APPENDIX A
SITE PHOTOGRAPHS

1.0 GEOLOGIC BORINGS

Soil cores at PGG-1. Arranged in 5-foot cores, top is shallowest core with top (up) on the right.

Photo 2. Drilling at location PGG-2 on Jasmine Ave.

Soil cores at location PGG-3.

Example of soils observed in hand auger locations north of Roma Avenue. Soils consisted of fine sand with organics. No low-permeability skin was observed and hand auger boring filled with water quickly.

2.0 SURFACE WATER OBSERVATIONS

Marsh Stake #13 location east of Sand Lake Road. Note metal stake used for water level measurements and orange bacterial mats consistent with groundwater discharge to the marsh area.

Photo at edge of marsh north of Roma Avenue, looking north. Note the orange bacterial mats consistent with groundwater discharge to surface water.

Drilling at location PGG-3 on Pollock Ave in background. Culvert for ditch running parallel to the fore-dune in foreground. A metal stake was set in the sedges to measure water levels when water is present. Water was only observed once in this ditch on March 1, 2018 during this study. Note that this ditch is different than the ditch paralleling Sand lake Road, which is located to the east.

Drainage ditch along Sand Lake Road at Jasmine Avenue at 11:20 am on February 15, 2018.

Drainage ditch on Sand Lake Road at 11:10 am on March 2, 2018.

Water over the PGG-3 wells on Pollock Ave at 11:15 am on March 2, 2018. Compare to photo below and hydrographs in main report.

PGG-3 wells on Pollock Ave at 17:09 on March 2, 2018. Water has infiltrated and wells are now accessible.


Looking southwest from Beltz Dike just east of the tide gate. This view shows the marsh area south of the dike.


Upstream end of Roma Ave. culvert, 2/12/2018.

Beltz Marsh viewed from Sand Lake Road where the East Marsh culvert discharges, 2/12/2018.

East Marsh and culvert facing south, 2/12/2018.


Pool downstream of Reneke Creek culvert viewed from Sand Lake Road, 2/12/2018.


Beltz Dike (right) and Beltz Marsh (left) facing west, 2/12/2018.


Closed tide gate at the outside of Beltz Dike, 2/12/2018.


Discharge from perched downstream culvert at Beltz Creek, 2/12/2018.

View of beaver dam from immediately downstream, 2/12/2018.

APPENDIX B
BORING LOGS AND SURVEY DATA

Table 1. Sitka Sedge Survey Notes

Survey Conducted by OPRD in March and April 2018.

OPRD Reference Number	Northing	Easting	Elevation	Point Type	Surveyor's Notes
104	600919.88	7313076.8	24.296	PK	Stamping:PKNote:OBEC flasherFnd / Set:fnd
109	601239.25	7313038.3	15.882	nl	Cap:w/ RPC
111	601252.47	7312650.1	12.819	nl	Cap:w/ RPC
132	600045.66	7312847.6	22.92	GLO	Depth:FlushStamping:T3SR10W S31/S6 T4SR10W 1976Note:3.25in brcap set in conc
133	598359.02	7310844.7	12.87	irod	Fnd/Set:fndCap:w/ YPCRod Diameter:5/8inDepth:-0.2Note:SW cor Roma & SLR
161	601282.35	7312474	14.531	NL	Fnd/Set:fndCap:w/ RPC
165	598592.42	7310261.8	17.782	nl	Cap:w/ RPC
167	598635.71	7310149.5	16.839	nl	Cap:w/ RPC
169	598654.1	7310160.5	17.029	irod	Cap:w/ YPCRod Diameter:5/8inDepth:0.0Stamping:KELLOW PLS 2027Note:N OF POST
171	600916.8	7313068.8	24.235	mon	Fnd/Set:fndDepth:FlushNote:rrspk
193	600665.55	7312844.8	19.896	nl	Fnd/Set:fndCap:w/ RPC
207	597199.14	7310203	18.735	irod	Fnd/Set:fndCap:No CapRod Diameter:5/8inNote:50 N. of NW cor Bilyeu (WWC 223 EL19.066)
208	597837.53	7310493.9	17.428	irod	Fnd/Set:fndCap:No CapRod Diameter:1/2inNote:SW cor Pier (WWC 230 EIL7.717)
209	598212.04	7310759.4	15.23	irod	Fnd/Set:fndCap:No CapRod Diameter:1/2inNote:SW cor Jasmine (WWC 226 EL 15.464)
239	598479.18	7310829.6	13.361	well	Note:PGG-1 top of pipe
240	598473.87	7310056.5	17.482	well	Note:PGG-3s (E] toop of pipe
241	598475.43	7310053.5	17.419	well	Note:PGG-3i (M) top of pipe
242	598475.26	7310050.3	17.269	well	Note:PGG-3d (W) top of pipe
243	598064.42	7310495.1	16.749	well	Note:PGG-2s (W) top of pipe
244	598063.11	7310498	16.785	well	Note:PGG-2i (M) top of pipe
245	598061.43	7310501.1	16.969	well	Note:PGG-2d (E) top of pipe
246	598062.16	7309921.2	18.561	well	Note:PGG-4i (W) top of pipe
247	598061.08	7309923	18.475	well	Note:PGG-4d (E) top of pipe
248	597187.54	7309994.4	19.693	GS	Note:COMMUNITY CENTER
249	598507.22	7311004.5	12.284	NL	Fnd/Set:setCap:w/ RPC
250	598663.57	7310064.3	15.366	NL	Fnd/Set:setCap:w/ RPC
251	598655.1	7310042	17.902	irod	Fnd/Set:fndCap:w/ YPCStamping:A.DUNCAN LSNote:TOP OF BANK W OF CHANNEL
252	598472.04	7309986.7	17.614	NL	Fnd/Set:setCap:w/ RPC
1500	598684.95	7311140.5	8.516	CULV	Material:CMPSize:24Note:2.05ABOVE TOP (inv calc 8.52-(2+2.05)=4.47
1501	598682.16	7311145.1	4.132	FLOW	
1502	598682.9	7311138.7	8.087	Shore	Note:water levelDate:3/7/2018 11:51
1503	598718.76	7311104.5	5.154	CULV	Material:CMPSize:24Note:inv elev
1504	598713.4	7311106.5	8.086	shore	Note:water levelDate:3/7/2018 11:53
1505	598716.85	7311101.4	5.47	FLOW	
1506	598694.8	7311089.9	5.885	FLOW	
1507	598675.52	7311078.3	7.331	FLOW	
1508	598654.22	7311062.8	7.418	FLOW	
1509	598634.42	7311049.5	7.459	FLOW	
1510	598606.28	7311030.3	8.014	FLOW	
1511	598585.89	7311014.1	7.815	FLOW	
1512	598564.61	7310998.8	7.633	FLOW	
1513	598547.83	7310985.8	7.907	FLOW	
1514	598526.66	7310970.5	7.746	FLOW	
1515	598503.61	7310953.5	7.645	FLOW	
1516	598479.84	7310937.7	8.414	FLOW	
1517	598459.86	7310922.7	8.618	FLOW	
1518	598437.92	7310908.1	8.959	FLOW	
1519	598412.91	7310891.8	10.103	FLOW	
1520	598387.82	7310875.5	10.799	FLOW	
1521	598358.85	7310844.5	12.822	see above	
1522	598358.85	7310844.5	12.821	see above	
1523	598651.41	7310086	16.341	GS	
1524	598655.76	7310077.4	15.949	GS	
1525	598658.88	7310070.8	15.567	GS	
1526	598660.11	7310064	15.589	GS	
1527	598662.29	7310057.1	15.911	GS	
1528	598665.89	7310049	16.291	GS	
1529	598670.46	7310040.7	16.712	GS	
1530	598674.49	7310041.2	17.103	GS	
1531	598670.24	7310050.2	16.443	GS	
1532	598666.82	7310059.4	15.984	GS	
1533	598665.39	7310064.6	15.657	GS	
1534	598661.28	7310073.2	15.598	GS	
1535	598657.07	7310082	16.1	GS	
1536	598654.8	7310088	16.108	GS	
1537	598661.99	7310087.6	17.585	GS	
1538	598665.94	7310080.3	15.846	GS	
1539	598668.53	7310077.1	15.053	GS	
1540	598671.05	7310073.7	14.828	GS	
1541	598672.07	7310069.7	14.918	GS	
1542	598673.61	7310066.4	15.235	GS	

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OPRD Reference Number	Northing	Easting	Elevation	Point Type	Surveyor's Notes
1543	598675.3	7310061.3	16.602	GS	
1544	598679.47	7310053.8	17.968	GS	
1545	598684.43	7310047.3	17.94	GS	
1546	598693.75	7310071.4	17.864	GS	
1547	598686.8	7310074.8	17.665	GS	
1548	598680.7	7310078.4	16.352	GS	
1549	598676.9	7310080.1	15.03	GS	
1550	598673.17	7310081.8	15.111	GS	
1551	598670.05	7310083.9	15.143	GS	
1552	598666.31	7310088.5	16.531	GS	
1553	598661.09	7310090.9	17.55	GS	
1554	598645.94	7310082.6	17.331	GS	
1555	598649.75	7310075.7	17.178	GS	
1556	598651.91	7310072.3	17.123	GS	
1557	598653.27	7310066.9	16.183	GS	
1558	598654.29	7310062.8	15.156	SHORE	3/7/2018 13:19
1559	598654.39	7310061.8	14.917	GS	
1560	598655.13	7310058.4	14.371	GS	
1561	598656.31	7310055	14.606	GS	
1562	598656.62	7310052.6	15.041	GS	
1563	598656.91	7310052.1	15.138	SHORE	3/7/2018 13:21
1564	598658.85	7310047.5	16.498	GS	
1565	598659.67	7310043	17.564	GS	
1566	598663.76	7310035.5	17.631	GS	
1567	598653.23	7310030	17.681	GS	
1568	598649.88	7310036.7	17.335	GS	
1569	598646.79	7310042.4	17.18	GS	
1570	598644.89	7310045.6	15.682	GS	
1571	598644.22	7310046.7	15.18	SHORE	3/7/2018 13:23
1572	598643.82	7310047.5	14.866	GS	
1573	598642.29	7310050.6	14.222	GS	
1574	598640.9	7310052.8	14.322	GS	
1575	598640.24	7310054.2	14.66	GS	
1576	598640.05	7310054.8	15.093	SHORE	3/7/2018 13:24
1577	598639.89	7310056.6	15.239	GS	
1578	598637.38	7310059.9	17.413	GS	
1579	598637.38	7310059.9	17.412	GS	
1580	598633.65	7310066	17.301	GS	
1581	598629.27	7310074	17.56	GS	
1582	598465.89	7309986.1	16.209	flow	
1583	598465.92	7309985.8	17.571	culv	Material:CMPSize:18Note:TOP (inv calc 17.57-1.5=16.07)
1584	598494.05	7309998.3	16.935	culv	Material:CMPSize:18Note:TOP (inv calc 16.94-1.5=15.54)
1585	598494.07	7309998.4	15.804	FLOW	
1586	598496.65	7309997.4	16.8	irod	Fnd/Set:fndCap:No CapRod Diameter:5/8inDepth:+1.0Note:IN CHANNEL N. OF POLLOCK
1587	598495.79	7309985.2	17.685	GS	
1588	598492.73	7309991.7	17.368	GS	
1589	598490.29	7309996.7	17.485	GS	
1590	598486.32	7310003.7	17.55	GS	
1591	598484.13	7310009.7	17.537	GS	
1592	598491.48	7310014.6	17.846	GS	
1593	598494.41	7310008.2	17.715	GS	
1594	598496.51	7310003.4	15.75	GS	
1595	598497.69	7310000.7	15.644	GS	
1596	598499.43	7309997.4	15.691	GS	
1597	598501	7309995.7	15.908	GS	
1598	598502.23	7309990.5	17.501	GS	
1599	598503.98	7309986.5	17.568	GS	
1600	598508.08	7310018.8	17.802	GS	
1601	598507.52	7310019.4	17.798	GS	
1602	598509.39	7310014.5	21.861	GS	
1603	598511.76	7310008.7	15.372	GS	
1604	598512.77	7310006.7	15.094	SHORE	3/7/2018 14:07
1605	598513.86	7310005	14.608	GS	
1606	598514.69	7310003.1	14.614	GS	
1607	598515.54	7310002.1	15.133	SHORE	3/7/2018 14:08
1608	598515.89	7310001.1	15.201	GS	
1609	598519.69	7309995.8	17.267	GS	
1610	598521.68	7309990.2	17.233	GS	
1614	597802.92	7310720.3	15.508	top wood stake	Note:water level -2.61Date:4/03/18 12:32pm

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OPRD Reference Number	Northing	Easting	Elevation	Point Type	Surveyor's Notes
1615	597802.54	7310719.2	13.669	top steel post	Note:water level -.0.79Date:4/03/18 12:33pm
1616	601295.51	7312499.9	8.44	TBM	Note:N. HEADGATE
1618	601255.09	7312494.1	8.328	TBM	20180404TDMgris.csv
1752	598684.65	7311141.1	4.628	flow	sediment level at inlet to culv
1755	598718.22	7311105.5	4.965	flow	
1760	598545.69	7311145.8	5.69	Grnd&Water	Note:water level +2.90ftDate:4/23/18 10:56:15am
1762	600418.94	7311878.2	9.138	XSec	Station:6-5Note:startDate:4/23/18
1763	600473.51	7311803.7	7.216	XSec	Station:6-5Note:grassDate:4/23/18
1764	600474.89	7311801.2	6.819	XSec	Station:6-5Note:grassDate:4/23/18
1765	600484.94	7311788.5	6.396	XSec	Station:6-5Note:grass/mudDate:4/23/18
1766	600505.5	7311759.3	5.658	XSec	Station:6-5Note:mudDate:4/23/18
1768	600506.73	7311757.8	5.496	XSec	Station:6-5Note:waterDate:4/23/18 1:01:12pm
1769	601097.19	7312518.7	7.744	XSec	Station:4-3Note:startDate:4/23/18
1770	601087.19	7312456.9	7.342	XSec	Station:4-3Date:4/23/18
1771	601098.35	7312399.9	7.129	XSec	Station:4-3Date:4/23/18
1772	601111.5	7312330.8	6.712	XSec	Station:4-3Date:4/23/18
1773	601113.19	7312309	6.366	XSec	Station:4-3Note:mudDate:4/23/18
1774	601115.98	7312296.9	5.589	XSec	Station:4-3Note:waterDate:4/23/18
1775	601189.79	7311860.8	5.478	XSec	Station:4-3Note:waterDate:4/23/18
1776	601191.3	7311856.4	6.174	XSec	Station:4-3Note:mud/grassDate:4/23/18
1777	601191.64	7311848	6.405	XSec	Station:4-3Note:grassDate:4/23/18
1778	601194.21	7311839.8	6.17	XSec	Station:4-3Note:mud/grassDate:4/23/18
1779	601194.84	7311829.2	5.366	XSec	Station:4-3Note:mudDate:4/23/18
1780	601199.88	7311802.9	6.029	XSec	Station:4-3Note:mud/grassDate:4/23/18
1781	601203.99	7311782.1	6.941	XSec	Station:4-3Note:grassDate:4/23/18
1782	601216.43	7311707.9	7.245	XSec	Station:4-3Note:grassDate:4/23/18
1783	601224.27	7311655.6	7.562	XSec	Station:4-3Note:grassDate:4/23/18
1784	601235.68	7311602.1	7.609	XSec	Station:4-3Note:grassDate:4/23/18
1785	601235.64	7311602.2	7.601	XSec	Station:4-3Note:grassDate:4/23/18
1786	601243.38	7311547.3	7.399	XSec	Station:4-3Note:grassDate:4/23/18
1787	601251.99	7311494	7.545	XSec	Station:4-3Note:grassDate:4/23/18
1788	601261.8	7311435.1	7.639	XSec	Station:4-3Note:grassDate:4/23/18
1789	601274.16	7311364.8	7.429	XSec	Station:4-3Note:grass/endDate:4/23/18
1790	601023.14	7311058.8	17.909	XSec	Station:5-6Note:grass/endDate:4/23/18
1791	600988.54	7311105.7	11.084	XSec	Station:5-6Note:grassDate:4/23/18
1792	600977.99	7311120.1	10.305	XSec	Station:5-6Note:tall grassDate:4/23/18
1793	600957.34	7311148.6	8.427	XSec	Station:5-6Note:tall grassDate:4/23/18
1794	600930.49	7311185	8.268	XSec	Station:5-6Note:tall grassDate:4/23/18
1795	600904.52	7311219.9	7.883	XSec	Station:5-6Note:tall grassDate:4/23/18
1796	600875.97	7311258.9	7.618	XSec	Station:5-6Note:tall grassDate:4/23/18
1797	600859.69	7311280	8.044	XSec	Station:5-6Note:edge brush tall grassDate:4/23/18
1798	600835.46	7311313.5	8.051	XSec	Station:5-6Note:edge brush tall grassDate:4/23/18
1799	600824.71	7311329	7.625	XSec	Station:5-6Note:tall grass to grassDate:4/23/18
1800	600802.66	7311357.3	7.228	XSec	Station:5-6Note:grassDate:4/23/18
1801	600778.14	7311391.6	6.07	XSec	Station:5-6Note:grass/mudDate:4/23/18
1802	600767.12	7311403.5	5.729	XSec	Station:5-6Note:mudDate:4/23/18
1804	600759.52	7311416.7	5.388	XSec	Station:5-6Note:mud/swampy/reedsDate:4/23/18
1805	600720.51	7311466.8	5.617	XSec	Station:5-6Note:swampy/reedsDate:4/23/18
1806	600705.75	7311490.6	5.299	XSec	Station:5-6Note:swampy/reedsDate:4/23/18
1807	600682.47	7311519.1	5.33	XSec	Station:5-6Note:swampy/reedsDate:4/23/18
1808	600659.5	7311550.4	5.372	XSec	Station:5-6Note:swampy/reedsDate:4/23/18
1809	600642.51	7311572	5.603	XSec	Station:5-6Note:swampy/reedsDate:4/23/18
1810	600630.88	7311590	6.246	XSec	Station:5-6Note:mud/grassDate:4/23/18
1811	600615	7311610.2	6.642	XSec	Station:5-6Note:grassDate:4/23/18
1812	600603.33	7311628.3	6.24	XSec	Station:5-6Note:grass/mudDate:4/23/18
1813	600597.71	7311635.2	5.714	XSec	Station:5-6Note:mudDate:4/23/18
1814	600596.83	7311635.6	5.501	XSec	Station:5-6Note:mudDate:4/23/18
1815	597749.4	7310944.6	11.081	Grnd&Water	Note:water level +0.77ftDate:4/25/18 12:56:54pm
1817	597461.56	7310831.2	12.307	Grnd&Water	Note:water level +0.37ft Date:4/25/18 1:25:52pm
1819	598097.32	7311090	10.03	Grnd&Water	Note:water level +0.91ftDate:4/25/18 1:56:59pm
1821	598934.3	7311256.7	7.847	shore	Date:4/25/18 3:00:12pm
1822	598969.7	7311260.2	7.167	xsec	Station:1-2Note:water level +0.7Date:4/25/18 3:04:22pm
1823	598994.16	7311202.8	7.897	xsec	Station:1-2Note:start catailsDate:4/25/18
1824	599010.34	7311163.7	7.705	xsec	Station:1-2Note:catailsDate:4/25/18
1825	599029.81	7311118.1	7.642	xsec	Station:1-2Note:catailsDate:4/25/18
1826	599033.92	7311109.3	7.129	xsec	Station:1-2Note:catails/channel water+0.77Date:4/25/18
1827	599037.79	7311104.8	5.232	xsec	Station:1-2Note:in channelDate:4/25/18
1829	599046.42	7311094.8	7.343	xsec	Station:1-2Note:channel/treesDate:4/25/18
1830	599053.26	7311078	8.419	xsec	Station:1-2Note:islandDate:4/25/18

