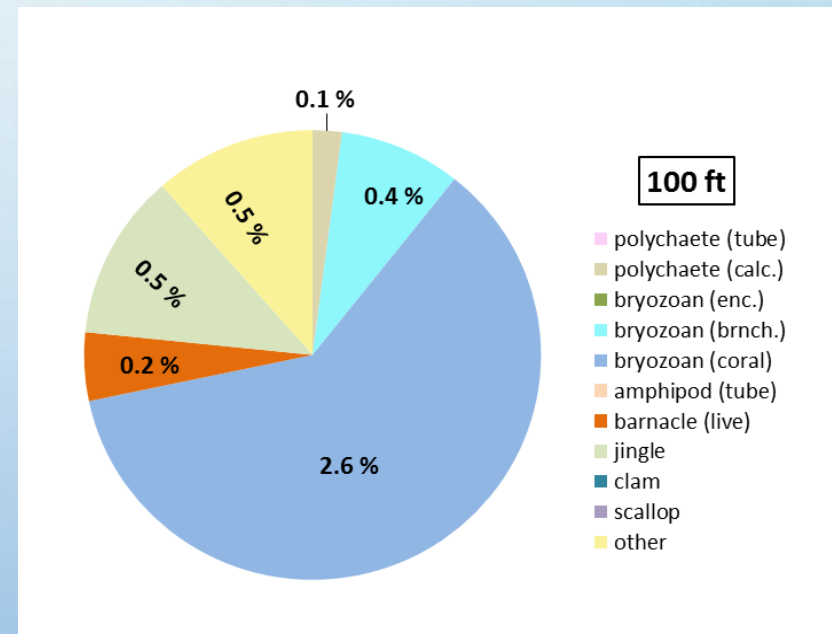


*Strongylocentrotus  
sp.*



- Least Diverse
- High % of barnacle scars (52.1% coverage)
- Avg. total % cover was 56.3%
- Avg. % cover for live organisms was 4.2%
- Barnacle settlement was substantial however, predation likely limited the presence
- It is expected that recruitment of new