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1831	599056.76	7311064.7	7.688	xsec	Station:1-2Note:island/channelDate:4/25/18
1832	599061.47	7311055.9	4.552	xsec	Station:1-2Note:in channelDate:4/25/18
1833	599070.76	7311024.8	7.971	xsec	Station:1-2Note:channel/islandDate:4/25/18
1834	599071.52	7311022.9	8.08	xsec	Station:1-2Note:islandDate:4/25/18
1835	599075.46	7311012.4	8.4	xsec	Station:1-2Note:islandDate:4/25/18
1836	599078.54	7311003.2	7.731	xsec	Station:1-2Note:island/channelDate:4/25/18
1837	599081.82	7310995.2	7.145	xsec	Station:1-2Note:end of reed grass/channelDate:4/25/18
1838	599081.39	7310990.1	4.224	xsec	Station:1-2Note:channelDate:4/25/18
1839	599081.06	7310988.8	3.644	xsec	Station:1-2Note:channelDate:4/25/18
1840	599194.37	7310758.8	10.598	xsec	Station:1-2Note:tall grass/endDate:4/25/18
1841	599167.54	7310808	8.453	xsec	Station:1-2Note:tall grassDate:4/25/18
1842	599160.47	7310825.5	8.263	xsec	Station:1-2Note:tall grass- low spotDate:4/25/18
1843	599156	7310832.9	7.787	xsec	Station:1-2Note:tall grass- blackberriesDate:4/25/18
1844	599139.31	7310861.4	8.373	xsec	Station:1-2Note:tall grass- blackberriesDate:4/25/18
1845	599136.13	7310867.7	7.61	xsec	Station:1-2Note:waterDate:4/25/18 4:44:09pm
1846	599131.81	7310875.8	4.787	xsec	Station:1-2Note:uwaterDate:4/25/18
1847	599131.67	7310880.9	7.747	xsec	Station:1-2Note:waterDate:4/25/18 4:49:49pm
1848	599123.3	7310899.1	9.324	xsec	Station:1-2Note:islandDate:4/25/18
1849	599117.09	7310919.3	8.024	xsec	Station:1-2Note:islandDate:4/25/18
1850	599105.95	7310939.4	7.516	xsec	Station:1-2Note:swampDate:4/25/18
1851	599095.22	7310960.9	7.659	xsec	Station:1-2Note:swampDate:4/25/18
1852	599089.77	7310972.4	7.326	xsec	Station:1-2Note:swampDate:4/25/18
1853	599088.73	7310978.9	6.883	xsec	Station:1-2Note:swamp top channelDate:4/25/18
1854	599088.71	7310978.9	6.906	xsec	Station:1-2Note:swamp top channelDate:4/25/18
1855	599088.09	7310981	5.287	xsec	Station:1-2Note:uwaterDate:4/25/18

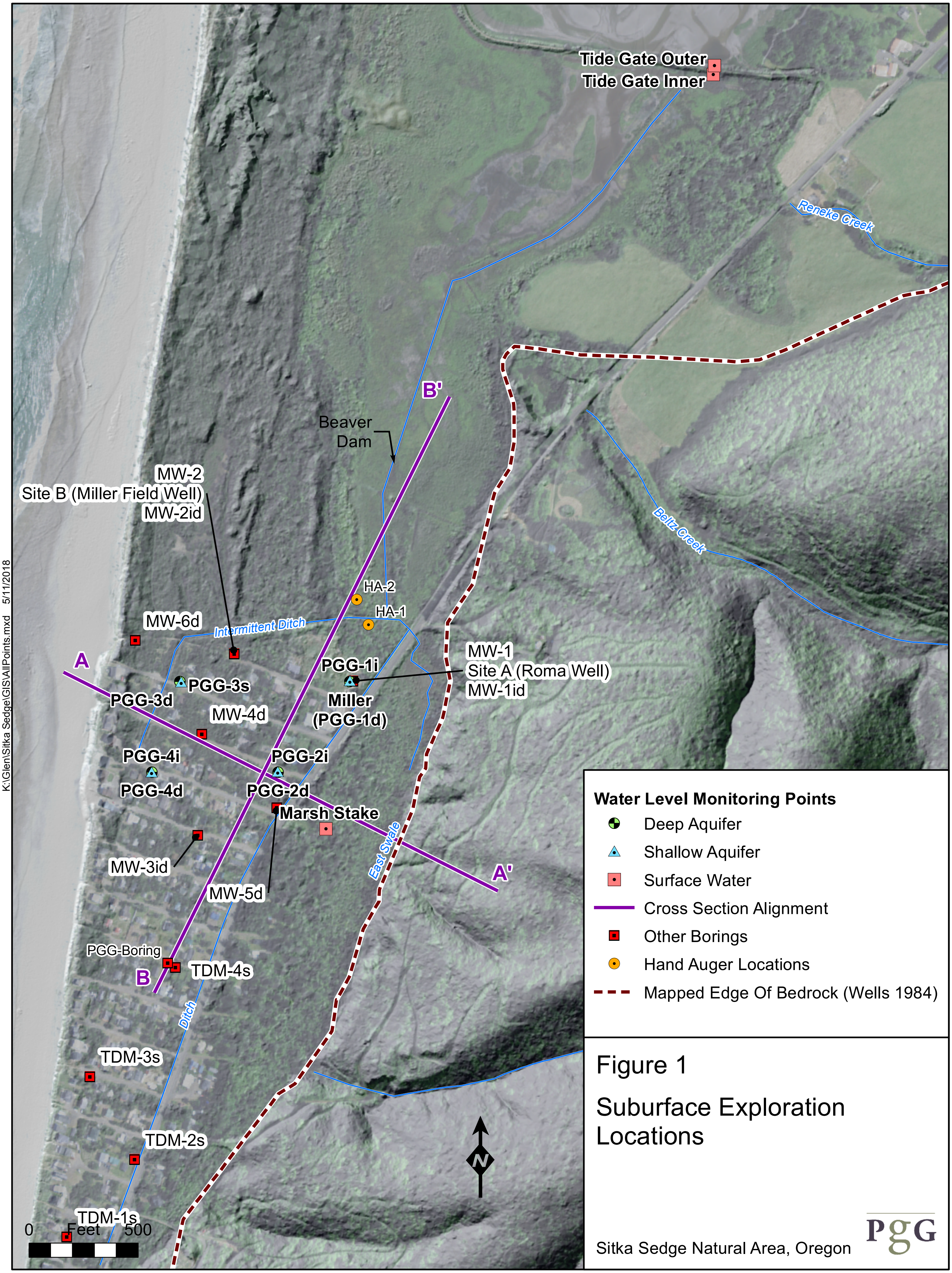


Figure 1

Suburface Exploration Locations

Sitka Sedge Natural Area, Oregon

K:\Glen\Sitka Sedge\GIS\AllPoints.mxd 5/11/2018

P2 Driller Rpt.

Date Started: 3/18/16	Date Completed: 3/18/16
Logged by: A. Jones	Checked by:
Location: N: 598,476.23 E: 7,310,830.07	
Ground Surface Elevation: 14.27 feet	
Horizontal Datum: OR State Plane N, NAD 83, ft.	
Vertical Datum: NAVD88	
Comments:	
Drilling Contractor/Crew: Western States Soil Conservation, Inc. / Brad Wright	
Drilling Method: Direct Push	
Rig Model/Type: Geoprobe®	
Hammer Type: NA	
Hammer Weight: NA	Hammer Drop Height: NA
Hammer Efficiency (%): Measured: NA	Estimated: NA
Auger Diameter: 4 inches	Casing Diameter:
Total Depth: 20 feet	Depth to Ground Water: 3.2 feet

Elevation (feet)	Depth (feet)	Sample Data: Type / Recovery / Length (inches)	Number / Tests	Material Description	Water Level
	0	60 / 36in.	S-1	(Loose), moist, brown, POORLY GRADED SAND (SP).	
				grades to wet	3/18/2016 ∇
10	5	60 / 36in.	S-2	grades to gray (hydric)	
5				(Soft), wet, brown, SANDY LEAN CLAY (CL).	
	10	60 / 60in.	S-3		
				Top of Seasonal W.T.	
				(Loose), wet, gray, POORLY GRADED SAND (SP), scattered roots.	
0	15	60 / 60in.	S-4	(Soft), wet, brown, SANDY LEAN CLAY (CL).	
				(Loose), wet, gray, POORLY GRADED SAND (SP), scattered roots.	
-5	20			Bottom of Borehole at 20.0 feet.	
-10					

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between soil strata or geologic units. Dashed stratum lines indicate gradual or approximate change between soil strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER	Project: Sand Lake Culvert Replacement Location: Tillamook County, Oregon Project No.:15942-05	Push Probe and Monitoring Well Log **MW-1**	Figure **A-2** Sheet 1 of 1

P-3 Drillers Rpt

Date Started: 3/18/16	Date Completed: 3/18/16	Drilling Contractor/Crew: Western States Soil Conservation, Inc. / Brad Wright	
Logged by: A. Jones	Checked by:	Drilling Method: Direct Push	
Location: N: 598,601.91 E: 7,310,286.29		Rig Model/Type: Geoprobe®	
Ground Surface Elevation: 17.94 feet		Hammer Type: NA	
Horizontal Datum: OR State Plane N, NAD 83, ft.		Hammer Weight: NA	Hammer Drop Height: NA
Vertical Datum: NAVD88		Hammer Efficiency (%): Measured: NA	Estimated: NA
Comments:		Auger Diameter: 4 inches	Casing Diameter:
		Total Depth: 20 feet	Depth to Ground Water: 3 feet

Elevation (feet)	Depth (feet)	Type	Recovery	Length (inches)	Number Tests	Graphic Log	Material Description	Water Level	Well Construction	Depth (feet)
	0		48in.	60	S-1		(Loose), moist, brown, POORLY GRADED SAND (SP), fine sand.			0
15							grades to wet	3/18/2016 ∇		
	5		60in.	60	S-2					5
10	10		60in.	60	S-3		grades to gray (hydric)			10
5							(Soft), moist, brown, LEAN CLAY (CL).			
							(Loose), wet, gray, POORLY GRADED SAND (SP), fine sand.			
	15		60in.	60	S-4					15
0										
	20						Bottom of Borehole at 20.0 feet.			20
-5										

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between soil strata or geologic units. Dashed stratum lines indicate gradual or approximate change between soil strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HC BORING LOG - F:\GINT\HC LIBRARY.GLB - 3/28/16 13:15 - \\PDXSRV\DATA\NOTEBOOKS\1594205_SAND LAKE CULVERT REPLACEMENT\FIELD DATA\PERM_GINT\1594205_MWS.GPJ

HARTCROWSER	Project: Sand Lake Culvert Replacement Location: Tillamook County, Oregon Project No.:15942-05	Push Probe and Monitoring Well Log **MW-2**	Figure A-3 Sheet 1 of 1

P-1 Drillers Rpt

Date Started: 3/18/16	Date Completed: 3/18/16	Drilling Contractor/Crew: Western States Soil Conservation, Inc. / Brad Wright	
Logged by: A. Jones	Checked by:	Drilling Method: Direct Push	
Location: N: 597,771.09 E: 7,310,117.82		Rig Model/Type: Geoprobe®	
Ground Surface Elevation: 19.108 feet		Hammer Type: NA	
Horizontal Datum: OR State Plane N, NAD 83, ft.		Hammer Weight: NA	Hammer Drop Height: NA
Vertical Datum: NAVD88		Hammer Efficiency (%): Measured: NA	Estimated: NA
Comments:		Auger Diameter: 4 Inches	Casing Diameter:
		Total Depth: 20 feet	Depth to Ground Water: 3.5 feet

Depth (feet)	Sample Recovery / Length (inches)	Number Tests	Material Description
0–5	38in. / 60	S-1	(Loose), brown, POORLY GRADED SAND (SP), fine sand. grades to wet
5–10	60in. / 60	S-2	grades to gray (hydric)
10–15	60in. / 60	S-3	(Stiff), moist, brown, SILT (ML), slight organic odor, scattered roots.
15–20	60in. / 60	S-4	(Loose), wet, gray, POORLY GRADED SAND (SP), fine sand.

Water Level: 3/18/2016 ▽ (3.5 feet)

Bottom of Borehole at 20.0 feet.

General Notes:

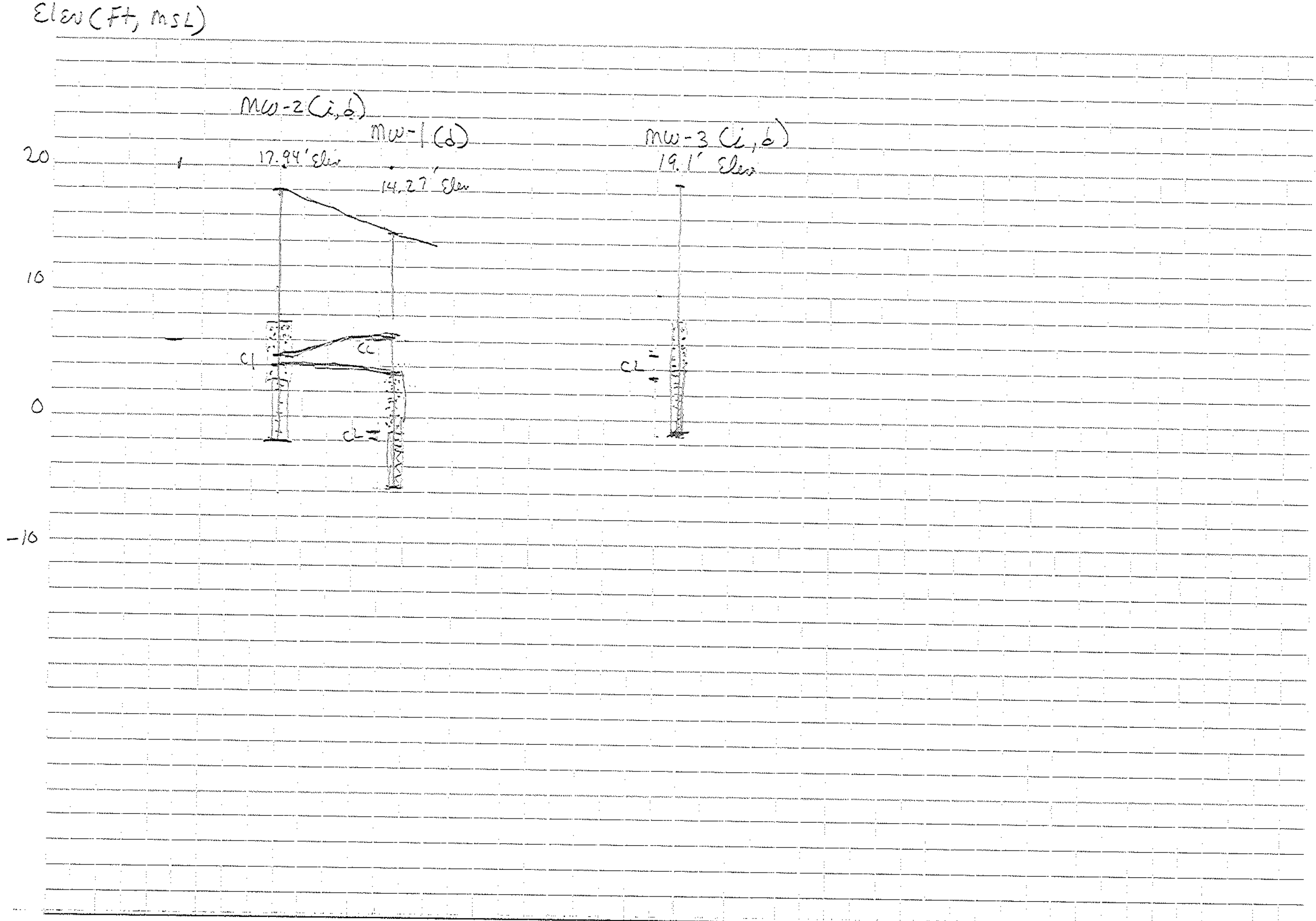
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual. Solid stratum lines indicate distinct contact between soil strata or geologic units. Dashed stratum lines indicate gradual or approximate change between soil strata or geologic units.
3. USCS designations are based on visual-manual identification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.

HARTCROWSER

Project: Sand Lake Culvert Replacement
Location: Tillamook County, Oregon
Project No.:15942-05

Push Probe and Monitoring Well Log
MW-3

Figure A-4
Sheet 1 of 1



MRK (Pacific Hydro-Geology)

Pacific Hydro-Geology Inc.

Log of Exploration

Exploration No. TDM-4

Sheet ______ of ______

Client/Owner TDMCC

Project No. TDM/ Sitka Sedges

Start Date 11/13/16

Hour ______

Ground Surface Conditions Undisturbed

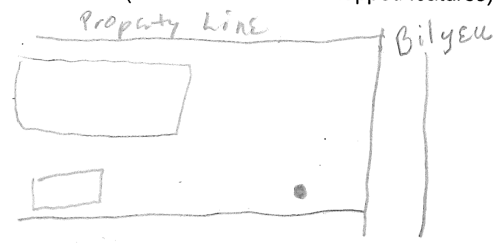
Weather Conditions cloudy, occasional light rain

Field Rep. GEK / MRK

Contractor/ Operator ______

Exploration Method Post hole digger, Auger, Shovel

Location Sketch (show dimensions to mapped features)



Surface elevation ______ Datum ______

Sampler and Hammer Information:

a = 2.42-in. I.D. Split Spoon
b = 2.0-in. O.D. Split Spoon
c = Shelby Tube
d = ______

1 = 300-lb. Hammer 30-inch Drop
2 = 140=lb. Hammer 30-inch Drop
3 = Pushed
4 = ______

Water Level Information

Date		
Time		
Depth to Water		
Hole Depth		
Casing depth		

Sample Interval (Top / Bot.)	Recovery (Top / Bot.)	Retained Interval (Top / Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
								0	SP/PT	7.5YR 2.5/2 Very dark brown, Very organic Fine SAND, poorly sorted, Roots	
1.7 / 2.2			1					1.1	CH	10YR 4/3 brown, CLAY with strong mottles 10YR6/4 light yellowish brown + 10YR 7/6 yellow	Redox Many, Fine, prominent. Fill?
2.6 / 3.1			2					2.6	SP	10YR 3/1 Very dark gray, Fine SAND	
3.1 / 3.4			3					3.1	SP	10YR 4/2 Dark grayish brown, Fine SAND	GW near bottom

4S 10W Sec 6 CB
04S10W06CB 5200

Total Depth 3.5'

Finish Date 11/13/16

Hour ______

Continued ☐

Form 1

Pacific Hydro-Geology Inc.