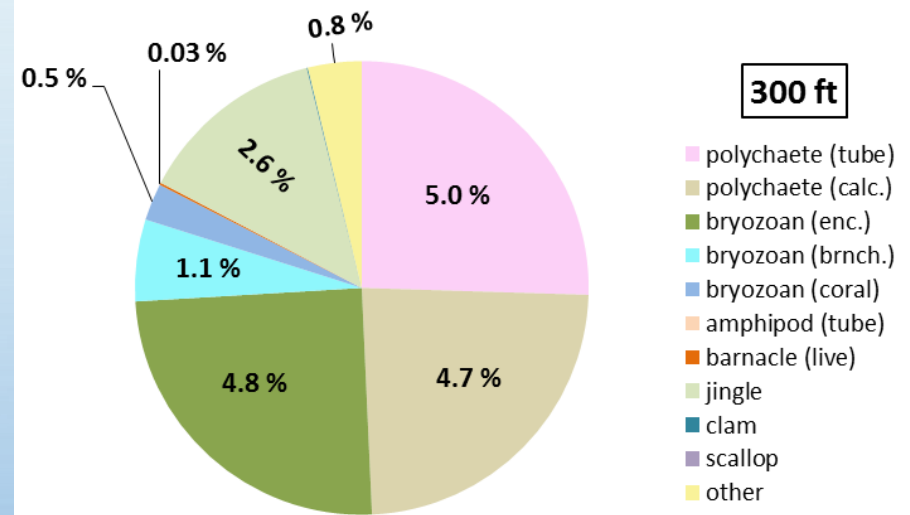
## 2014 SAMPLE 100 FEET





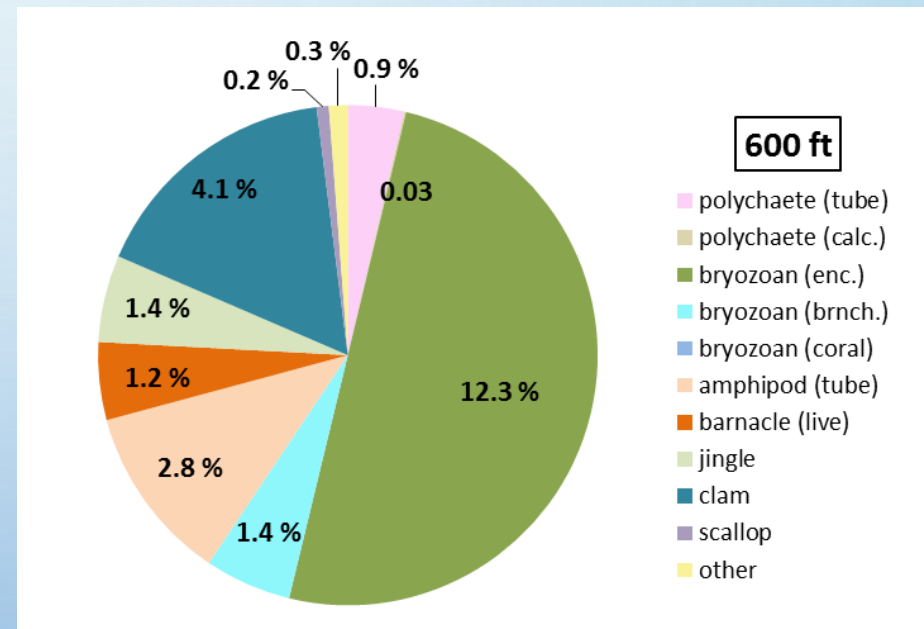
# 2014 SAMPLE 300 FEET

- Tube worms were the most abundant
- Live barnacles 0.03%
- Total percent cover 47.9%
- Due to the presence of dead barnacles
- 19.6% cover of live organisms



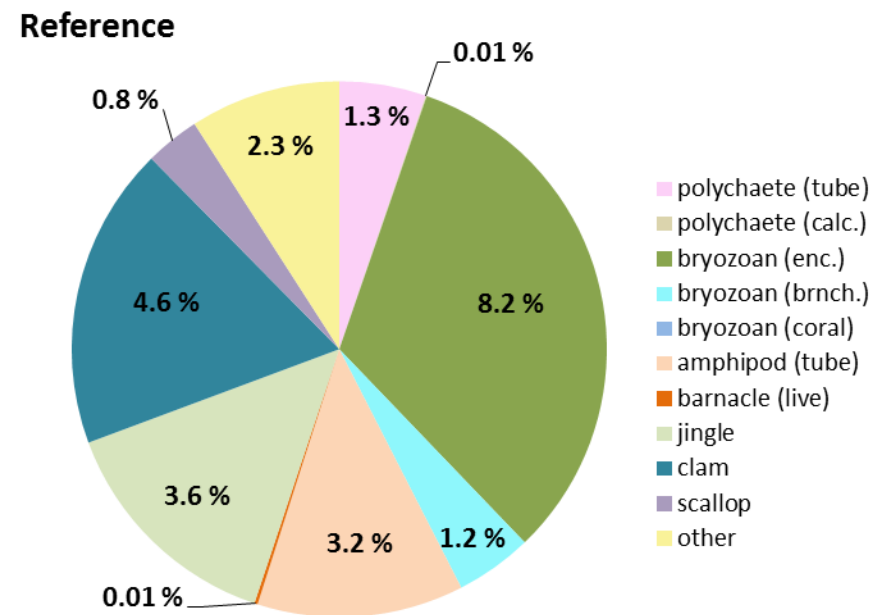
# 2014 SAMPLE 600 FEET

- The coral bryozoan was seen at lower depths but not at 600ft
- The scallops were recently settled (small), not seen at other depths
- Few motile organisms
- Total percent cover at this depth averaged 60%