As-Built Well Completion Form

Project: TDM Community Center

Project No.: ______

Well(s) No.: TDM-4

Drilling Co.: ______

PHG Rep(s): GEK/MRK

Installation Start Date: 6/13/16 Hour: ______

Installation Finish Date: 6/13/16 Hour: ______

Well Type: ☒ Single ☐ Nested ☐ Clustered

EQUIPMENT USED

☐ Hollow Stem Auger ☐ Cable Tool ☐ Air Rotary

☒ Other Post hole digger, Auger, Shovel

MATERIALS USED

Calculated	Actual	
____	____	Sacks of ______ Sand
____	____	Sacks of ______ Sand
____	____	Sacks of ______ Concrete/Cement
____	____	Sacks of Powdered/Granular Bentonite
2/8	3/8	Pounds of Bentonite Pellets/Chips
____	____	Feet of ___-inch Diameter PVC Blank Casing
____	____	Feet of ___-inch Diameter PVC Slotted Screen (___-inch Slot Size)

___ Centralizer V PVC End Cap V PVC Well Cap X Padlock

Other Materials: Native sand around screen

GROUT WEIGHT

Date:	Time:	Grout Wt.*

* lbs./gal.

DEVELOPMENT

Method of Development:

Begin Date: Time:

Finish Date: Time:

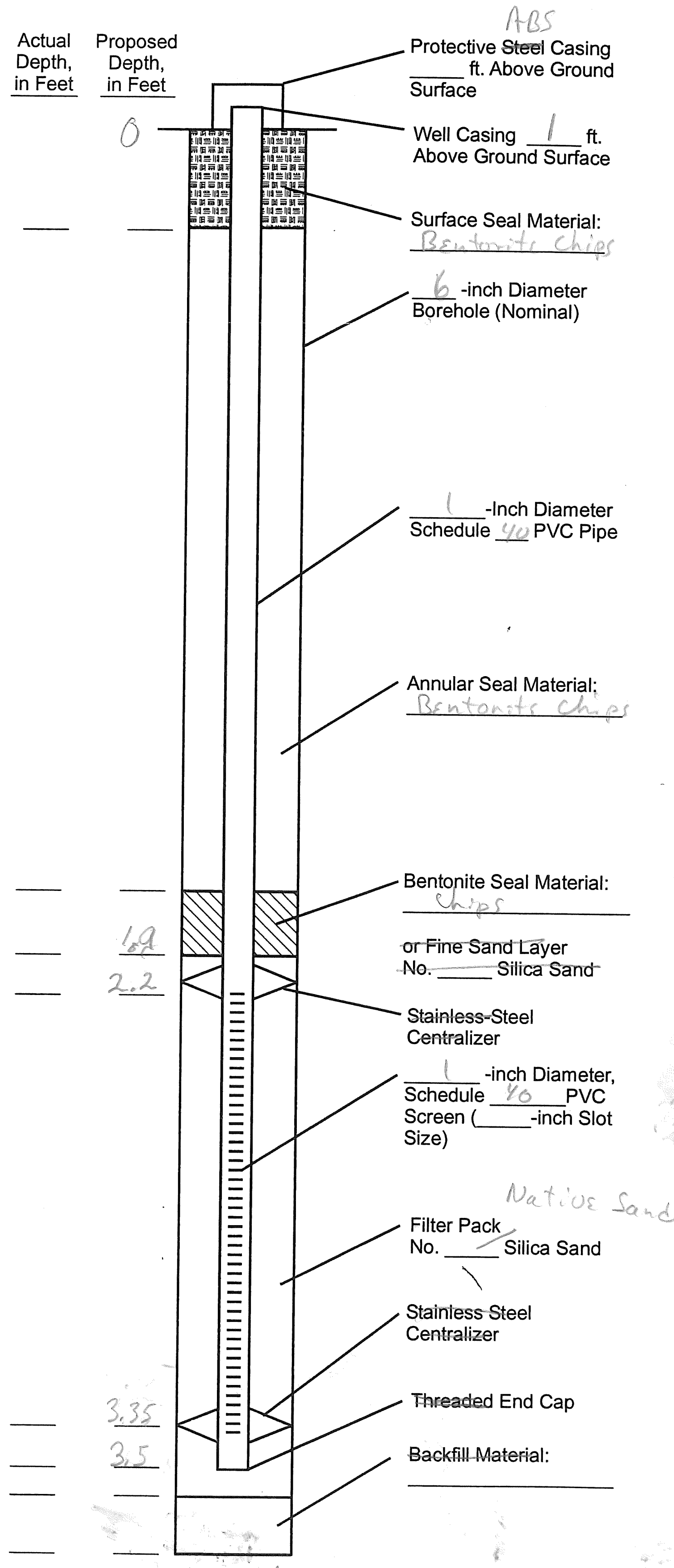
Yield: Initial: Final: Depth to Water After Development: ______ Feet

Estimate of Total Volume of Water Removed During Development: Gallons

Description of Turbidity at End of Development: ☐ Clear ☐ Slightly Cloudy ☐ Mod. Turbid ☐ Very Cloudy

Odor of Water: ☐ No Odor ☐ Other ______

Water Discharged To:



Depth of Boring 3.5' feet (BGS, BTOC)

Depth to Water ______ feet (BGS, BTOC)

Form 2

Pacific Hydro-Geology Inc.

Log of Exploration

Exploration No. TDM-3

Sheet ______ of ______

Client/Owner: Andy Ewing

Project No.: TDM/Sitka Sedges

Start Date: 11/13/16

Hour: ______

Ground Surface Conditions: Undisturbed

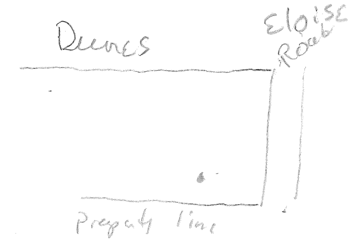
Weather Conditions: Cloudy, light rain

Field Rep.: GEK / MRK

Contractor/Operator: ______

Exploration Method: Post hole digger, Auger, Shovel

Location Sketch (show dimensions to mapped features)



Surface elevation ______ Datum ______

Sampler and Hammer Information:

a = 2.42-in. I.D. Split Spoon	1 = 300-lb. Hammer 30-inch Drop
b = 2.0-in. O.D. Split Spoon	2 = 140=lb. Hammer 30-inch Drop
c = Shelby Tube	3 = Pushed
d = ______	4 = ______

Water Level Information

Date		
Time		
Depth to Water		
Hole Depth		
Casing depth		

Sample Interval (Top / Bot.)	Recovery (Top / Bot.)	Retained Interval (Top / Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
							0.45	0	SP	7.5 YR 2.5/1 Black, Fine SAND, poorly sorted with organics	
1.8			1					1	SP	7.5 YR 4/1 dark gray, Fine SAND, poorly sorted, no organics, quartz + heavy metals	
								2			No GW
								3			
								4			
								5		Andy Ewing	
								6			
								7			
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Total Depth 3.5' Finish Date 11/13/16 Hour ______ Continued ☐

Pacific Hydro-Geology Inc.

As-Built Well Completion Form

Project: Andy Ewing

Project No.: TDM // Sitka Sedge

Well(s) No.: TDM-3

Drilling Co.: ______

PHG Rep(s): GSK/MRK

Installation Start Date: 11/13/2016 Hour: ______

Installation Finish Date: 11/13/2016 Hour: ______

Well Type: ☒ Single ☐ Nested ☐ Clustered

EQUIPMENT USED

☐ Hollow Stem Auger ☐ Cable Tool ☐ Air Rotary

☒ Other Post hole digger, Auger, shovel

MATERIALS USED

Calculated	Actual	
____	____	Sacks of ______ Sand
____	____	Sacks of ______ Sand
____	____	Sacks of ______ Concrete/Cement
____	____	Sacks of Powdered/Granular Bentonite
318	318	Pounds of Bentonite Pellets/Chips
____	____	Feet of 1-inch Diameter PVC Blank Casing
____	____	Feet of 1-inch Diameter PVC Slotted Screen (___-inch Slot Size)

___Centralizer ✓ PVC End Cap ✓ PVC Well Cap ✓ Padlock

Other Materials: Native sand around screen

GROUT WEIGHT

Date:	Time:	Grout Wt.*

* lbs./gal.

DEVELOPMENT

Method of Development:

Begin Date: Time:

Finish Date: Time:

Yield: Initial:
Final:

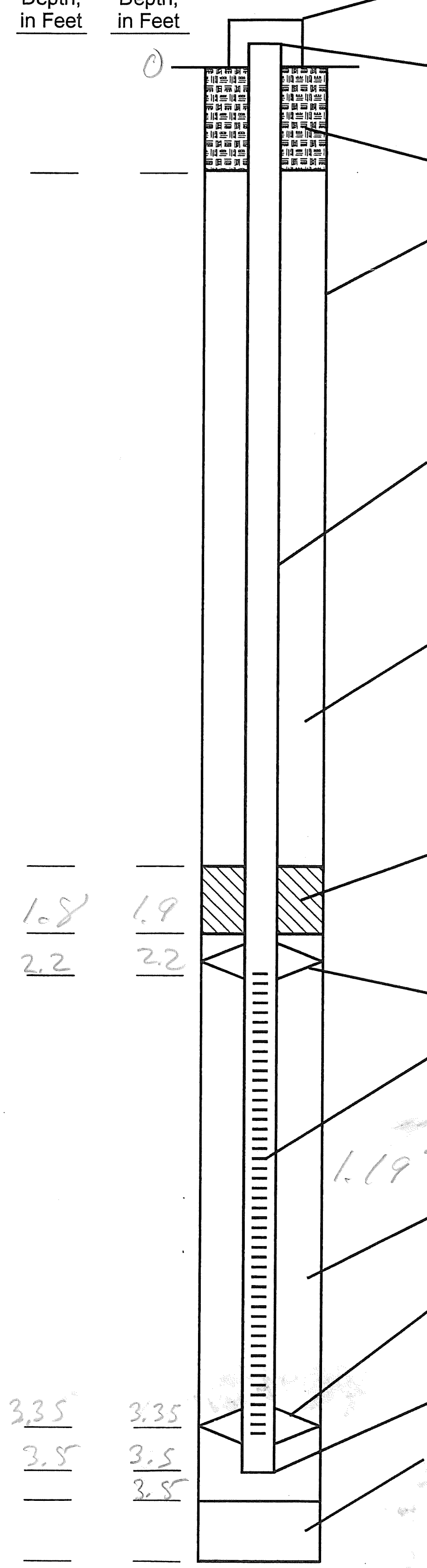
Depth to Water After Development: ______ Feet

Estimate of Total Volume of Water Removed During Development: Gallons

Description of Turbidity at End of Development: ☐ Clear ☐ Slightly Cloudy ☐ Mod. Turbid ☐ Very Cloudy

Odor of Water: ☐ No Odor ☐ Other ______

Water Discharged To:



Depth of Boring ______ feet (BGS, BTOC)

Depth to Water ______ feet (BGS, BTOC)

Form 2

Pacific Hydro-Geology Inc.

Log of Exploration

Exploration No. TDM-2

Sheet ______ of ______

Client/Owner Kevin Quille Project No. TDM/Quille

Start Date 11/14/16 Hour ______

Ground Surface Conditions Undisturbed soil

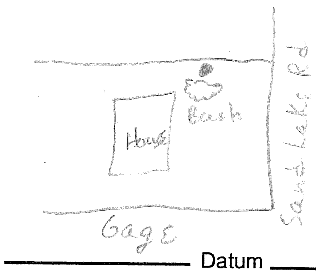
Weather Conditions Cloudy, saturated air

Field Rep. GEK/MRK Contractor/Operator ______

Exploration Method Post hole digger, Hand auger

Location Sketch (show dimensions to mapped features)

North Arrow



Surface elevation ______ Datum ______

Sampler and Hammer Information:

- a = 2.42-in. I.D. Split Spoon
- b = 2.0-in. O.D. Split Spoon
- c = Shelby Tube
- d = ______
- 1 = 300-lb. Hammer 30-inch Drop
- 2 = 140=lb. Hammer 30-inch Drop
- 3 = Pushed
- 4 = ______

Water Level Information

Date		
Time		
Depth to Water	1.5'	
Hole Depth		
Casing depth		

Sample Interval (Top / Bot.)	Recovery (Top / Bot.)	Retained Interval (Top / Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
0 / 0.45			1					0 – .45	SP	(10YR 2/1) Black, Fine SAND with organics, Poorly sorted	
0.45 / 0.8			2					.45 – 0.8	SP	(10YR 4/2) Dark yellowish-brown, Fine SAND,	1.5' H_2O
								2	SP	(10YR 3/2) Very dark grayish brown, Fine SAND, Poorly sorted	
1.5 / 3.5			3					3			
								4			
								5		Kevin Quille 5860 Gage Cloverdale, OR 97112	
								6			
								7			
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Total Depth 3.5' Finish Date 11/14/16 Hour ______ Continued ☐

Pacific Hydro-Geology Inc.

As-Built Well Completion Form

Project: Kann Quills / TDM / Sitka Sedges
Project No.: ____

Well(s) No.: TDM-2
Drilling Co.: ____
PHG Rep(s): GSK / MRK
Installation Start Date: 11/14/16 Hour: ____
Installation Finish Date: 11/14/16 Hour: ____
Well Type: ☑ Single ☐ Nested ☐ Clustered

EQUIPMENT USED

☐ Hollow Stem Auger ☐ Cable Tool ☐ Air Rotary
☒ Other Post hole digger, Hand Auger

MATERIALS USED

Calculated	Actual	
____	____	Sacks of ____ Sand
____	____	Sacks of ____ Sand
____	____	Sacks of ____ Concrete/Cement
____	____	Sacks of Powdered/Granular Bentonite
3 18	3 18	Pounds of Bentonite Pellets/Chips
____	____	Feet of ___-inch Diameter PVC Blank Casing
____	____	Feet of ___-inch Diameter PVC Slotted Screen (___-inch Slot Size)

___Centralizer X PVC End Cap X PVC Well Cap X Padlock

Other Materials: Native Sand For Sand Pack

GROUT WEIGHT

Date:	Time:	Grout Wt.*

* lbs./gal.

DEVELOPMENT

Method of Development:

Begin Date: Time:

Finish Date: Time:

Yield: Initial: Final:

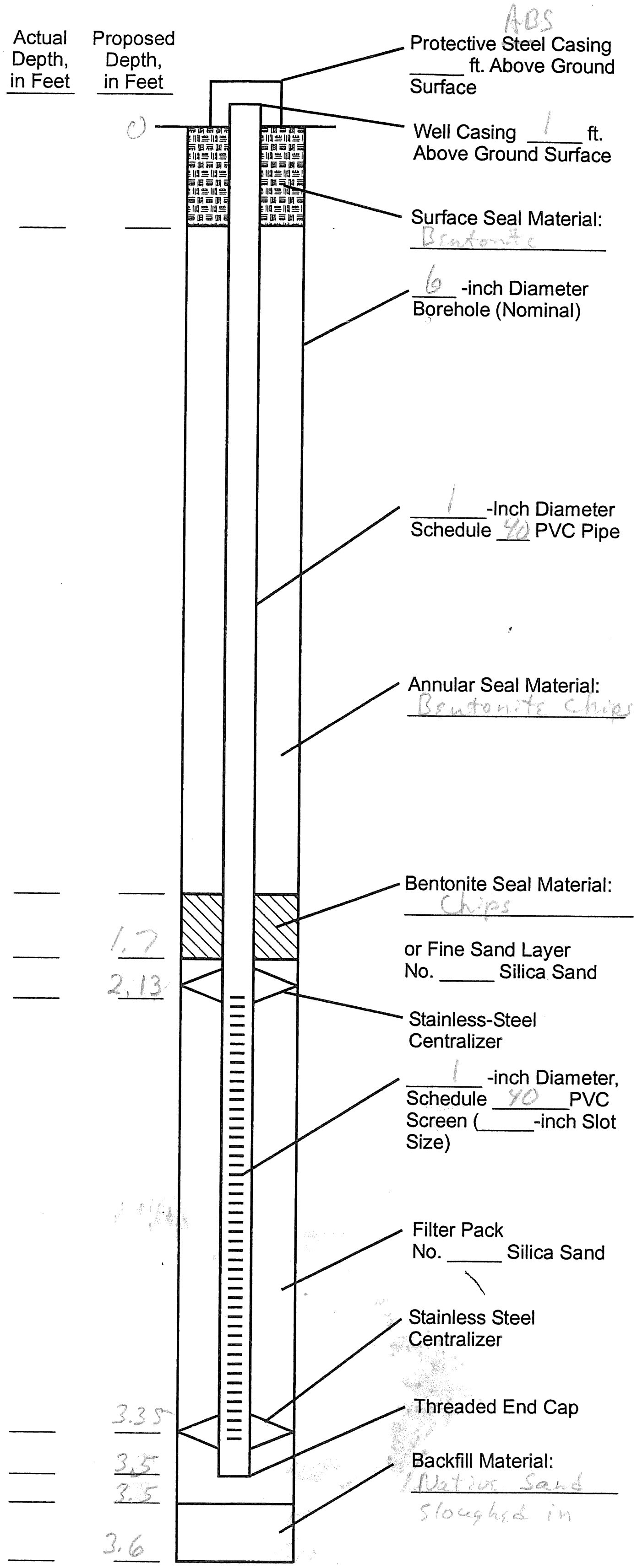
Depth to Water After Development: ____ Feet

Estimate of Total Volume of Water Removed During Development: Gallons

Description of Turbidity at End of Development: ☐ Clear ☐ Slightly Cloudy ☐ Mod. Turbid ☐ Very Cloudy

Odor of Water: ☐ No Odor ☐ Other ____

Water Discharged To:



Depth of Boring ____ feet (BGS, BTOC)
Depth to Water ____ feet (BGS, BTOC)

Form 2

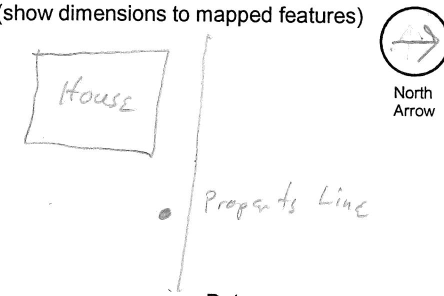
Pacific Hydro-Geology Inc.