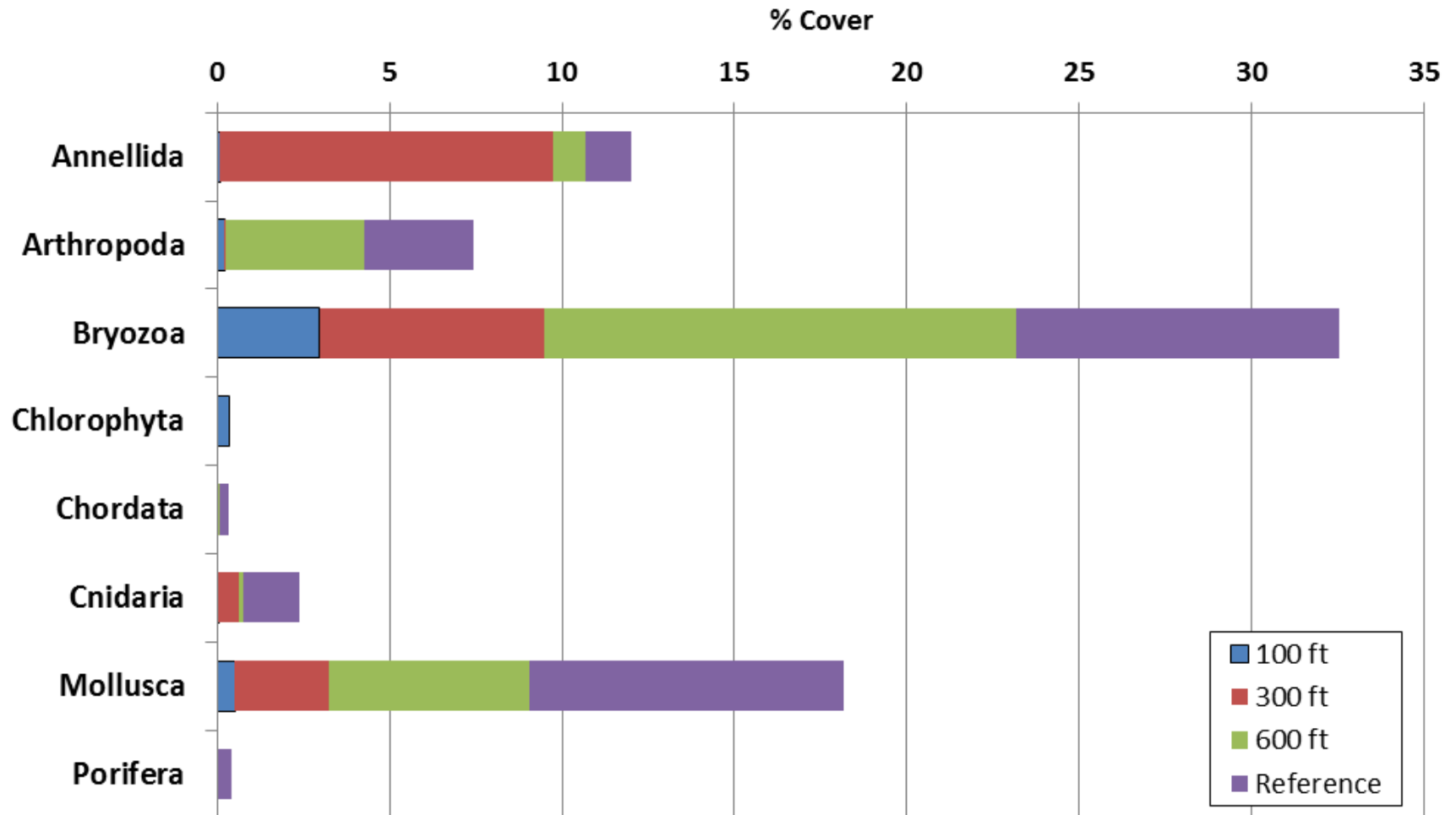
# 2014 SAMPLE 600 FEET REFERENCE

- The most motile organisms
- Total percent cover at this site averaged 67.8%, the highest of all four sites
- Percent cover of live organisms is 25.2%

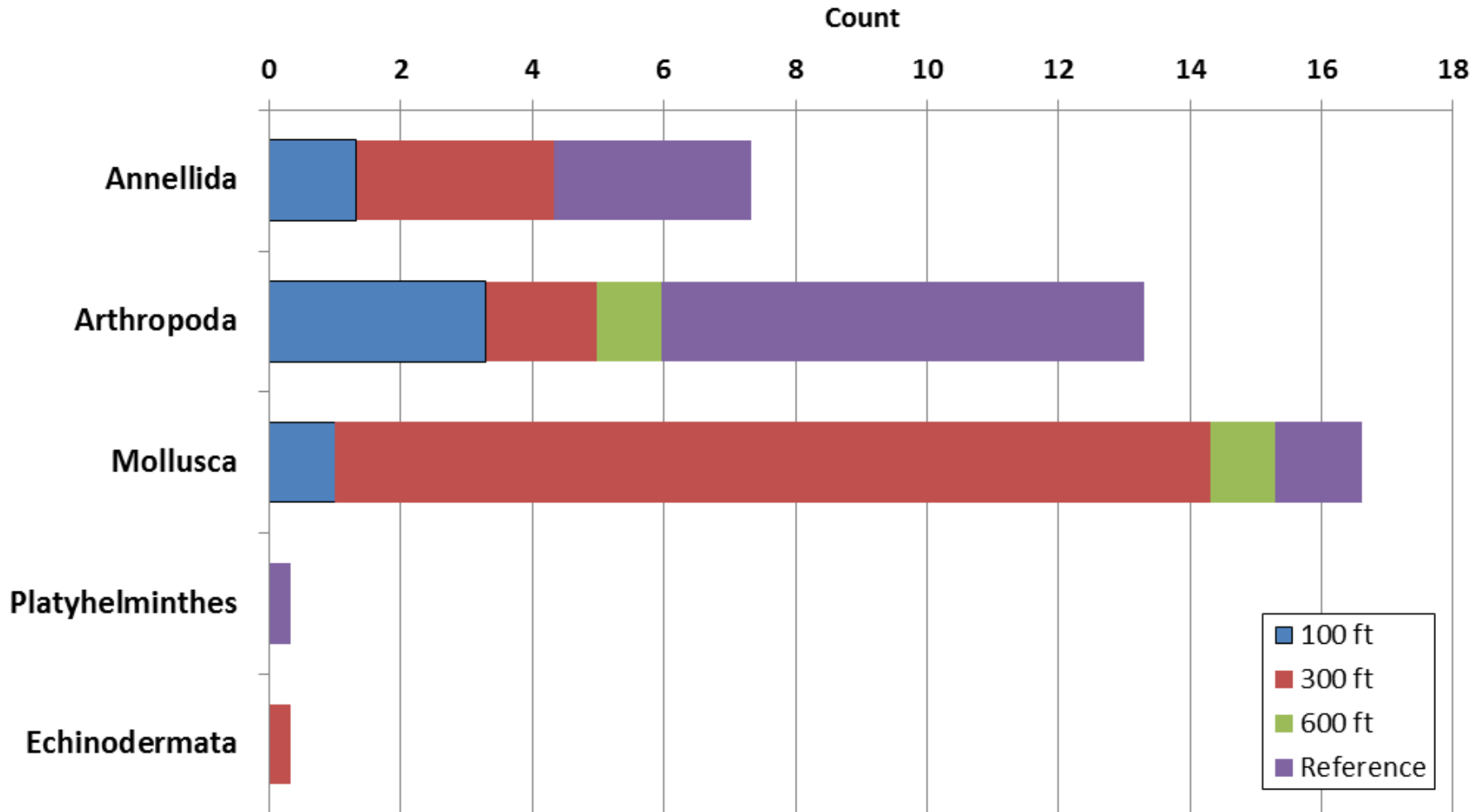




# AVERAGE PERCENT COVER OF NON-MOTILE ORGANISMS BY PHYLUM FOR ALL SITES



# AVERAGE PERCENT COVER OF MOTILE ORGANISMS BY PHYLUM FOR ALL SITES



		100 ft				300 ft				600 ft				Reference: 600 ft			
Non-motile (% cover)	Phylum	Rep 1	Rep 2	Rep 3	100 ft	Rep 1	Rep 2	Rep 3	300 ft	Rep 1	Rep 2	Rep 3	600 ft	Rep 1	Rep 2	Rep 3	Reference
calcareous tubeworm	Annelida	0	0.08	0.19	<b>0.09</b>	5.34	5.58	3.08	<b>4.66</b>	0.03	0	0.06	<b>0.03</b>	0.04	0	0	<b>0.01</b>
polychaete: tube	Annelida	--	--	--	--	7.47	0.19	7.32	<b>4.99</b>	1.50	0.31	0.86	<b>0.89</b>	2.12	1.86	0	<b>1.33</b>
amphipod	Arthropoda	--	--	--	--	--	--	--	--	4.81	2.56	1.05	<b>2.81</b>	2.12	5.74	1.60	<b>3.15</b>
live barnacle	Arthropoda	0.49	0	0.15	<b>0.21</b>	0	0.10	0.00	<b>0.03</b>	0.09	3.61	0	<b>1.23</b>	0.02	0	0	<b>0.01</b>
branched bryozoan	Bryozoa	0	0.31	0.79	<b>0.37</b>	1.47	0.64	1.32	<b>1.14</b>	1.09	0.63	2.42	<b>1.38</b>	2.15	1.02	0.35	<b>1.17</b>
coral bryozoan	Bryozoa	1.56	3.01	3.27	<b>2.61</b>	0.53	0.59	0.44	<b>0.52</b>	--	--	--	--	--	--	--	--
encrusting bryozoan	Bryozoa	--	--	--	--	1.23	6.95	6.37	<b>4.85</b>	11.28	13.77	11.82	<b>12.29</b>	15.87	3.37	5.40	<b>8.21</b>
<i>Ulva</i>	Chlorophyta	0	1.13	0	<b>0.38</b>	--	--	--	--	--	--	--	--	--	--	--	--
tunicate	Chordata	--	--	--	--	0.12	0	0	<b>0.04</b>	0.11	0.00	0	<b>0.04</b>	0.33	0.02	0.38	<b>0.24</b>
anemone	Cnidaria	0	0	0.14	<b>0.05</b>	1.82	0	0	<b>0.61</b>	--	--	--	--	4.24	0	0	<b>1.41</b>
hydroid	Cnidaria	--	--	--	--	--	--	--	--	0	0	0.29	<b>0.10</b>	0.00	0.00	0.62	<b>0.21</b>
bivalve: clam	Mollusca	--	--	--	--	0	0.03	0.01	<b>0.01</b>	3.39	4.95	3.75	<b>4.03</b>	2.15	9.56	2.14	<b>4.62</b>
jingle	Mollusca	0.22	1.14	0.17	<b>0.51</b>	1.75	2.17	3.95	<b>2.63</b>	1.51	0.65	1.99	<b>1.38</b>	5.91	1.22	3.63	<b>3.59</b>
limpet	Mollusca	--	--	--	--	0.02	0	0.00	<b>0.01</b>	0	0	0.02	<b>0.01</b>	--	--	--	--
scallop	Mollusca	--	--	--	--	--	--	--	--	0.22	0.34	0.02	<b>0.19</b>	1.48	1.01	0	<b>0.83</b>
slipper	Mollusca	0.03	0	0	<b>0.01</b>	0.12	0	0.11	<b>0.08</b>	0.36	0	0.12	<b>0.16</b>	0.03	0.15	0.05	<b>0.08</b>
mussel	Mollusca	--	--	--	--	--	--	--	--	0	0.09	0	<b>0.03</b>	--	--	--	--
calcareous sponge	Porifera	--	--	--	--	--	--	--	--	--	--	--	--	0.09	0.09	0.62	<b>0.26</b>
demosponge	Porifera	--	--	--	--	0.07	0	0	<b>0.02</b>	--	--	--	--	0	0	0.36	<b>0.12</b>
<b>Motile (count)</b>																	
polychaete: errant	Annelida	0	2	1	<b>1</b>	4	3	2	<b>3</b>	--	--	--	--	4	5	0	<b>3.00</b>
amphipod/shrimp	Arthropoda	--	--	--	--	1	1	0	<b>0.67</b>	--	--	--	--	0	2	0	<b>0.67</b>
Cancridae crab	Arthropoda	3	3	2	<b>2.67</b>	1	2	0	<b>1</b>	--	--	--	--	--	--	--	--
Majoidae crab	Arthropoda	--	--	--	--	--	--	--	--	1	1	1	<b>1</b>	0	1	1	<b>0.67</b>
sea urchin	Echinodermata	--	--	--	--	1	0	0	<b>0.33</b>	--	--	--	--	--	--	--	--
snail gastropod	Mollusca	--	--	--	--	--	--	--	--	0	1	0	<b>0.33</b>	0	1	0	<b>0.33</b>
<i>Trichotropsis</i> gastropod	Mollusca	--	--	--	--	18	4	18	<b>13.33</b>	0	1	1	<b>0.67</b>	0	1	2	<b>1.00</b>
ribbon worm	Nemertea	--	--	--	--	--	--	--	--	--	--	--	--	0	2	0	<b>0.67</b>
flatworm	Platyhelminthes	--	--	--	--	--	--	--	--	--	--	--	--	0	0	1	<b>0.33</b>
<b>Miscellaneous</b>																	
unidentified		--	--	--	--	0	0.07	0.02	<b>0.03</b>	0.06	0.04	0	<b>0.03</b>	0.34	0.01	1.85	<b>0.73</b>
Total % cover		59.25	53.23	56.39	<b>56.29</b>	48.16	51.67	43.78	<b>47.87</b>	55.26	64.07	60.91	<b>60.08</b>	60.64	74.33	68.36	<b>67.78</b>