Log of Exploration

Exploration No. TDM-1
Sheet 1 of 1

Client/Owner: Mary Voboril
Project No.: TDM/Sitka Sedge
Start Date: 11/13/2016
Hour:
Ground Surface Conditions: Undisturbed
Weather Conditions: Cloudy
Field Rep.: GEK/MRK
Contractor/Operator:
Exploration Method: Post Hole Digger, Auger, + Shovel

Location Sketch (show dimensions to mapped features)



Surface elevation ______ Datum ______

Sampler and Hammer Information:
a = 2.42-in. I.D. Split Spoon; b = 2.0-in. O.D. Split Spoon; c = Shelby Tube; d = ______
1 = 300-lb. Hammer 30-inch Drop; 2 = 140=lb. Hammer 30-inch Drop; 3 = Pushed; 4 = ______

Water Level Information		
Date		
Time		
Depth to Water		
Hole Depth		
Casing depth		

Sample Interval (Top / Bot.)	Recovery (Top / Bot.)	Retained Interval (Top / Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
								0 – 4"	SP	2.5 YR 2.5/1 Reddish black Fine SAND, poorly sorted with organics	
0.4' / 3.5'			1					1	SP	10 YR 5/2 Grayish brown, Fine SAND, poorly sorted, no organics quartz and heavy metals.	
								2			
3.5' / 3.6'			2					3			No GW, but sand wetter @ 3.6'
								4	SP	10 YR 2/1 Black, Fine SAND, poorly sorted, quartz and heavy metals	
								5			
								6		Mary Vorboril 5800 Irish	
								7		Cloverdale, OR 97112	
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Total Depth 3.5' Finish Date 11/13/2016 Hour ______ Continued ☐

Form 1

Pacific Hydro-Geology Inc.

As-Built
Well Completion Form

Project: Mary Vobaril

Project No.: TDM / Sitka Sedge

Well(s) No.: TDM-1

Drilling Co.: ______

PHG Rep(s): Greg + Malia Kupillas

Installation Start Date: 11/13/2016 Hour: ______

Installation Finish Date: 11/13/2016 Hour: ______

Well Type: ☐ Single ☐ Nested ☐ Clustered

EQUIPMENT USED

☐ Hollow Stem Auger ☐ Cable Tool ☐ Air Rotary

☒ Other Post hole digger, Auger, + Shovel

MATERIALS USED

Calculated	Actual	
____	____	Sacks of ______ Sand
____	____	Sacks of ______ Sand
____	____	Sacks of ______ Concrete/Cement
____	____	Sacks of Powdered/Granular Bentonite
≈18	≈18	Pounds of Bentonite Pellets/Chips
____	____	Feet of 1-inch Diameter PVC Blank Casing
____	____	Feet of 1-inch Diameter PVC Slotted Screen (___-inch Slot Size)

___Centralizer X PVC End Cap X PVC Well Cap X Padlock

Other Materials: Native Sand around Screen

GROUT WEIGHT

Date:	Time:	Grout Wt.*

* lbs./gal.

DEVELOPMENT

Method of Development:

Begin Date: Time:

Finish Date: Time:

Yield: Initial: Final:

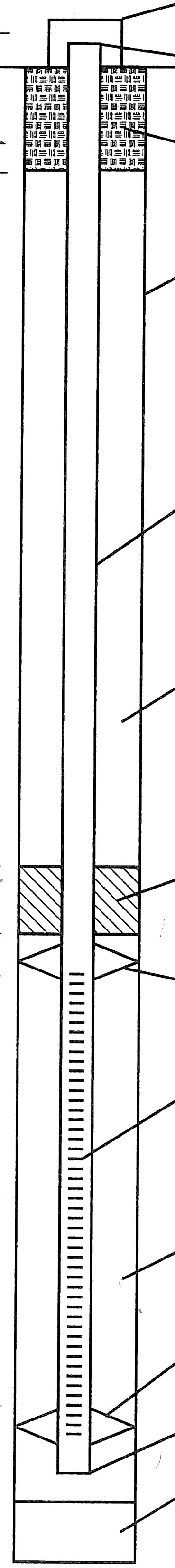
Depth to Water After Development: ______ Feet

Estimate of Total Volume of Water Removed During Development: Gallons

Description of Turbidity at End of Development: ☐ Clear ☐ Slightly Cloudy ☐ Mod. Turbid ☐ Very Cloudy

Odor of Water: ☐ No Odor ☐ Other ______

Water Discharged To:



Actual Depth, in Feet	Proposed Depth, in Feet
	0
____	____
____	____
1.9	1.9'
2.2	2.2
3.35	3.35
3.5	3.5
____	3.6
____	____

ABS ~~Steel~~ Protective Casing ______ ft. Above Ground Surface

Well Casing 1 ft. Above Ground Surface

Surface Seal Material: Bentonite

6 -inch Diameter Borehole (Nominal)

1 -Inch Diameter Schedule 40 PVC Pipe

Annular Seal Material: Bentonite

Bentonite Seal Material: Chips

or Fine Sand Layer No. ______ Silica Sand — Native sand

Stainless-Steel Centralizer

1 -inch Diameter, Schedule 40 PVC Screen (______-inch Slot Size)

Filter Pack No. ______ Silica Sand — Native Sand

~~Stainless Steel~~ Centralizer

~~Threaded~~ End Cap

Backfill Material: Native Sand

Depth of Boring 3.6' feet (BGS, BTOC)

Depth to Water ______ feet (BGS, BTOC) — no water

Form 2

Whale Island

Pacific Hydro-Geology Inc. — Log of Exploration

Exploration No. MW-WI

Sheet 1 of 1

Client/Owner	
Project No.	
Start Date	11/15/16
Hour	~~8:36~~ 9:11
Ground Surface Conditions	Undisturbed, Sandy
Weather Conditions	Cool, Partly Cloudy
Field Rep.	MRK
Contractor/Operator	Stratus
Exploration Method	Geoprobe

Location Sketch (show dimensions to mapped features)

North Arrow

Surface elevation ≈ 15'

Datum Google Earth

Sampler and Hammer Information:

a = 2.42-in. I.D. Split Spoon
b = 2.0-in. O.D. Split Spoon
c = Shelby Tube
d =

1 = 300-lb. Hammer 30-inch Drop
2 = 140=lb. Hammer 30-inch Drop
3 = Pushed
4 =

Water Level Information

Date		
Time		
Depth to Water		
Hole Depth		
Casing depth		

Sample Interval (Top/Bot.)	Recovery (Top/Bot.)	Retained Interval (Top/Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
0/5	2.5/5	1.5/5	1					0	SP	2.5Y 5/2 grayish brown, Fine SAND no organics	No A horizon. Sand wet @ 3'
								1–5			
5/10	6.9/10	5/3.5						5.10	SP	2.5Y 5/3 light olive brown, Fine SAND w 2.5Y 5/4 mottles. Faint	5.5 color change redox. 5.10 hydric
		6.9/9.2	2					7	SP	Gley1 3/N1 Dark greenish Gray Fine SAND with Gley1 10Y 4/1	
		9.2/9.5	3					9			
		9.5/10	4						SP		10' to Pulto [illegible]
10	10/10.4		5				10.4	10	OH	2.5Y 3/2 Very Dark Grayish Brown, Organic clay. Clay changes to 2.5Y 4/2 grayish brown	10.4 Soil+CL. 10.4 to 10.9 Gray CL
	10.4/10.9		6				10.9	11	CL		
	10.9/15		7					12	SP	Gley1 3/1 10Y Dark Greenish Gray, Fine SAND with some roots near top of sample	roots @ 10.9
			8					13–15			
15								15–18.9			
								18.9 / 19.1	CL	CL Lens	
20								20	SP	Gley1 3/1 10Y Dark Greenish Gray, Fine SAND	

Total Depth 20 Finish Date 11/15/16 Hour Continued ☐

Form 1

Pacific Hydro-Geology Inc.

Log of Exploration

Exploration No. MW-4 Jasmine's
Sheet 1 of 1

Client/Owner: TDM / Sitka
Project No.:
Start Date: 11/15/16
Hour:
Ground Surface Conditions:
Weather Conditions: Cloudy - Occasional rain
Field Rep.: MRK
Contractor/Operator: Stratus
Exploration Method: Geoprobe

Location Sketch (show dimensions to mapped features)
North Arrow
Surface elevation:
Datum:

Sampler and Hammer Information:
a = 2.42-in. I.D. Split Spoon
b = 2.0-in. O.D. Split Spoon
c = Shelby Tube
d =
1 = 300-lb. Hammer 30-inch Drop
2 = 140=lb. Hammer 30-inch Drop
3 = Pushed
4 =

Water Level Information

Date		
Time		
Depth to Water		
Hole Depth		
Casing depth		

Sample Interval (Top/Bot.)	Recovery (Top/Bot.)	Retained Interval (Top/Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
0 / 5	1.5'	0 / 10	1					0	SP	0 to 0.12 Topsoil 10YR 2/2 Very dark brown, very organic Fine SAND 90% organics 0.12 to 1.5 2.5Y 5/3 light olive brown Fine SAND no organics w/ well rounded gravel	Well rounded gravel damaged sample tube
5 / 10	2.6'							5		Same as above. Gravel is compromising recovery	
10 / 15	3.8'							10			10 & 15 ft may have clay at top
		14.15 / 14.45	2					14	OH	Black (Gley 1 2.5/N) CLAY with organics	14.15 to 14.45
15 / 18	1.7							15	SP		
18 / 20	1	19 / 20	3					18		Gley 2 4/N Dark gray, Fine SAND, poorly sorted	
								20			

Total Depth 20'
Finish Date 11/15
Hour 14:02
Continued ☐

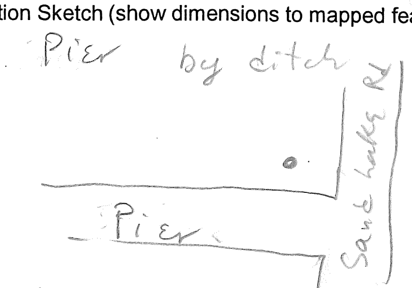
Form 1

Pacific Hydro-Geology Inc. — Log of Exploration

Exploration No. MW-5
Sheet 1 of 2

Client/Owner ______ Project No. ______
Start Date 11/16/16 Hour 835a
Ground Surface Conditions ______
Weather Conditions ______
Field Rep. MRK Contractor/Operator ______
Exploration Method Push probe

Location Sketch (show dimensions to mapped features)



Surface elevation ______ Datum ______

Sampler and Hammer Information:
a = 2.42-in. I.D. Split Spoon
b = 2.0-in. O.D. Split Spoon
c = Shelby Tube
d = ______
1 = 300-lb. Hammer 30-inch Drop
2 = 140=lb. Hammer 30-inch Drop
3 = Pushed
4 = ______

Water Level Information			
Date			
Time			
Depth to Water			
Hole Depth			
Casing depth			

Sample Interval (Top/Bot.)	Recovery (Top/Bot.)	Retained Interval (Top/Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)
0 / 5	5	2.9	1					0–1
			2					1–2
			3					2–3
5 / 10	1.5	1.5 R	4					5–6
10 / 15	1.5							10–11
							11.7	11–12
		14.5 / 18	5					13–14
							14.5	14–15
15 / 20	3.2	15 / 16.8	6					15–16
		16.8 / 17.5	7				16.7	16–17
		17.5	8				18.1	17–18
		18 / 19	9					18–19
		19 / 25	10					19–20

USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
GM	(2.5Y 2.5/1) Black, sandy, organic Fine GRAVEL (0 to 0.5')	904 DTW = 4.2' BGS
SP	(10YR 3/2 very dark grayish brown, Fine SAND. (0.5 to 0.9')	
SP	(2.5Y 7/4) pale yellow, Fine SAND (0.9 to 1.65) poorly sorted. Changes color to (2.5Y 5/3) @ 1.65	
	(2.5Y 4/2) dark grayish brown, Fine SAND	
	11.7 change in color to or	
	13.5 Changes in color to GLEY 1 4/N	
OH	?? 10YR 2/1 Black, CLAY with organics	
	(Gley 1 4/10Y) Dark greenish gray CLAY, with root traces near top	clay 16.7 to 18.1
OH		Peat 18.1 to 18.8
PT	Black (Gley 1, 2.5/N) PEAT	clay 18.8 to 18.9
OH	Same description as above for OH	
SP	Fine SAND (4/N) Gley 1, Dark Gray, Fine SAND.	Heaving

Total Depth ______ Finish Date ______ Hour ______ Continued ☑

Pacific Hydro-Geology Inc.

Log of Exploration

Exploration No. MW-5
Sheet 2 of 2

Client/Owner TDMCC Project No.
Start Date 11/16/16 Hour
Ground Surface Conditions
Weather Conditions cloudy w/ occasional rain
Field Rep. Contractor/Operator
Exploration Method

Location Sketch (show dimensions to mapped features) North Arrow

Surface elevation Datum

Sampler and Hammer Information:
a = 2.42-in. I.D. Split Spoon | 1 = 300-lb. Hammer 30-inch Drop
b = 2.0-in. O.D. Split Spoon | 2 = 140=lb. Hammer 30-inch Drop
c = Shelby Tube | 3 = Pushed
d = ______ | 4 = ______

Water Level Information			
Date			
Time			
Depth to Water			
Hole Depth			
Casing depth			

Sample Interval Top/Bot.	Recovery Top/Bot.	Retained Interval Top/Bot.	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
20/22	21/22							20	SP	(4/N) Dark gray, FINE SAND Gley 1 poorly sorted, with trace wood fragments. Same as above	
								21			
22/25	24/25							22			
								23			
								24			
								25			
								6			
								7			
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Total Depth 25' Finish Date 11/16/16 Hour Continued ☐

Form 1

Pacific Hydro-Geology Inc. **Log of Exploration**

Buck's Property

Exploration No. MW-6

Sheet 1 of 2

Client/Owner: Tierra Del Mar — Project No.: Sitka Sedge

Start Date: 11/16/18 — Hour: 12:38

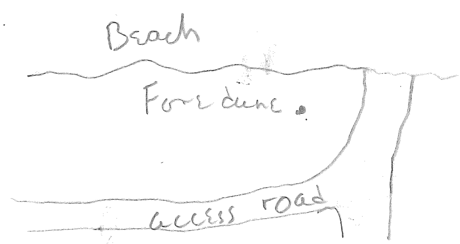
Ground Surface Conditions: Undisturbed Foredune

Weather Conditions: Partly cloudy

Field Rep.: MRK — Contractor/Operator:

Exploration Method: Push probe

Location Sketch (show dimensions to mapped features)



Surface elevation: — Datum:

Sampler and Hammer Information:

- a = 2.42-in. I.D. Split Spoon
- b = 2.0-in. O.D. Split Spoon
- c = Shelby Tube
- d =
- 1 = 300-lb. Hammer 30-inch Drop
- 2 = 140=lb. Hammer 30-inch Drop
- 3 = Pushed
- 4 =

Water Level Information		
Date		
Time		
Depth to Water		
Hole Depth		
Casing depth		

Sample Interval (Top/Bot.)	Recovery (Top/Bot.)	Retained Interval (Top/Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Dark gray) Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit)	Comments and Notes on Drilling Action
0 / 5	3.6'	0 / 0.7	1					0 – 0.7	SP	2.5Y 4/1) Dark brown organics w/ Fine SAND,	0.05' organic
		0.7 / 1.8	2					0.7 – 1.8	SP	Pale yellow Fine SAND. 2.5Y 8/2, Dry	
		2.5 / 6.1	3					2.7	SP	Change in color to light (gray) (2.5Y 6/2 light) brownish gray Fine SAND	
5 / 10	4.3'							5		Wet	
								6.5	SP	Less bands of heavy metals (2.5Y 7/3) Pale yellow, Fine SAND	
			4								
10 / 15	3.8							11	SP	Change in color → increase in heavy metals	
								12	SP	Layers of heavy metals	
		14.5 / 14.7	5					14.5	SP / PT	Change in color reduces GLEY 1 4/N Black (Gley 1, 2.5N) PEAT	14.5' Top of Seasonal W.T.
			6					16	SP	(2.5Y 6/2) light brownish gray Fine SAND	Tried to measure WL when she's in peat. No water. Heaving sands after Peat
			7					18.3	SP	18.3 change in color: Brown 10YR 2/1 Black May have humic staining.	18.3
15 / 20	4.2		8					19.1	SP	19.1 (2.5Y 3/1) Very dark gray, Fine SAND	

Total Depth: 25' — Finish Date: 11/16/16 — Hour: 13:20 — Continued ☑

Form 1

Pacific Hydro-Geology Inc. Log of Exploration

Exploration No. MW-6
Sheet 2 of 2

Client/Owner Tierra Del Mar　Project No. Sitka Sedge
Start Date 11/16/18　Hour
Ground Surface Conditions
Weather Conditions
Field Rep.　Contractor/ Operator
Exploration Method

Location Sketch (show dimensions to mapped features)　North Arrow

Surface elevation　Datum

Sampler and Hammer Information:

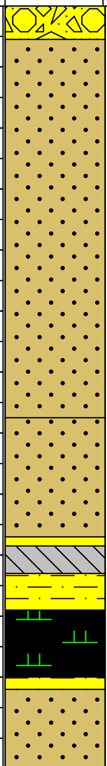
a = 2.42-in. I.D. Split Spoon　1 = 300-lb. Hammer 30-inch Drop
b = 2.0-in. O.D. Split Spoon　2 = 140=lb. Hammer 30-inch Drop
c = Shelby Tube　3 = Pushed
d = 　4 =

Water Level Information			
Date			
Time			
Depth to Water			
Hole Depth			
Casing depth			

Sample Interval (Top/Bot.)	Recovery (Top/Bot.)	Retained Interval (Top/Bot.)	Sample Number	PID Reading	Dye Test	UV Light Test	Sheen	Depth Scale (ft)	USCS Symbol	Sample Description (Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit))	Comments and Notes on Drilling Action
20 / 22.5	1.7	20 / 25	9					20	SP	(Gley 1 3/N) Very dark gray FINE SAND	heaving sand
								21			
								22			
								23			
22.5 / 25	1.6							24			
								25			
								6			
								7			
								8			
								9			
								0			
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								0			

Total Depth 25'　Finish Date 11/16/16　Hour　Continued ☐

Form 1

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description	Well Construction
0				Base fill GRAVEL	Bentonite Seal
2				Wet, brown, fine SAND	
14				Wet, gray, fine SAND	
18				Wet, black, organic SILT	
20				Wet, blue-gray, CLAY	
22				Wet, olive, SILT; layered with organics, leaves and roots	
24				Wet, brown, PEAT	
26				Wet, gray SILT	
28				Wet, gray, fine SAND	
30				Geology not logged 25-55 feet; drive point advanced to gradual refusal at 54 feet bgs; refusal is assumed to be contact with weathered bedrock surface	

Depth scale (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54

Address: Bileyu at Community Center
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/15/18

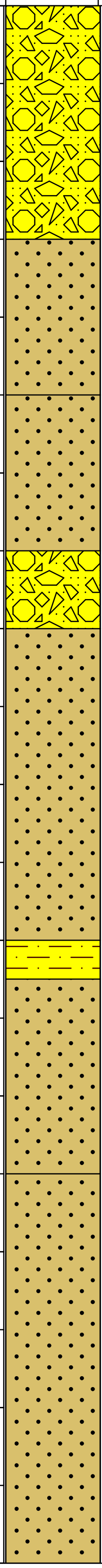
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: n/a
DTW: Not Recorded
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-Boring