# STRUCTURAL ANALYSIS OF 2014 SAMPLES

- Uponor, the pipe supplier, provided the samples
- Inspection team fabricated stands and racks
- Uponor agreed to do testing and provide data in exchange for



**BUSINESS NUMBER (BN) - IMPORT/EXPORT ACCOUNT REGISTRATION FORM FOR BROKERS AND AGENTS**  
The entire form must be completed for clients who do not have a Canadian Federal Business Number (Payroll, G.S.T., Corporate Tax, etc.). Part 2 can be left blank when a BN has been entered in Part 1.  
If your client is incorporated and does not already have a BN, please include a copy of the Certificate of Incorporation with this application.

**Part 1 - Client Identification**

Legal status (check one): ☐ Individual proprietor ☐ Partnership ☐ Corporation ☒ Other - describe: **County government entity**

Legal name: (As it appears on a Birth Certificate or a Certificate of Incorporation): **King County, Washington**

Business name or division name (When different from legal name):

Business address: (street, city, province/state, country, postal code/zip code)  
**201 S. Jackson ST  
KSC-NR-0508  
Seattle, WA 98104**

Mailing address: (If different from business address)  
c/o

Language preference: ☒ English ☐ French

Contact who can be reached at this business:  
First name: **Jeffrey** Last Name: **Lundt**  
Telephone: (206) 477-5582 Fax: (206) 484-1710

Part 2 - Owner Information (name of proprietor, partner or executive officer of the corporation)  
First name: **Dow** Last name: **Constance**  
Canadian Social Insurance Number: **Not applicable** Title: **King County Executive**  
Telephone: **not available** Fax: **not available**

Part 3 - Import/Export Account Information

Check one of the following: ☐ Export Account ☒ Import Account ☐ Import-export account ☐ MCIT

Type of goods exported: **RDPE Samples** Estimated annual value of goods exported: **\$42 USD**

Part 4 - Broker/Agent Information

Broker agent first name: **NORM** Broker agent last name: **CRTZ**  
Brokerage: **FEDEx TRADE NETWORKS TRANSPORT & BROKERAGE**  
Telephone: 1 800 588 9479 X 290 Fax: (905) 362 2345

Departmental use - Importer/Exporter # \_\_\_\_\_ RM \_\_\_\_\_

**UNIFORM STRAIGHT BILL OF LADING ORIGINAL - NOT NEGOTIABLE**  
ISSUED BY THE SHIPPER AND CARRIER FOR THE SHIPPER'S USE ONLY - (SECTION 1 OF 2)

**FedEx**  
Type 2

Shipper's Reference: **2014** Shipper's Name: **King County** Shipper's Address: **201 S. Jackson ST, Seattle, WA 98104**

Consignee's Name: **King County** Consignee's Address: **201 S. Jackson ST, Seattle, WA 98104**

Commodity: **pipe samples (to be returned to original manufacturer)**

Quantity: **2**

Weight: **210**

Volume: **210**

Value: **42.00**

Incoterms: **EXW**

Mode of Transport: **TRUCK**

Origin: **USA** Destination: **USA**

Carrier: **FedEx** Vessel: **TRUCK** Date of Shipment: **2014**

Signature of Shipper: \_\_\_\_\_ Signature of Consignee: \_\_\_\_\_

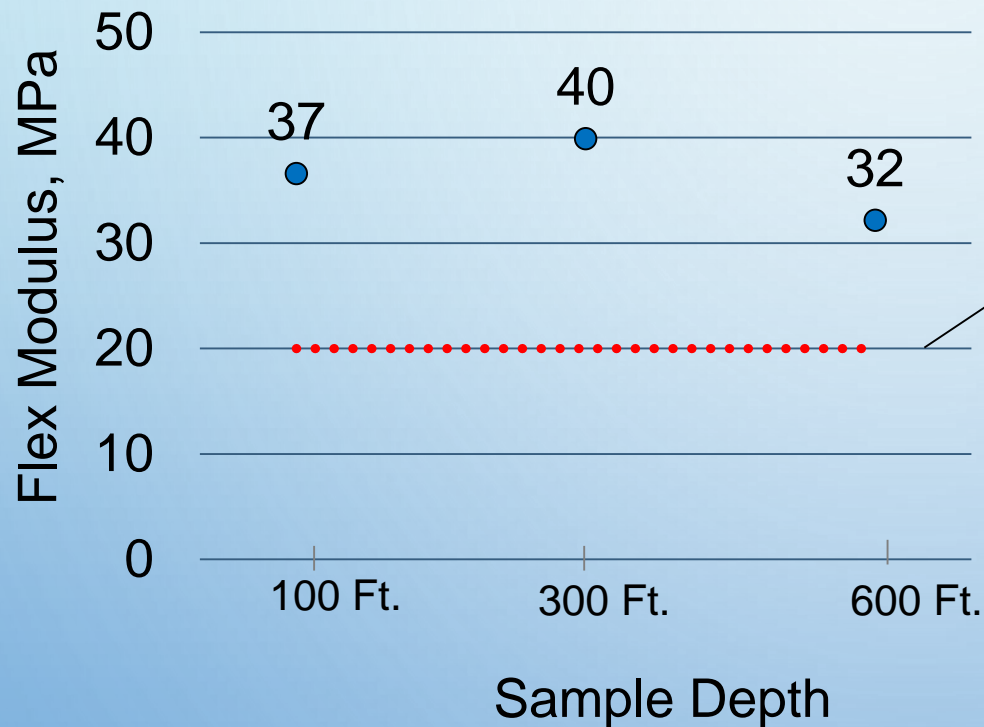
Stamp: **2014**

# STRUCTURAL ANALYSIS 2014 SAMPLES

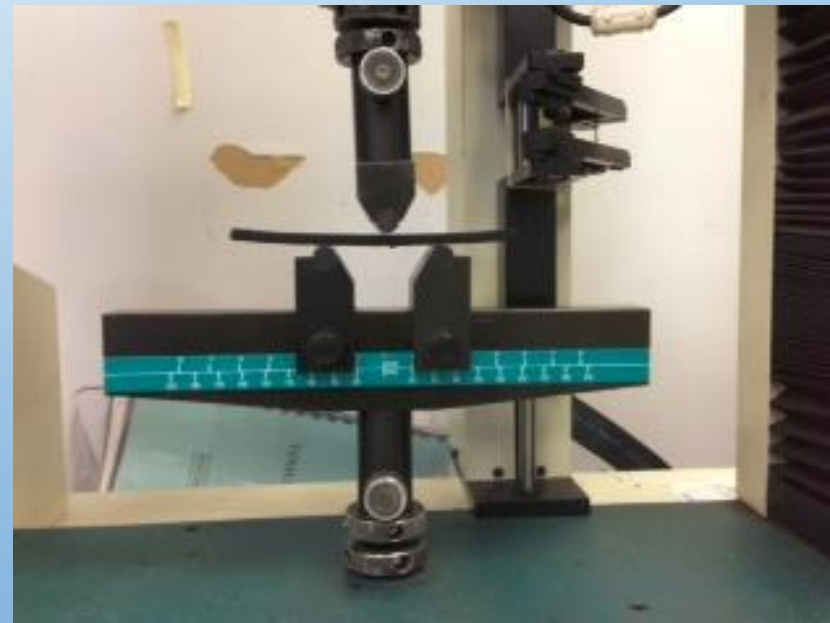
- Uponor's QA material testing lab in Saskatoon, Saskatchewan.
- Samples tested for:
  - Tensile strength,
  - Flex modulus @ 5% strain,
  - Flex modulus @ 2% strain