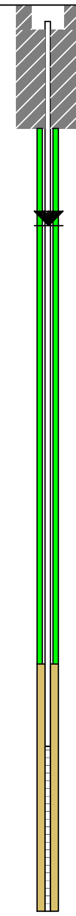
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0–3				Hand clear to 3 ft; Moist, brown sandy angular cobbles
3–5				Wet, brown to black, fine SAND; well graded; fine black heavy metal laminations; typical area sands
5–7				Wet, brown, fine SAND; same as above
7–8				Wet, brown, sandy basalt CLAST; rounded clast
8–12				Wet, brown, fine SAND; no laminations
12–12.5				Wet, black, organic SILT; humic odor
12.5–15				Wet, gray-brown, fine SAND; scattered roots
15–20				Wet, gray, fine SAND



Well Construction



Morris-type flush mount monument

Cement

Bentonite Seal

1 inch flush thread PVC casing

Sand pack 10/20

Pre-pack PVC screen

Geology logged from adjacent direct-push borehole

Address: West end Pier Ave
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/15/18

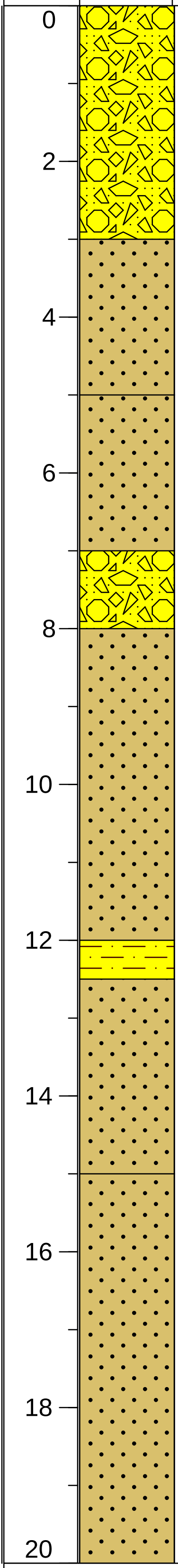
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106647
DTW: 2.68 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-4i

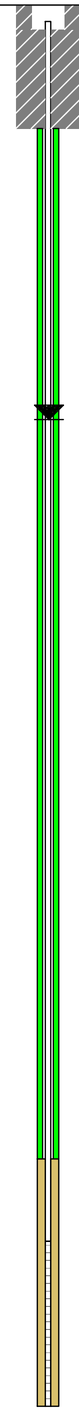
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0–3				Hand clear to 3 ft; Moist, brown sandy angular cobbles
3–5				Wet, brown to black, fine SAND; well graded; fine black heavy metal laminations; typical area sands
5–7				Wet, brown, fine SAND; same as above
7–8				Wet, brown, sandy basalt CLAST; rounded clast
8–12				Wet, brown, fine SAND; no laminations
12–12.5				Wet, black, organic SILT; humic odor
12.5–15				Wet, gray-brown, fine SAND; scattered roots
15–20				Wet, gray, fine SAND



Well Construction



Morris-type flush mount monument

Cement

Bentonite Seal

1 inch flush thread PVC casing

Sand pack 10/20

Pre-pack PVC screen

Geology logged from adjacent direct-push borehole

Address: West end Pier Ave
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/15/18

Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106646
DTW: 5.03 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

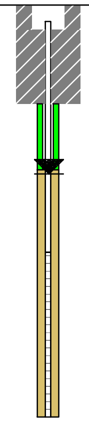
Figure
Boring Log and As-Built
PGG-4d

OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0				Topsoil
				Moist, gray-brown, fine SAND
2				No recovery
4				
6				Wet, brown, fine SAND; basalt cobble at 6.3 ft; fine black laminations 6.3 to 7.5 ft; homogeneous 7.5 to 10 ft
8				
10				Wet, gray, fine SAND
				Wet, black, organic SILT; roots below
12				Wet, gray-brown, fine SAND; variable grain size over 10cm intervals; scattered roots
14				
16				Wet, gray, SAND
18				
20				

Well Construction



Morris-type flush mount monument

Cement

1 inch flush thread PVC casing

Bentonite Seal

Pre-pack PVC screen

Sand pack 10/20

Geology logged from adjacent direct-push borehole

Address: West end Pollock Rd
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/14/18

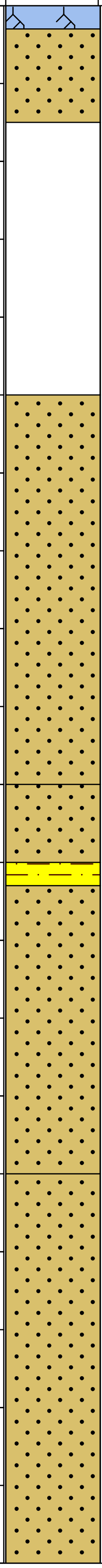
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106641
DTW: 2.05 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-3s

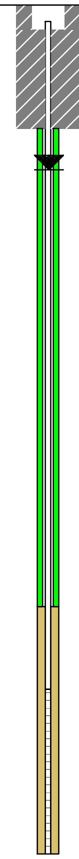
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0				Topsoil
				Moist, gray-brown, fine SAND
2				No recovery
4				
6				Wet, brown, fine SAND; basalt cobble at 6.3 ft; fine black laminations 6.3 to 7.5 ft; homogeneous 7.5 to 10 ft
8				
10				Wet, gray, fine SAND
				Wet, black, organic SILT; roots below
12				Wet, gray-brown, fine SAND; variable grain size over 10cm intervals; scattered roots
14				
				Wet, gray, SAND
16				
18				
20				



Well Construction



Morris-type flush mount monument

Cement

Bentonite Seal

1 inch flush thread PVC casing

Sand pack 10/20

Pre-pack PVC screen

Geology logged from adjacent direct-push borehole

Address: West end Pollock Rd
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/14/18

Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106642
DTW: 2.00 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-3i

OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0				Topsoil
				Moist, gray-brown, fine SAND
2				No recovery
4				
6				Wet, brown, fine SAND; basalt cobble at 6.3 ft; fine black laminations 6.3 to 7.5 ft; homogeneous 7.5 to 10 ft
8				
10				Wet, gray, fine SAND
				Wet, black, organic SILT; roots below
12				Wet, gray-brown, fine SAND; variable grain size over 10cm intervals; scattered roots
14				
				Wet, gray, SAND
16				
18				
20				

Well Construction

Morris-type flush mount monument

Cement

Bentonite Seal

1 inch flush thread PVC casing

Sand pack 10/20

Pre-pack PVC screen

Geology logged from adjacent direct-push borehole

Address: West end Pollock Rd
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/14/18

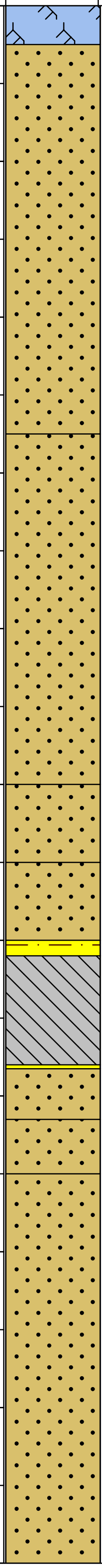
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106640
DTW: 3.94 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-3d

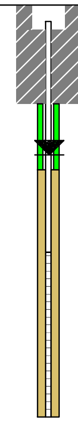
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0				Topsoil
				Wet, brown, SAND; fine black heavy metal laminations indicative of water transport
2				
4				
6				Wet, brown, fine SAND; scattered fine black heavy metal laminations
8				
10				Wet, brown, fine SAND
				Wet, gray, fine SAND
12				Wet, black, organic SILT
				Wet, dark blue-gray, CLAY
14				Thin, black, paleosol
				Wet, dark brown, fine SAND; roots
				Wet, gray, fine SAND
16				Wet, gray, fine SAND; scattered trace roots at 17.6; no laminations
18				
20				



Well Construction



Morris-type flush mount monument

Cement

1 inch flush thread PVC casing

Bentonite Seal

Pre-pack PVC screen

Sand pack 10/20

Geology logged from adjacent direct-push borehole

Address: East end Jasmine Ave
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/15/18

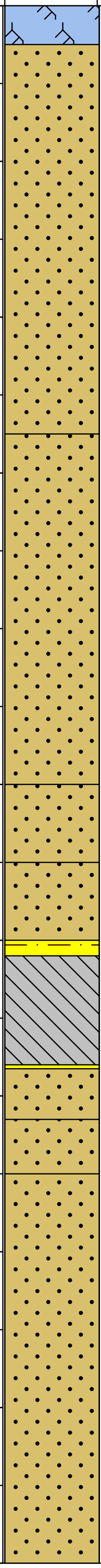
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106645
DTW: 1.82 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-2s

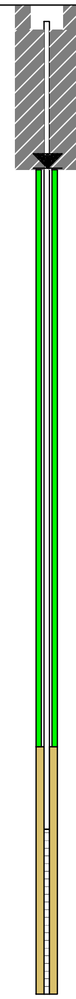
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples: Sample ID	Samples: Type	Description
0				Topsoil
				Wet, brown, SAND; fine black heavy metal laminations indicative of water transport
2				
4				
6				Wet, brown, fine SAND; scattered fine black heavy metal laminations
8				
10				Wet, brown, fine SAND
				Wet, gray, fine SAND
12				Wet, black, organic SILT
				Wet, dark blue-gray, CLAY
14				Thin, black, paleosol
				Wet, dark brown, fine SAND; roots
				Wet, gray, fine SAND
16				Wet, gray, fine SAND; scattered trace roots at 17.6; no laminations
18				
20				



Well Construction



Morris-type flush mount monument

Cement

Bentonite Seal

1 inch flush thread PVC casing

Sand pack 10/20

Pre-pack PVC screen

Geology logged from adjacent direct-push borehole

Address: East end Jasmine
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/15/18

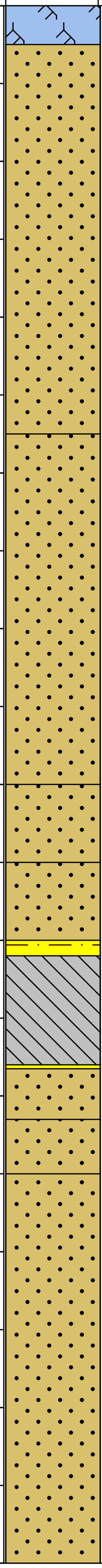
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106644
DTW: 1.98 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-2i

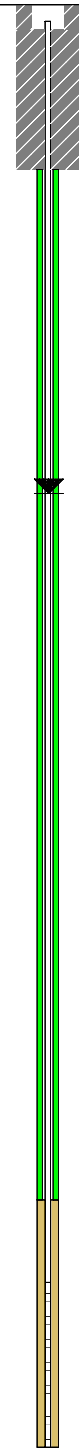
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PGG

Depth (ft)	Graphic Log	Sample ID	Type	Description
0				Topsoil
				Wet, brown, SAND; fine black heavy metal laminations indicative of water transport
6				Wet, brown, fine SAND; scattered fine black heavy metal laminations
10				Wet, brown, fine SAND
				Wet, gray, fine SAND
12				Wet, black, organic SILT
				Wet, dark blue-gray, CLAY
14				Thin, black, paleosol
				Wet, dark brown, fine SAND; roots
				Wet, gray, fine SAND
16				Wet, gray, fine SAND; scattered trace roots at 17.6; no laminations
20				



Well Construction



- Morris-type flush mount monument
- Cement
- Bentonite Seal
- 1 inch flush thread PVC casing
- Pre-pack PVC screen
- Sand pack 10/20
- Geology logged from adjacent direct-push borehole

Address: East end Jasmine
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/15/18

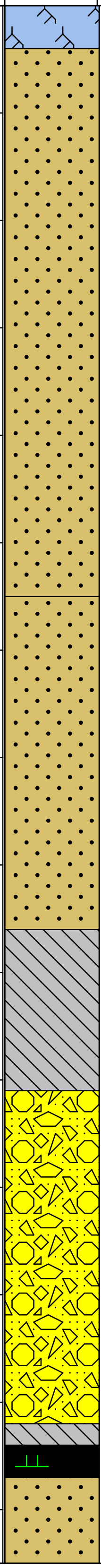
Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106643
DTW: 5.93 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-2d

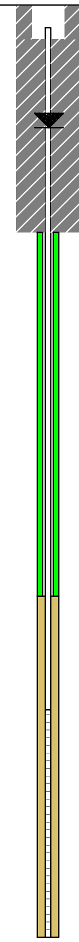
OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Sample ID	Type	Description
0				Topsoil
				Wet, brown, SAND; homogeneous well-graded fine sand; dune sand
2				
4				
				Wet, gray, SAND; homogeneous well-graded fine sand; dune sand; grades to gray between 6.5 and 7 feet
6				
8				
				Moist, brown, silty, CLAY
10				Wet, silty, fine GRAVEL; downward coarsening
12				
		Kupalis-Radiocarbon		Wet, dark gray, CLAY
14				Wet, brown, PEAT



Well Construction



Well Construction
Morris-type flush mount monument
Cement
Bentonite Seal
1 inch flush thread PVC casing
Pre-pack PVC screen
Sand pack 10/20

Address: Roma Ave and Sand Lake Rd
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/14/18

Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106639
DTW: 1.08 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-1i

OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

PgG

Depth (ft)	Graphic Log	Samples		Description	Well Construction
		Sample ID	Type		

Wet, gray, fine-SAND; trace roots; well graded

Address: Roma Ave and Sand Lake Rd
City, State: Tierra Del Mar, OR
Horizontal Loc.: N 200000.0 ft, E 1000000 ft
Consulting Firm: Pacific Groundwater Group
Logged by: Glen Wallace
Date: 2/14/18

Drilling Firm: Holocene Drilling
Drilling Method: Direct Push
Well ID: L106639
DTW: 1.08 ft bmp
MP Elevation: 00.00 ft
Datum: NAVD 88

Figure
Boring Log and As-Built
PGG-1i

OPRD Sitka Sedge
Hydrogeologic Investigation
JG1704

APPENDIX C
GRAIN SIZE ANALYSIS REPORT

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

May 2, 2018

KA No. 096-18097
Lab Report No. 2

Mr. Bert Clothier (E-Mail)
Pacific Groundwater Group
2377 Eastlake Avenue E, Suite #200
Seattle, WA 98102

RE: SOILS LABORATORY TESTING
2018 Control Samples
4303 198th Street SW
Lynnwood, Washington

Dear Mr. Clothier,

In accordance with your request and authorization, we have performed laboratory tests for the above referenced project.

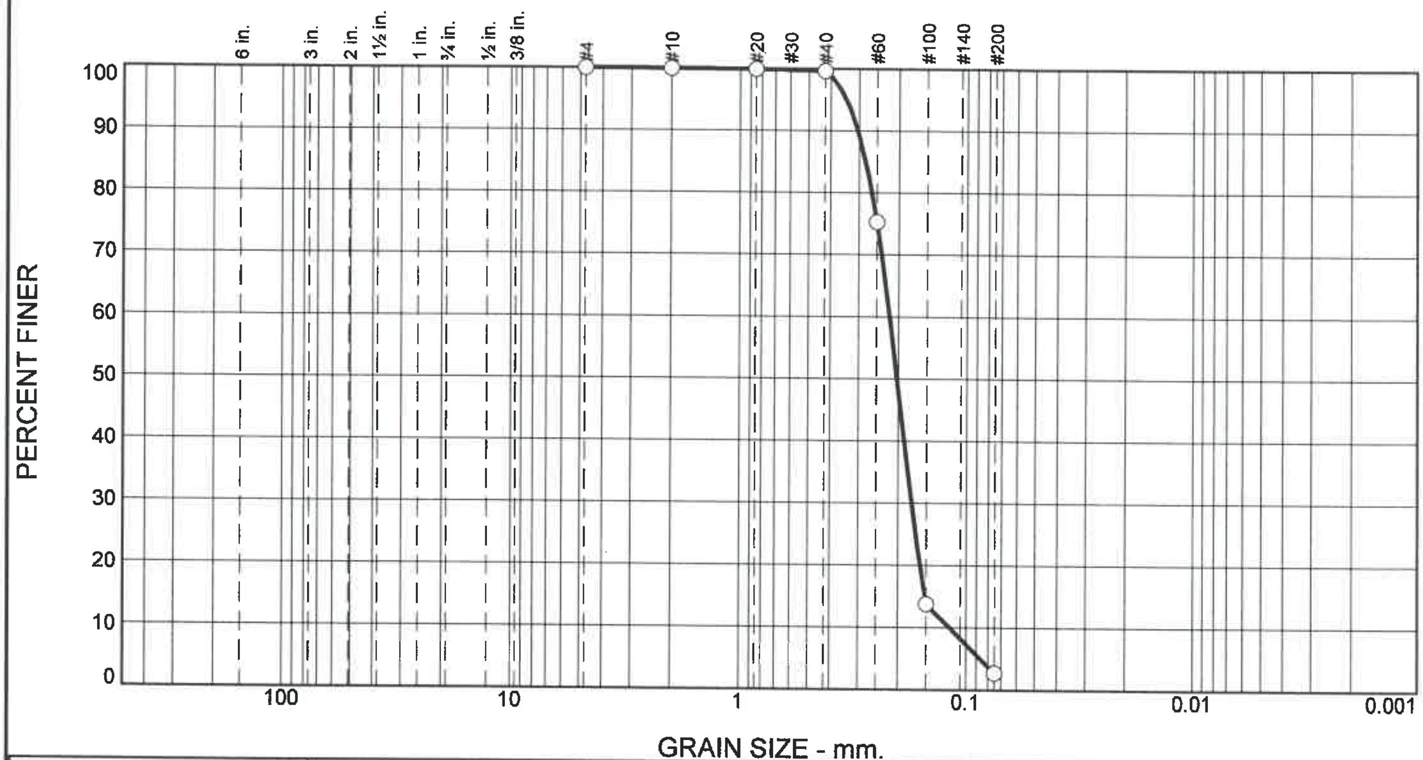
Laboratory testing was performed in accordance with ASTM standards. Attached are the results of the Four (4) Sieve Analysis' for sample numbers 62630-A to 62630-D dated April 27, 2018 as performed in the Krazan and Associates laboratory. If you have any questions; or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Corbett W. Mercer
Project Manager/Lab Manager
Pacific Northwest Division

CWM/lkj

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	96.9	2.7	

Test Results (ASTM C-136 & ASTM C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.6		
#60	75.2		
#100	13.8		
#200	2.7		

* (no specification provided)

Material Description

Gray poorly graded fine sand.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

D_{90}= 0.3039 D_{85}= 0.2804 D_{60}= 0.2190
D_{50}= 0.2028 D_{30}= 0.1740 D_{15}= 0.1520
D_{10}= 0.1183 C_u= 1.85 C_c= 1.17

Remarks

Sample ID: 62630-A.

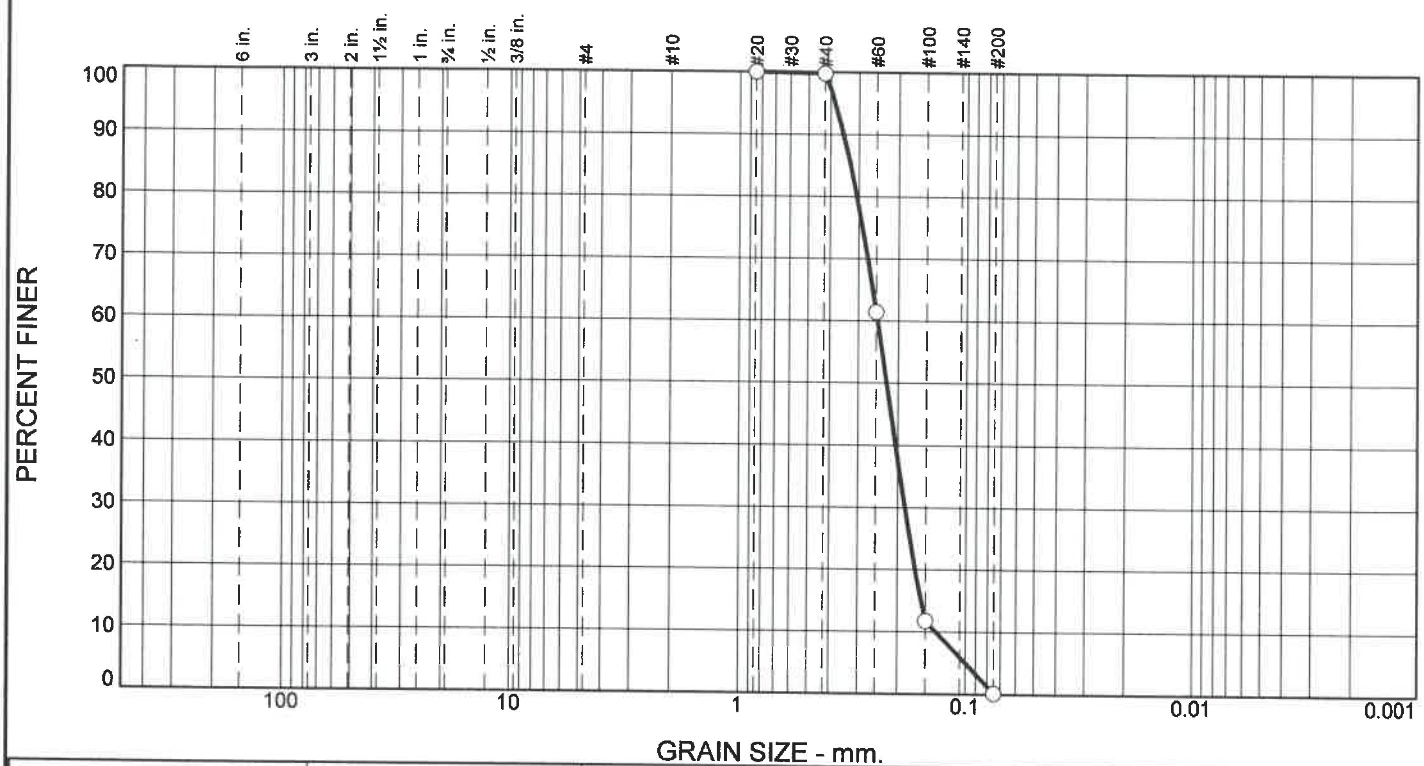
Date Received: 4/27/18 **Date Tested:** 4/30/18
Tested By: Ross Goff
Checked By: Corbett Mercer
Title: Lab Manager

Location: Sitka Sedge (#JG-1704); Client Supplied, PGG-2
Sample Number: 62630-A **Depth:** 17' - 19'
Date Sampled: 4/27/18

Krazan

Client: Pacific Groundwater Group
Project: 2018 Control Samples
Project No: 09618097

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	99.6	0.2	

Test Results (ASTM C-136 & ASTM C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#20	100.0		
#40	99.8		
#60	61.4		
#100	11.8		
#200	0.2		

* (no specification provided)

Material Description

Light brown poorly graded fine sand.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

D_{90}= 0.3510 D_{85}= 0.3265 D_{60}= 0.2466
D_{50}= 0.2243 D_{30}= 0.1855 D_{15}= 0.1569
D_{10}= 0.1349 C_u= 1.83 C_c= 1.03

Remarks

Sample ID: 62630-B.

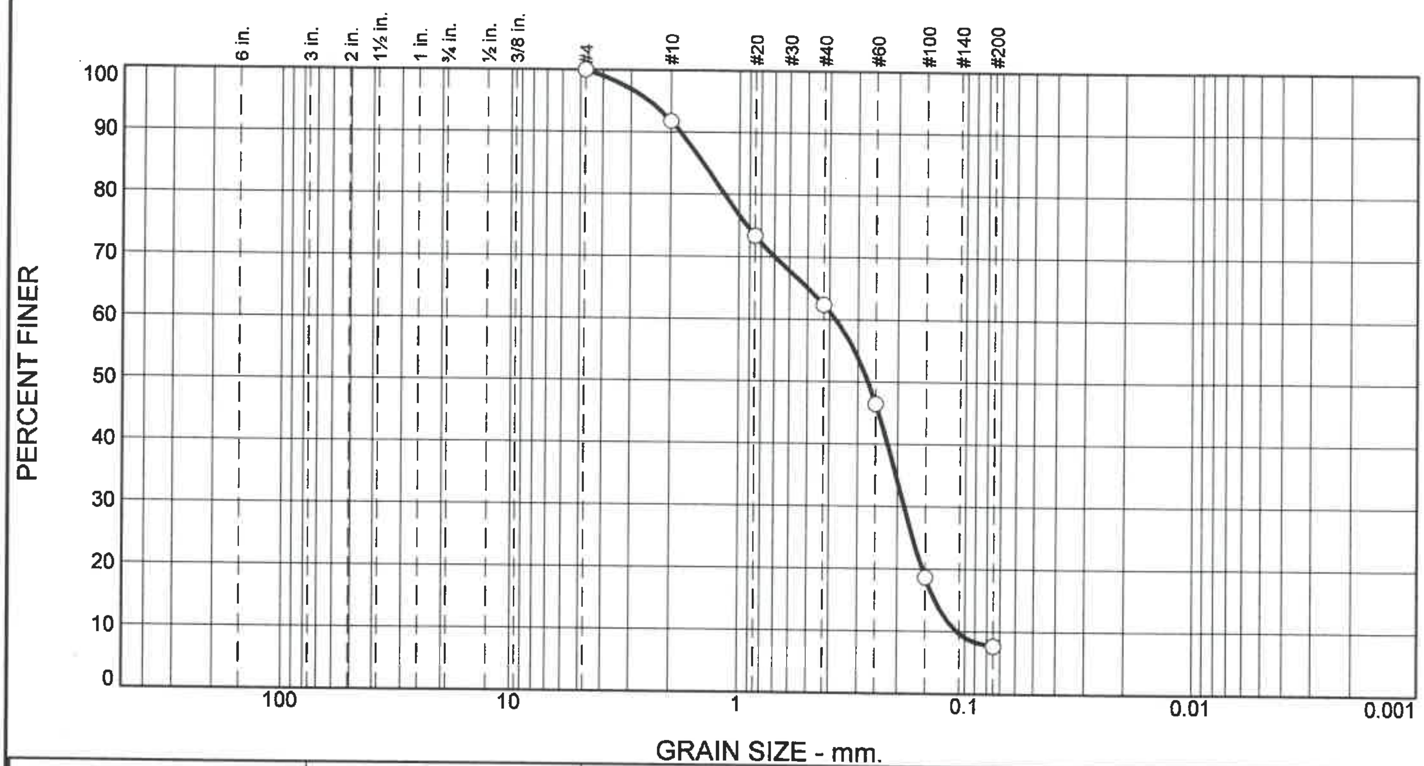
Date Received: 4/27/18 **Date Tested:** 4/30/18
Tested By: Ross Goff
Checked By: Corbett Mercer
Title: Lab Manager

Location: Sitka Sedge (#JG-1704); Client Supplied, PGG-2
Sample Number: 62630-B **Depth:** 7' - 8'
Date Sampled: 4/27/18

Krazan

Client: Pacific Groundwater Group
Project: 2018 Control Samples
Project No: 09618097

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	8.2	29.4	54.7	7.7	

Test Results (ASTM C-136 & ASTM C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	91.8		
#20	73.3		
#40	62.4		
#60	46.5		
#100	18.7		
#200	7.7		

* (no specification provided)

Material Description

Light to dark gray poorly graded sand with silt and organics.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 1.8127 D_{85}= 1.4373 D_{60}= 0.3767
D_{50}= 0.2704 D_{30}= 0.1865 D_{15}= 0.1360
D_{10}= 0.1086 C_u= 3.47 C_c= 0.85

Remarks

Sample ID: 62630-C.

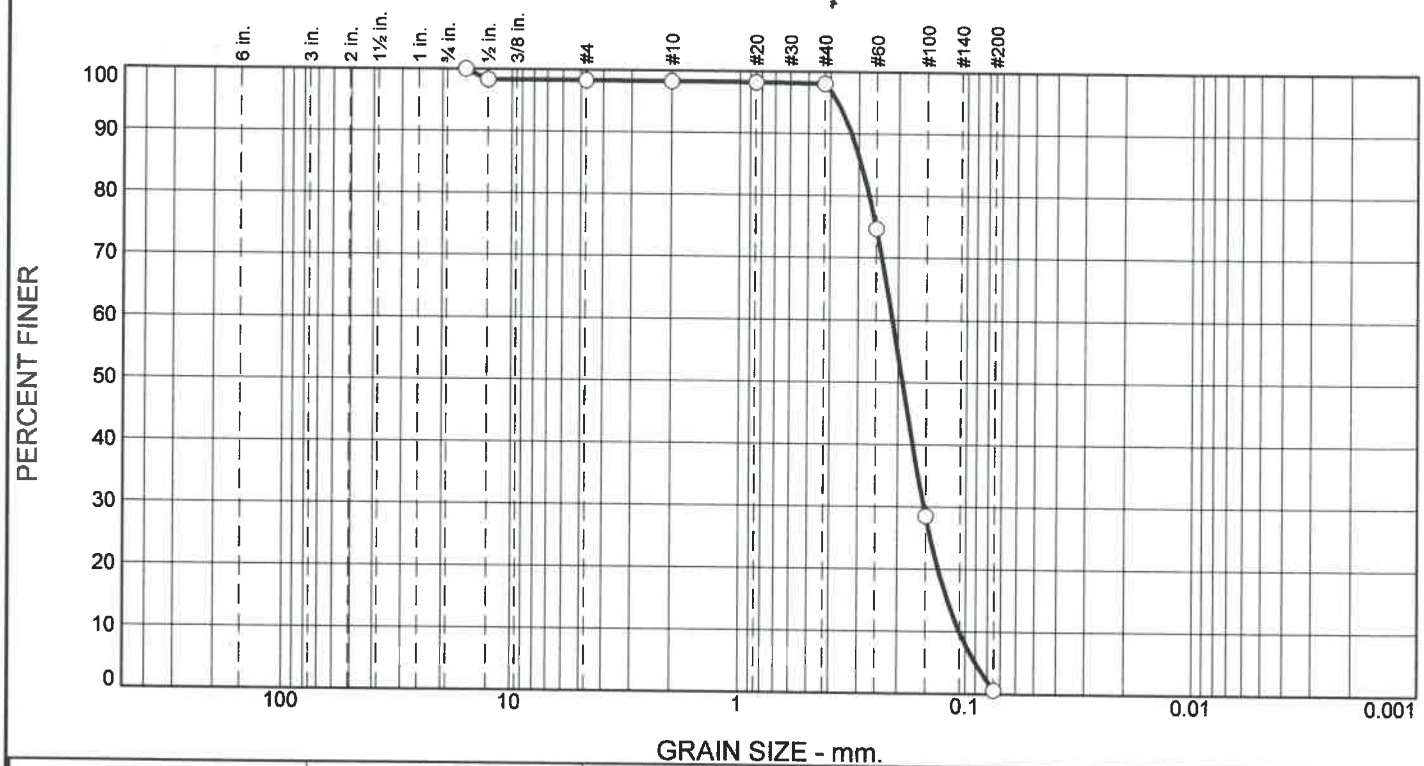
Date Received: 4/27/18 **Date Tested:** 4/30/18
Tested By: Ross Goff
Checked By: Corbett Mercer
Title: Lab Manager

Location: Sitka Sedge (#JG-1704); Client Supplied, PGG-4
Sample Number: 62630-C **Depth:** 12' **Date Sampled:** 4/27/18

Krazan

Client: Pacific Groundwater Group
Project: 2018 Control Samples
Project No: 09618097

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.7	0.0	0.2	97.5	0.6	

Test Results (ASTM C-136 & ASTM C-117)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.625	100.0		
.5	98.3		
#4	98.3		
#10	98.3		
#20	98.3		
#40	98.1		
#60	74.6		
#100	28.5		
#200	0.6		

* (no specification provided)

Material Description

Light brown poorly graded fine sand.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.3227 D_{85}= 0.2919 D_{60}= 0.2116
D_{50}= 0.1907 D_{30}= 0.1529 D_{15}= 0.1202
D_{10}= 0.1065 C_u= 1.99 C_c= 1.04

Remarks

Sample ID: 62630-D.

Date Received: 4/27/18 **Date Tested:** 4/30/18

Tested By: Ross Goff

Checked By: Corbett Mercer

Title: Lab Manager

Location: Sitka Sedge (#JG-1704); Client Supplied, PGG-4
Sample Number: 62630-D **Depth:** 5'

Date Sampled: 4/27/18

Krazan

Client: Pacific Groundwater Group
Project: 2018 Control Samples

Project No: 09618097

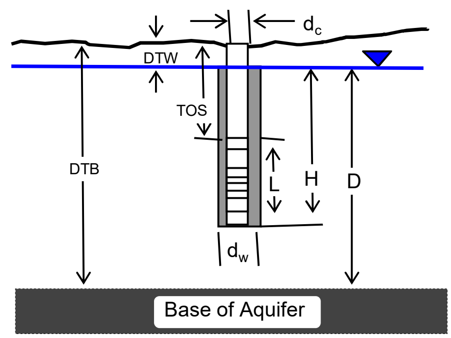
APPENDIX D
SLUG HYDRAULIC TESTS

WELL ID: PGG-4i

Local ID: PGG-4i
Date: 2/15/2018
Time: 13:19

INPUT

Construction:	
Casing dia. (d_c)	1 Inch
Annulus dia. (d_w)	6 Inch
Screen Length (L)	2 Feet
Depths to:	
water level (DTW)	2.39 Feet
top of screen (TOS)	9 Feet
Base of Aquifer (DTB)	11 Feet
Annular Fill:	
across screen --	Fine Sand
above screen --	Bentonite
Aquifer Material --	Medium Sand



COMPUTED

L_{wetted}	2 Feet
D =	8.61 Feet
H =	8.61 Feet
L/r_w =	8.00
$y_{0\text{-DISPLACEMENT}}$ =	2.57 Feet
$y_{0\text{-SLUG}}$ =	4.23 Feet

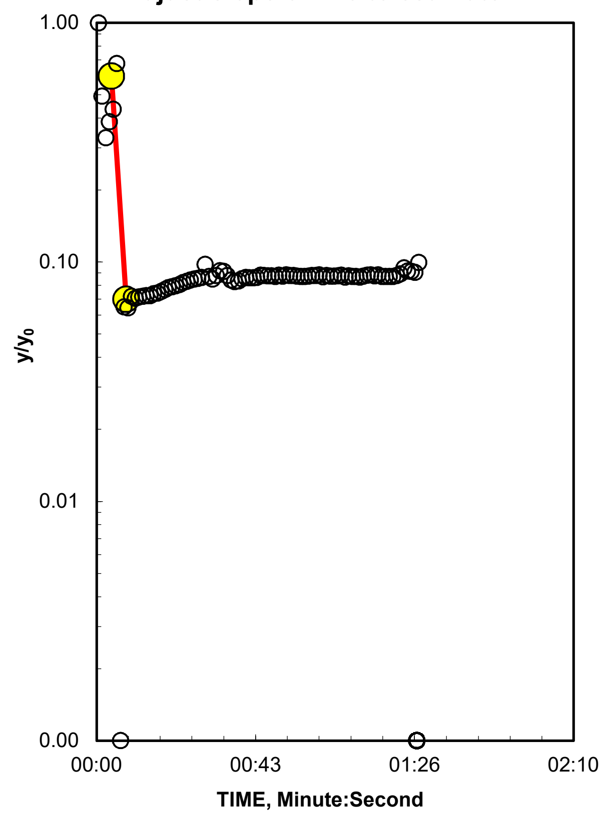
From look-up table using L/r_w

Fully penetrate C =	1.102
ln(Re/rw) =	2.229
Re =	2.32 Feet
Slope =	0.233263 $\log_{10}$/sec
$t_{90\%}$ recovery =	4 sec

Input is consistent.

K = 45 Feet/Day

Adjust slope of line to estimate K



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

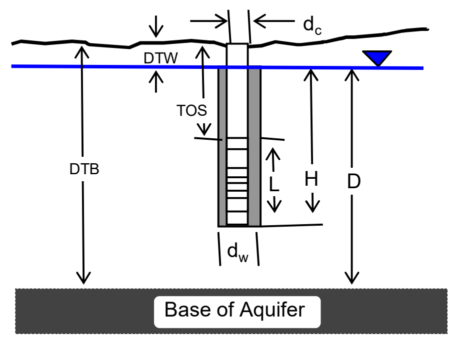
Halford, K., and Kuniansky, E., 2002. *Documentation of Spreadsheets for the Analysis of Aquifer-Test and Slug-Test Data.* U.S. Geological Survey Open-File Report 02-197.