# FLEX MODULUS @ 5% STRAIN – 2 YEAR

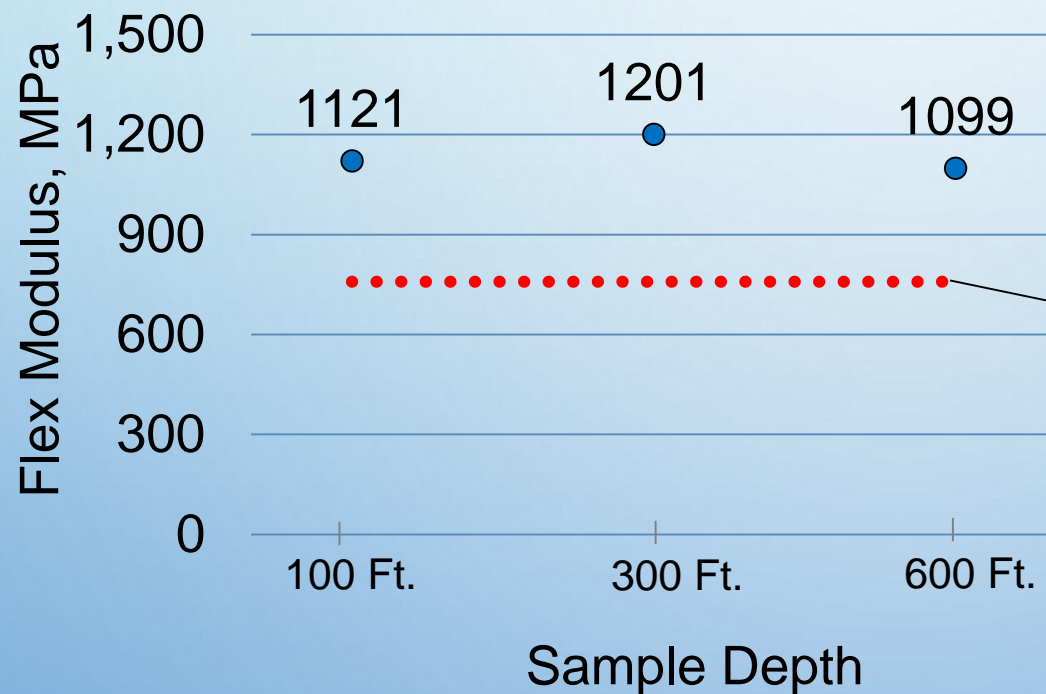


Reference minimum flex modulus–5% value for Udonor's solid-walled HDPE (20 MPa)