WELL ID: PGG-4d

Local ID: PGG-4d
Date: 2/15/2018
Time: 13:44

INPUT

Construction:	
Casing dia. (d_c)	1 Inch
Annulus dia. (d_w)	6 Inch
Screen Length (L)	2 Feet
Depths to:	
water level (DTW)	0.02 Feet
top of screen (TOS)	9 Feet
Base of Aquifer (DTB)	11 Feet
Annular Fill:	
across screen --	Fine Sand
above screen --	Bentonite
Aquifer Material --	Fine Sand



COMPUTED

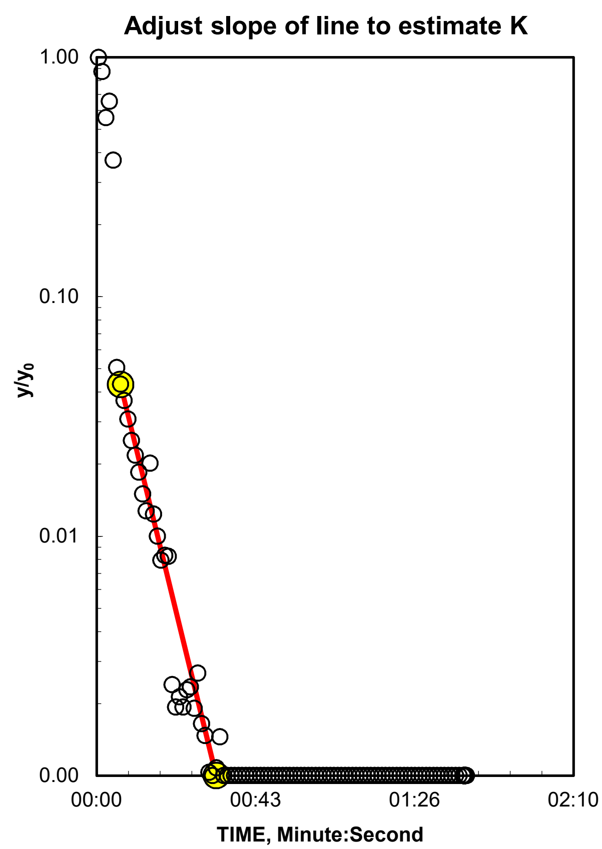
L_{wetted}	2 Feet
D =	10.98 Feet
H =	10.98 Feet
L/r_w =	8.00
$y_{0\text{-DISPLACEMENT}}$ =	4.55 Feet
$y_{0\text{-SLUG}}$ =	4.23 Feet

From look-up table using L/r_w

Fully penetrate C =	1.102
ln(Re/rw) =	2.333
Re =	2.58 Feet
Slope =	0.062826 $\log_{10}$/sec
$t_{90\%}$ recovery =	16 sec

Input is consistent.

K = 13 Feet/Day



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Halford, K., and Kuniansky, E., 2002. *Documentation of Spreadsheets for the Analysis of Aquifer-Test and Slug-Test Data.* U.S. Geological Survey Open-File Report 02-197.

APPENDIX E
TIDAL DIFFUSIVITY CALCULATIONS

1.0 APPENDIX E – TIDAL DIFFUSIVITY CALCULATIONS

Groundwater level monitoring in wells completed in the shallow and deep aquifers showed that small tidal variations (several tenths of a foot) were noted in deep-aquifer wells whereas no tidal signal was observed in the shallow-aquifer wells. Lack of tidal response in the shallow aquifer could be interpreted multiple ways, including:

1) Lack of hydraulic connection between the shallow aquifer and marine water;

2) Aquifer properties damping out the tidal signal with distance from the shoreline.

Hydrogeologic characterization performed by PGG suggests that the shallow aquifer should be hydraulically connected to marine water, and the depositional environment (beach and dune sands) does not easily support a hypothetical low permeability hydraulic barrier between the shoreline and the monitoring wells. It therefore appears that aquifer properties are the most logical explanation for lack of tidal response in shallow-aquifer wells. In order to test the theory that hydraulic properties estimated for the shallow aquifer could fully dampen the tidal response in wells located >500 feet from the shoreline, PGG performed screening calculations using the solution of Jacob and the aquifer property estimates discussed in the main body of this report. While the Jacob equation assumes confined conditions, it can be applied to unconfined and semiconfined conditions when the tidal signature does not significantly affect the saturated thickness of the aquifer. Calculations are presented on Table E-1, and employ the following assumptions:

- Hydraulic conductivity (K) is 9E-3 cm/sec, as discussed in the main body of this report.
- Aquifer thickness is assumed to be 10 feet for the shallow aquifer and 25 feet for deep aquifer.
- Storage coefficient is on the order of 0.1 for the shallow (unconfined) aquifer and 0.001 for the deep (represented as semi-confined) aquifer.
- The average tidal range is 6 feet (thus providing a tidal amplitude of 3 feet).
- Two tide cycles occur per day.

The Jacob Equation allows calculation of tidal efficiency (the ratio of groundwater tidal variation to marine tidal variation at a given distance from the coastline) and tidal lag (the time lag between the peak of a marine tidal cycle to the peak of the groundwater response). For a well 650 feet from the shoreline, the calculations suggest that tidal groundwater response would be unobservable in the shallow (unconfined) aquifer but a tidal amplitude of ± 0.17 feet (tidal efficiency of approximately 6%) would be observed in the deep (semi-confined) aquifer. This prediction is similar to the observed range of tidal groundwater level variation in the deep aquifer.

Table 1. Tidal Variations Relative to Dampening and Lag

Sitka Sedge Natural Area, Oregon

Parameter	Units	Shallow Aquifer Unit *(unconfined)*	Deep Aquifer Unit *(semi-confined)*
Inputs			
Distance from Coast (x)	feet	650	650
Tidal Amplitude (ho)	feet	3	3
Tidal Period (to)	days	0.25	0.25
Storage Coefficient (S)	--	0.1	0.001
Hydraulic Conductivity (K)	cm/sec	9.0E-03	9.0E-03
Hydraulic Conductivity (K)	ft/d	25.5	25.5
Assumed Fixed Aquifer Thickne	feet	10.0	25.0
Transmissivity (T)	gpd/ft	1907	4768
Transmissivity (T)	ft2/d	255	637
Calculated Values			
GW Amplitude (hx)	feet	4.6E-20	1.7E-01
GW Time Lag (tl)	days	1.816	0.115
GW Time Lag (tl)	min	2615	165
Tidal Efficiency (=hx/ho)	--	0.000	0.056

Notes:

Based on solution of Jacob (1950) presented in Fetter (1994) p. 376-77.

hx = ho * exp(-x((pi*S)/(to*T))^.5)

tl = x * (to*S/(4*pi*T))^.5

ho is half the tidal range

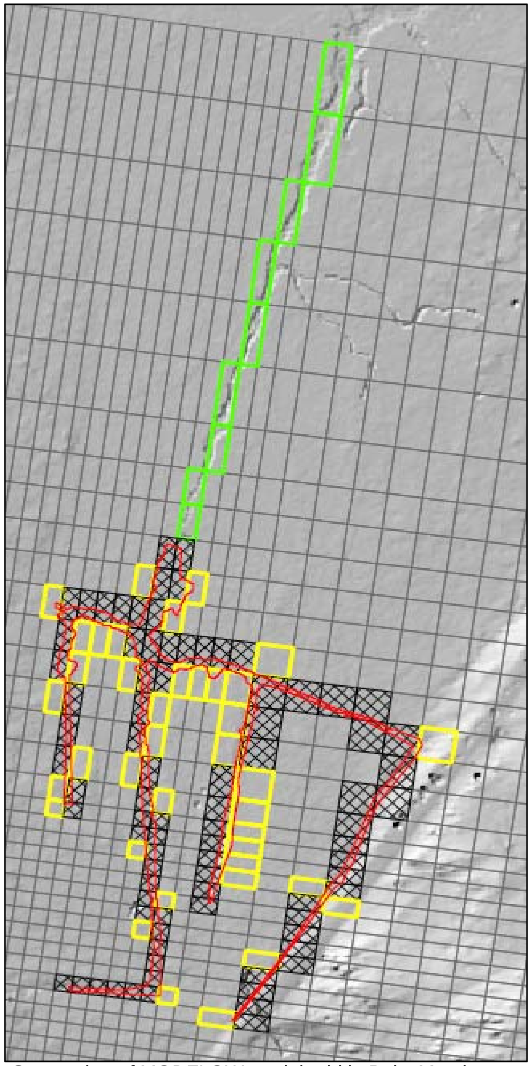
to is the time for tide to go from one extreme to another

APPENDIX F
ALGORITHM FOR DEFINING BELTZ MARSH CHANNEL & FLOOR ELEVATIONS

Table F-1: Algorithm for Defining Beltz Marsh Floor Elevations

Sitka Sedge Natural Area

Background: Reference land surface elevations (marsh floor elevations) for Beltz Marsh were generated using LiDAR/PhoDAR (L/P) coverage developed by OPRD. The L/P coverage is superior to the 2009 LiDAR coverage for representing marsh floor elevations because PhoDAR modification were performed from photographs taken at a lower tidal inundation elevation (6.0 feet rather than 7.3 feet). The Lidar/PhoDAR (L/P) coverage better defines channel features within the marsh, but channel bottoms below 6.0 feet are not defined.
Assumptions: The algorithm makes use of the facts that: the lowest tidal elevation behind the dike predicted by ESA is 5.68 feet, the lowest measured during the monitoring period was 5.38 feet, and the bottom of model layer 1 (L1-Bot) is around 5.0 feet in the marsh vicinity. In order to properly apply the MODFLOW river condition so inundation exchanges with the top layer of the model (L1), the modeled tidal elevation must always exceed L1-Bot.
Base Level: In order to correct for noise in the PhoDAR refinements (lower-than-actual ele-vations), all cells with a L/P elevation < 5.38 were assigned a default marsh-floor elevation of 5.3 feet. This is purely a housekeeping step to remove spurious values, and has no actual effect on MODFLOW calculation of groundwater/surface-water exchanges using the river boundary condition. In PGG's application of the river boundary condition, river cell calculations reference the tidal elevation rather than the marsh-floor elevation, and the tidal elevation never falls below 5.38 feet (and therefore always exceeds L1-Bot). In addition, PGG identified 8 isolated model cells where representative L/P elevations were significantly lower than neighboring cells (but >5.38) and were considered “spurious”. For these spurious cells, we assigned marsh-floor values closer to their neigh-boring cells.
Beltz Marsh Cell Types: River cells within the Beltz Marsh were divided into three categories: non-channel cells, cells in channels south of the beaver dam, cells in channels north of the beaver dam. Because actual channel footprints were not always coincident with model grid cells, PGG selectively assigned “channel” status to some cells near actual channels but removed channel status from others in order to achieve similar modeled channel footprints relative to actual conditions. The image to the right shows how channels inundated behind the beaver dam were limited to black hatched cells to avoid over representing channel footprints, thus disregarding model cells outlined in yellow. For the model cells that included portions of a channel but were not assigned “channel” status, the marsh floor elevation was set to the average L/P elevation of the model cell (thus avoiding the low (minimum) channel elevations that occur in limited portions of the model cell).
Non-Channel Cells: The procedure to address model cells that include small portions of the beaver dam channels but were assigned "non-channel" status is described immediately above. For all other non-channel cells, as long as the L/P minimum elevation per model cell was > 5.3 feet NAVD88, PGG used the minimum L/P elevation for the marsh floor elevation. Otherwise, PGG assumed an elevation of 5.3 feet.
Channel Cells South of the Beaver Dam were assigned marsh floor elevations of 7.05 feet for the calibration simulations (current condition) and 5.3 feet for the predictive future simulations. Raising the marsh floor elevations to 7.05 feet for the current condition allowed groundwater discharge to inundation behind the beaver dam to occur at the current beaver dam elevation of 7.05 feet. (Note that model predictions always showed groundwater discharging to the inundated area behind the dam, rather than flow in the opposite direction.) However, predictive future simulations assumed removal of the beaver dam, so channels in the marsh floor were simulated at the default elevation of 5.3 feet.
Channel Cells North of the Beaver Dam were assigned marsh floor elevations of 5.3 feet for both current (calibration) and future (predictive) simulations.



Screenshot of MODFLOW model grid in Beltz Marsh area. Grayscale basemap is the photgrammertically updated LiDAR topography. Colors reflect Beltz Marsh model cell type.

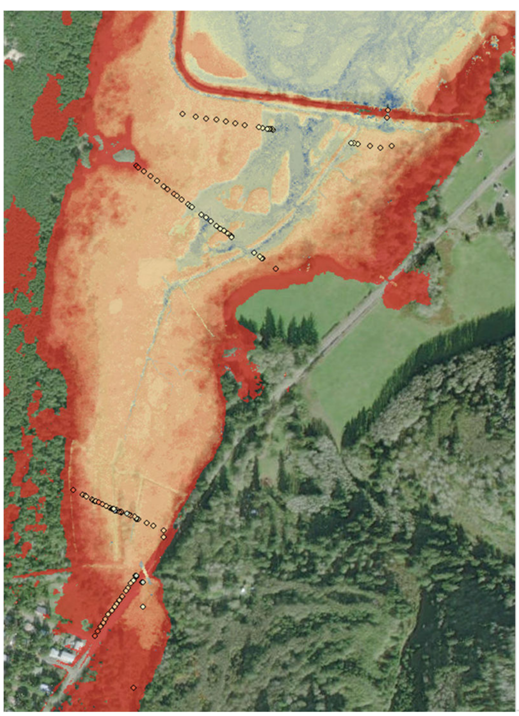
APPENDIX G
ANALYSIS OF PHODAR ACCURACY & ADEQUACY

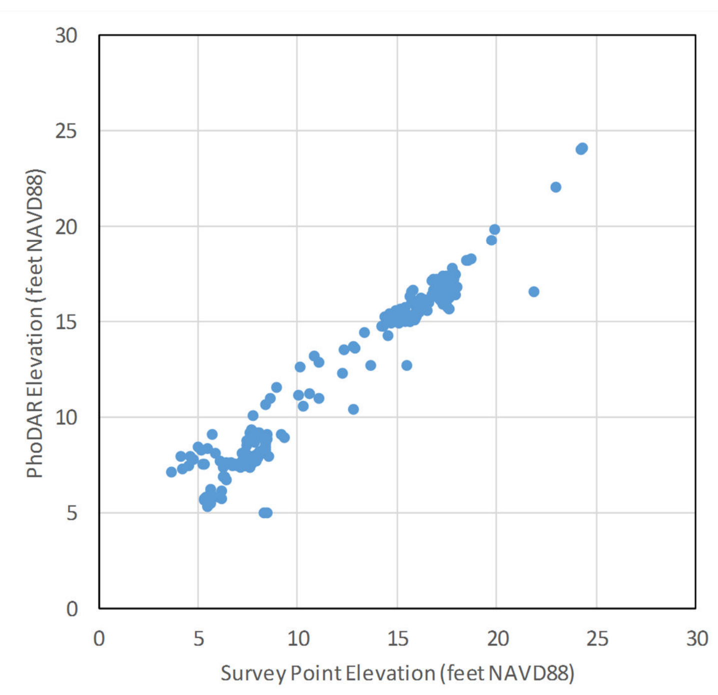
APPENDIX G: ANALYSIS OF PHODAR ACCURACY & ADEQUACY

The PhoDAR bare earth DEM was compared against topographic survey data collected in the marsh in March and April 2018 by OPRD. Topographic surveys conducted with standard survey equipment act as a benchmark in these comparisons since they provide an accurate elevation of the ground surface, whereas aerial methods can sometimes experience a vertical bias from the presence of dense vegetation on the surface.

The figure below compares the bare earth DEM (blue represents low elevations and red represents high) overlaid with the spring 2018 survey points. The figure on the right is a comparison of the elevations from both datasets at the locations of the survey points. Overall, there is not a consistent bias between the datasets except below elevations of about 6 feet NAVD88. Above 6 feet NAVD88, the average error is less than one tenth of a foot, although individual points sometimes had a larger error on the order of 1-2 feet, presumably due to the presence of dense vegetation. Despite this, the PhoDAR-derived surface is a more accurate representation of the marsh surface than previous LiDAR.

Below ~6 feet NAVD88, the PhoDAR surface begins to over-predict the elevation consistently. This is due to the inundation of the marsh with water from Sand Lake Estuary. Due to the presence of the mudflats in Sand Lake immediately north of the culvert, water levels are not able to drop below this approximate level. This does not affect the accuracy of the modeling results described in the main body of the report, since the alternatives focus on the type of connection through the levee, and the outlying mudflats would still presumably prevent water levels from draining below current minimum levels in the future. Since these permanently-inundated areas never drain, errors in the DEM below this level do not affect estimates of surface water flows into and out of the marsh through the dike.





ESA

APPENDIX H
PUBLIC COMMENT AND OPRD TEAM RESPONSES

APPENDIX H

Response to public comments and modeling recommendations for further hydrological modeling

Sitka Sedge State Natural Area Hydrology and Ground Water Risk Modeling Study

Comment period: February and March 2019

OPRD preliminary comments and background

This document compiles stakeholder comments received after Public Meeting #2 of the Sitka Sedge Hydrology Study. There were several duplicate comments from different commenters, and the comments and requests compiled below summarize and paraphrase the original content.

Many of the comments received touch on aspects of dike alteration decision-making that are outside of the scope of the current contract. This type of comment is very useful to the overall planning process, and will be retained for future phases of the process even if they are not immediately relevant to the current contract. The overall process for scoping the future of the Beltz dike is necessarily divided into stages that build on each other, and the dividing lines between the steps can be difficult to track. The current hydrological study is focused on assessing groundwater and tidal surface water risks to neighboring private property that could result from a set of representative examples of potential dike alteration scenarios that could be implemented to improve fish passage and/or habitat. The outcome of the study will provide sideboards for more refined collaborative design alternatives and environmental effects assessment that will follow after the completion of the hydrologic risk assessment. Future assessment will transition from risk assessment to more detailed ecological and environmental assessment that will incorporate more detailed study of water quality, habitat shifts, and species effects. OPRD anticipates the following timeline for completion of the assessment and planning steps that will lead to a decision:

June -Aug 30, 2019:

- Completion of the current hydrologic model development and scenario effects study.
- Identification of thresholds for tidal influx that meet project objectives while avoiding significant increased risk to TDM. This does not include completion of the more detailed design process.

Aug 2019 – January 2020

- Collaborative stakeholder meetings to identify potential design alternatives that fit within the acceptable hydrological parameters that were determined not to present significant risk by the current study.
- A public meeting to review preferred alternatives

- Completion of assessments of environmental effects of the alternatives – including water quality, species effects, vegetation shifts, erosion, etc.
- Identification of a preferred alternative
- Creation of Aquatic Habitat Enhancement Plans for the top alternative(s).
- A public meeting to present OPRD's final preferred alternative

January 2020 – September 2020:

- Development of a preliminary Habitat Restoration Project Design and funding strategy for Beltz Marsh, Reneke Creek and Beltz Creek and adjacent areas.

October 2020 – October 2021

- Securing funding, development of construction specifications, and obtaining permits.
- Project construction

Summary of comments received

Comment/Request: Follow PGG/ESA recommendation for further assessment - i.e., assess the sensitivity of predictive scenarios to increasing the hydraulic connection between the marsh and the shallow aquifer, and of increasing the effective thickness of the shallow aquifer beneath Beltz Marsh. The channels may be capped with lower permeability sediments that restrict the communication of groundwater with surface water in the fresh water marsh.

> ***OPRD/PGG/ESA Response:*** *PGG will use the model to assess sensitivity to these variables. If there is a significant model response, additional work might be necessary to fine-tune thickness and permeability characteristics of the marsh and the channels within it. Because this would call for additional field work, this would require additional contract amendment and budget. If model predictions prove insensitive to a reasonable range of these variables, no further model simulations will be needed to address associated uncertainty.*

Comment/Request: Assess flooding effects and erosion risk due to shifts in vegetation resulting from each of the newly scoped surface water regimes.