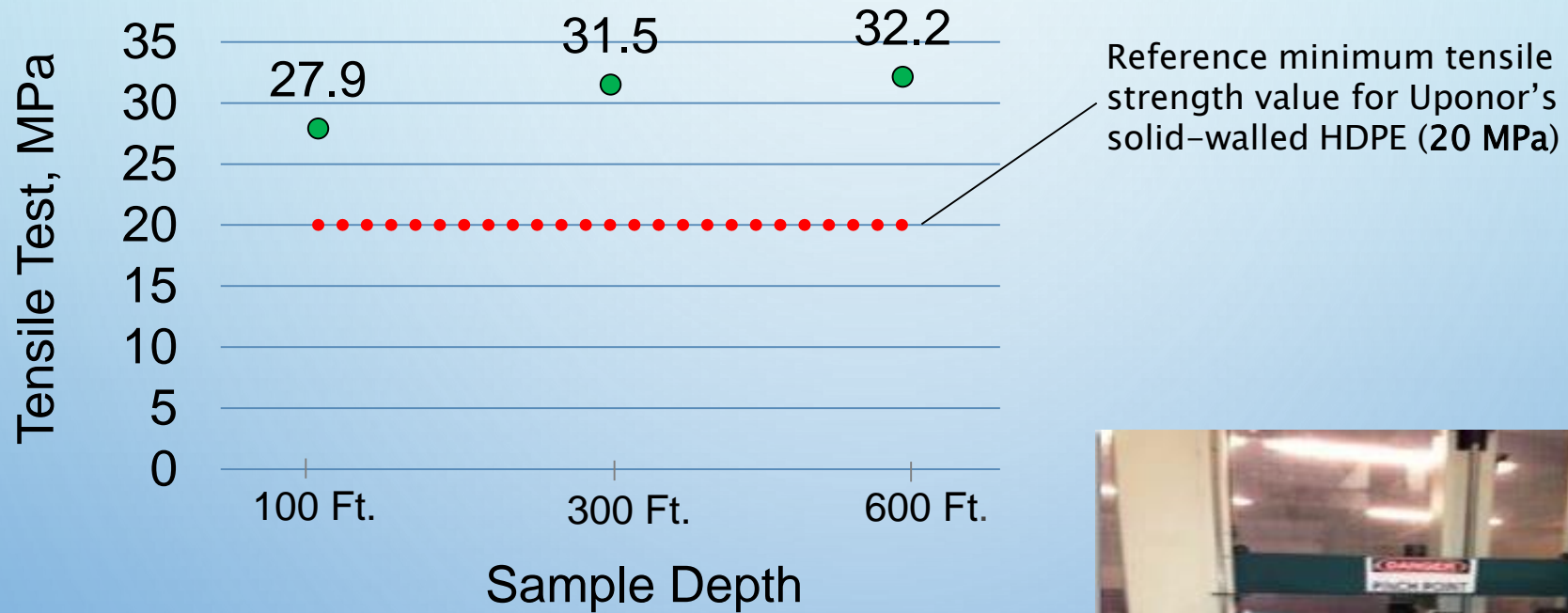




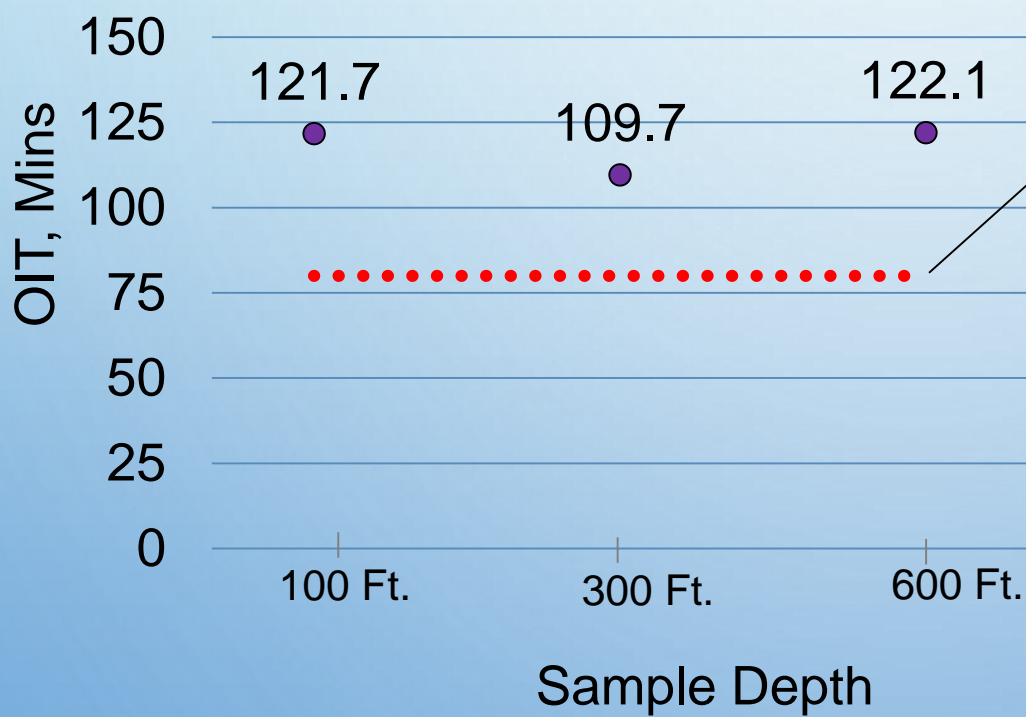
# FLEX MODULUS (SECANT) @ 2% STRAIN – 2 YEAR DATA



# TENSILE TEST



# OXIDATIVE INDUCTION TIME



Reference minimum tensile strength value for Uponor's solid-walled HDPE (80 mins)





# CONCLUSION

- It does not appear that the effluent has had a substantial impact on the biological colonization and composition of the plates.
- The outfall pipe made a habit for marine life
- HDPE pipe was found to be above baseline strength
- Numbering & marking on weights & ports is quickly hidden by marine growth
- 10 year's data should provide good info for habitat evaluation

# COMMENTS & QUESTIONS



For more information please contact:

Jeff Lundt

[jeff.lundt@kingcounty.gov](mailto:jeff.lundt@kingcounty.gov)

206/477-5582