> ***OPRD/PGG/ESA Response:*** *This work is outside of the scope of the current hydrology contract, but is definitely an item that will be evaluated in the next phases of environmental effects assessment that will occur after the hydrology risk study's conclusion in the process of reviewing finer scaled dike alteration alternatives.*

Comment/Request: Assess beaver dam effect on reservoir capacity behind the dike

__OPRD/PGG/ESA Response:__ As presented in the study report and Meeting #2, PGG already determined that TDM groundwater was not sensitive to the effect of the beaver dam - so this is primarily a surface water question. ESA will perform basic calculations to determine the approximate magnitude of effect the addition this storage capacity would have on the previous predictions of water surface elevation (for example, by what amount the water surface elevation might be reduced at high tide relative to the existing condition with the beaver dam present). The results of this basic characterization will be presented in the next report draft. Since the lack of a beaver dam would, if anything, insignificantly <u>reduce</u> surface water levels, and since the intent of the study is to determine risk, this will not lead to full reworking of the previous scenarios completed with the beaver dam intact. The previous modeling approach is conservative and more indicative of a maximum effect or risk.

Comment/Request: Explore potential effects of ditch manipulations in TDM.

__OPRD/PGG/ESA Response:__ While this would be useful to TDM or the county, it is outside OPRD's land and authority to spend or plan since the study indicates no significant groundwater effect for the scenarios assessed. If desired by TDM or Tillamook County, PGG may estimate costs and assessment options for further study by the community or provide an example of the kind of simple modeling result they might expect. This is not part of the current contract.

Comment/Request: Explore water quality effects of the scenarios: temperature, groundwater, dissolved oxygen, and bacteria.

__OPRD/PGG/ESA Response:__ Assessment of water quality details is outside the scope of the <u>current</u> study and contract. Water quality will be addressed in detail in later phases of assessment outside of this hydrological study. Water quality modeling would require summer data that is not part of this storm-season risk assessment. Data requirements could include groundwater temperature, stream temperature, sand lake temperature, stream dissolved oxygen (DO), Sand Lake DO, groundwater DO, etc. Groundwater contribution to the mass balance in the marsh might be possible by using the existing groundwater model approach and framework, but summer data would be necessary to assess summer water quality conditions.

Comment/Request: Future scenarios should not be constrained to binary choices, but should attempt to encompass a wide variety of components and strategies to meet all the values the Park can offer.

__OPRD/PGG/ESA Response:__ Agreed. OPRD and stakeholders will continue to further assess wider effects in a more holistic way in later phases of assessment that will occur after the completion of the current hydrologic risk scoping study. Phases of study to follow will involve more detailed *alternatives and more comprehensive accounting of the full range of environmental and recreation effects.*

Comment/Request: include bridge considerations in breach and tide gate scenarios to make sure that scenarios capture any required footing and slope requirements.

> ***OPRD/PGG/ESA Response:*** *Bridge construction considerations are not limiting to the design process, and bridge designs can be tailored to meet the hydrological ideal. Typical bridge footing and base requirements are compatible with the slope and design criteria used to scope the breach scenario. More detailed designs will be identified and assessed in stages of planning and collaboration that will follow the completion of the current hydrological risk assessment.*

Comment/Request: Incorporate necessary increase to the elevation of Sand Lake Road and include appropriate water passage structures under the road in any future designs.

> ***OPRD/PGG/ESA Response:*** *These important fine-scale aspects of construction design and effects analysis will be addressed in later stages of assessment that will follow conclusion of the current hydrological risk assessment.*

Comment/Request: Consider a scenario for a setback levee somewhere near or south of the current beaver dam.

> ***OPRD/PGG/ESA Response:*** *This is a scenario that will be likely be addressed in fuller detail in analysis that will come after completion of this current hydrological risk assessment. A full simulation of a setback dike scenario would require complete reconstruction of surface water and groundwater models, which is not possible with the remaining study contract budget. ESA will, however, preliminarily scope this process and determine whether a setback dike could be located such that it would result in the desired surface water characteristics. If ESA scoping determines that a setback dike is feasible, this option will be assessed in fuller detail in phases of analysis that will follow completion of the current hydrological risk assessment.*

Comment/Request: Run a scenario in which Reneke Creek is diverted to the north of the dike in its old location to see if smaller tide gates would suffice and/or to assess water quality and fish passage effects.

OPRD/PGG/ESA Response: *The water quality and fish passage aspects of this scenario will be addressed in fuller detail in analysis that will come after completion of this current hydrological risk assessment.*

In terms of tide gate sizing, because the tide gate and breach openings are sized primarily based on meeting fish passage criteria under frequent, tidally-driven hydrology conditions, the size of the openings would not be significantly different with Reneke Creek's flows redirected outside of the diked system. A more detailed sizing analysis would be required for fish passage approval in a subsequent design phase.

In terms of TDM groundwater, since the previous modeling scenarios showed no significant adverse groundwater effect in either the modern tide gate or breach scenarios, neither will a scenario in which Reneke is re-routed to the outside of the dike.

Comment/Request: Run a worse storm scenario.

OPRD/PGG/ESA Response: *The 50 year event previously modeled reached the top of the dike. Larger storms would not result in water levels higher than the top of the dike because impounded storm water would overtop the dike and spill into Sand Lake. The elevation of the top of the dike limits the maximum water surface elevation inside the marsh. The only condition that would cause a higher water level in Beltz Marsh would be a higher tide that overtops the dike associated with rising sea level (climate change), which is addressed in the next comment and response below.*

Under the modern tide gate scenario (which did not result in water reaching the top of the dike in previous model runs), a worse storm event could result in higher impounded water levels during tide gate closure. However, because of the efficient drainage of a modern tide gate, because of blocking high incoming tides, and because of the limitation of dike elevation on maximum water level, a modern tide gate could not result in water levels that exceed predictions for either the breach or the existing tide gate. Since neither of these scenarios led to a significant TDM groundwater risk under maximum water level conditions, full numerical modeling of a worse storm event with a modern tide gate is not warranted.

Larger, greater duration storm events could cause more prolonged maximum water levels in the marsh, but this would still be worse under the existing tide gate configuration due to its *inefficient drainage capacity than under either the modern tide gate or breach configurations. Both modern tide gate and breach scenarios would result in complete release of impounded water at low tide, while the existing condition would maintain very high water surface levels for days in spite of low tides due to the constricted outflow through the small existing tide gate.*

Comment/Request: We understand the fact that sea level rise would result in overtopping the dike, but would the dike still offer some protection to TDM from high tides and sea level rise?

OPRD/PGG/ESA Response: *Under a breach scenario, no. Water levels inside and outside the dike would essentially be in equilibrium at all times. Under a tide gate scenario, the dike could slow down an incoming event in the short term. The amount of buffer time the dike might give before the full tide height is reached near TDM would depend on how much higher than the dike the tide got. If the dike height were exceeded by more than a few inches, the basin behind the dike would fill very fast. Additionally, water overtopping the dike could cause erosion and potentially cause an unplanned dike breach. ESA will estimate the time to fill the marsh once the water level has exceeded the dike top by running a weir flow calculation based on 6" and 1' depth over the dike. The results of this estimation will be described in the summary report.*

Comment/Request: Consider including sea-level rise in all future scenarios.

OPRD/PGG/ESA Response: *OPRD and stakeholders will assess sea level rise in consideration of construction/alteration designs with respect to engineering for stability and sustainability in later and more refined phases of project scoping and design that will follow completion of the hydrological risk assessment.*

In terms of future modeling efforts, once the levee is overtopped, none of the scenarios under consideration provide significantly different levels of protection to TDM. Tide gate scenarios might provide a minor delay in maximum water surface elevations behind the dike. ESA will estimate the time to fill the marsh once the water level has exceeded the dike top by running a weir flow calculation based on 6" and 1' depth over the dike. The results of this estimation will be described in the summary report.

Comment/Request: Improve assessment of east marsh/ TDM ditches flow and effect of outgoing freshwater that gets blocked from flowing out by incoming tidal water. Constriction at Sand Lake Road, and effect on backed up water in East Marsh?

OPRD/PGG/ESA Response: *In order to investigate the Sand Lake Road culvert effects, ESA will develop some culvert capacity calculations and compare the capacity with peak flows estimated from the East Marsh drainage basin.*

When "tidewater" is high inside Beltz Marsh, this would generate an outlet controlled scenario which can affect capacity. However, the culvert is a 24" diameter pipe that has a negative slope *(invert elevation on the east side of the road was surveyed as lower than the invert elevation on the downstream/west side of the road). This means this culvert would function based on the difference in head/water level on either side of the culvert. A small/undersized culvert certainly would provide resistance/capacity limitations for water moving in either direction. If the water level in Beltz Marsh is high, it wouldn't necessarily cause water in the East Marsh to "pile up", but it would allow the water level in Beltz Marsh to propagate back into the east marsh and lead to higher water levels in the east marsh (unless it was fitted with a tide gate). The existing groundwater model already assumes this equilibration and propagation of Beltz Marsh tidewater back into the east marsh.*

Similarly, in the east ditch along Sand Lake Road, elevated water levels in Beltz Marsh would propagate up the ditch at approximately the same elevation of the water in Beltz Marsh. The lowest/northernmost culvert in this ditch (under Roma Ave.) has an invert elevation of 11.72', and a 12-inch diameter (top elevation of 12.72'). If water levels in Beltz Marsh exceed 11.72', tailwater conditions would begin to influence culvert capacity, and if water levels exceeded 12.72', the culvert would exhibit full outlet controlled hydraulic conditions which can reduce capacity of water to pass through (potentially backing water up in the ditch upstream of the Roma Ave culvert. If the culvert was not present, elevated water levels in the ditch could cause a minor 'pillowing' effect of storm water flowing down the ditch, but this zone of influence would be very small.

Regarding groundwater flow in compacted sediments beneath the road: the model was constructed with the assumption that groundwater flow was uninhibited under the road. Model calibration was successful with this assumption. It is worth noting that Sand Lake Road elevations range from 15-22 feet MSL along TDM whereas characterization of the clay layer shows that it generally occurs at an elevation of around 4-5 feet MSL. No information is available regarding the construction base of Sand Lake Road. Assuming that the road was built upon a base of crushed rock positioned on top of native materials, the thickness of sandy materials beneath the road is expected to range from about 10-18 feet. Compaction is expected to be more significant in clayey sediments than sandy sediments. PGG is investigating any potential significant effect compaction beneath the road might have on free movement of groundwater beneath it. Findings will be included in the report.

Comment/Request: Run the model through the summer under average tides and precipitation conditions for the modern tide gate and breached dike scenarios in relation to the current tide gate configuration. We suggest running these scenarios with and without Reneke Creek discharging behind the dike.

These scenarios would simulate the summertime groundwater response beneath TDM which may, in turn, be projected to estimate summertime groundwater flux into the marsh.

> ***OPRD/PGG/ESA Response:*** *This assessment, while important to the water quality aspect of the dike alteration question, is outside of the scope and goals of the current hydrological/groundwater risk study. Water quality evaluations can be pursued in phases of alternative scoping and effects assessment that will follow completion of the current hydrological risk assessment. The proposed work can be completed using the models from the current study in combination with summer water level data collected in previous studies to approximate groundwater flux, but in order to be useful for water quality assessment, other data on summer temperature and dissolved oxygen of the groundwater and surface water sources would be necessary.*

Comment/Request: We understand the modern tide gates can be adjusted to change the elevation of water held back behind the dike. It would be interesting to see how the summertime conditions would respond to different tide gate settings to control storage of fresh water, from both surface water and groundwater influx, behind the dike. We suggest running these scenarios with and without Reneke Creek discharging behind the dike. These scenarios might help to understand how to improve summertime fresh water quality conditions for the fish in the area between the dike and TDM.

> ***OPRD/PGG/ESA Response:*** *Water quality effects will be pursued in phases of alternative scoping and effects assessment that will follow completion of the current hydrological risk assessment. However, assessment of alternative tide gate closure set points during winter and storm conditions may provide information useful to the groundwater and risk assessment, as described below.*
>
> *The 7' set point for the tide gate was originally selected to give enough additional storm water storage capacity to minimize maximum water level while still providing some out-of-channel dispersal habitat for fish under normal conditions. Increasing the set point to 7.5 or 8 feet would have an effect of diluting and decreasing the proportion of the marsh's total surface water inside and outside of the channels that comes from groundwater, and would also increase maximum water levels under storm conditions. Lowering the set point to 6 feet would confine the water within the marsh almost completely to being within the channels, presumably increase the percentage of total surface water within the channels that comes from groundwater (at least during some phases of the cycle), and decrease the foraging habitat for fish outside of the channels. Increasing or decreasing the dilution or percentage of surface water originating from groundwater (rather than surface water) contribution might have an effect on water temperature and chemistry that would influence overall water quality for fish. This difference between surface water source ratios and its effects on fish habitat and water quality will be addressed in more detail in phases of assessment that will occur after completion of the current study's risk assessment.*

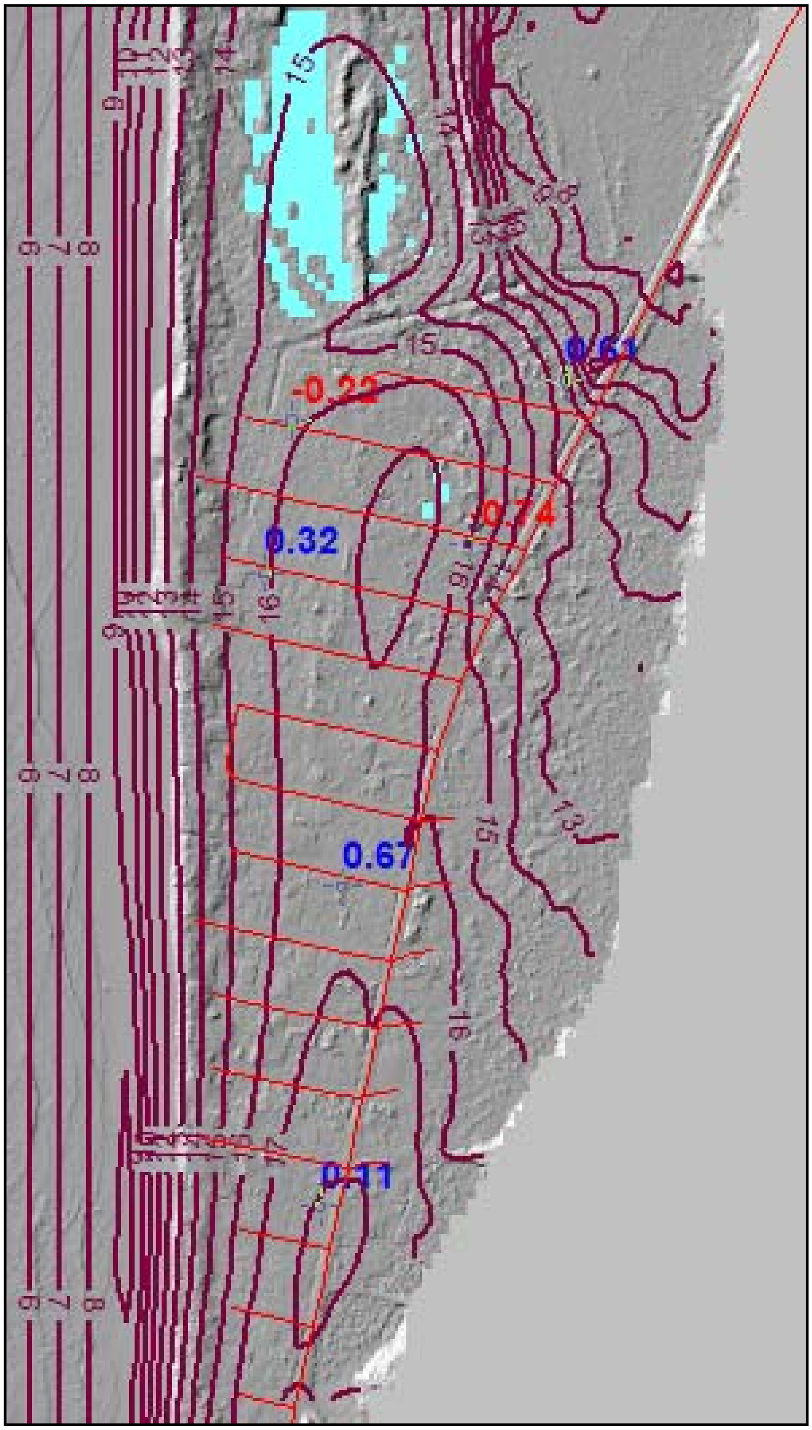
Although water quality analysis will come in a later phases of assessment outside of the current contract, OPRD sees value in assessing TDM groundwater effects of a higher set point to see if there is a significant groundwater effect in case later water quality, habitat, or other assessment determines that a different set point is preferable. Surface water models for 7.5 and 8.0 foot set points will be created and groundwater assessment will be performed for the 8.0 foot scenario to gauge effect as a test case. While current budget won't allow for multiple set-point-driven groundwater model iterations, the 8 foot scenario should provide an indication of magnitude of effect, and finer tuning might be possible later through contract amendment if the 8 foot scenario indicates a significant effect and a need to try lower set points.

APPENDIX I
SUPPLEMENTAL GROUNDWATER MODEL SIMULATIONS

APPENDIX I - SUPPLEMENTAL GROUNDWATER MODEL SIMULATIONS

This appendix presents the results of supplemental groundwater model simulations described in Sections 7.4.3 (*Supplemental Groundwater Model Sensitivity Analysis*) and 7.4.4 (*Groundwater Model Simulation of 8-ft Cutoff Modern Tide Gate*) of the main report. During the supplemental sensitivity analysis, steady-state calibration using the enhanced marsh connectivity (EMC) version of the Tillamook model realization (v12) showed very similar WLE predictions as the original version of the model. Steady-state EMC model calibration results are shown on Figures I-1 and I-2 and can be compared to Figures 6-14 and 6-15 of the main report. Similarly, transient EMC model calibration results (Figures I-3 through I-8) showed similar calibration success as the original model (Figures 6-21 through 6-30). Once PGG established that a similar quality calibration was achieved with the EMC model, it was used to run the 38-day predictive simulation described in Sections 7.3.1 and 7.3.2 of the main report. Predictive results for all referenced wells using the EMC model are presented on Figures I-9 thru I-14. Shallow-Aquifer responses are of greatest concern to TDM, and Shallow-Aquifer predictions generally show no significant difference from results generated with the original model (Figures 7-5 thru 7-14). The only notable difference occurs for Shallow-Aquifer Well PGG-1i (located closest to Beltz Marsh), where EMC-model predicted WLE's changes for the alternative dike configurations (relative to the current tide gate) are as much as 0.1 feet lower than the original model during the "flood" period.

Figures I-15 and I-16 present predictive simulations using the original Tillamook and Cloverdale model realizations where the modern tide gate was simulated with shutoff elevations of both 7- and 8- feet. Model predictions were extracted for all referenced monitoring wells; however, the only Shallow-Aquifer well that exhibited a minor difference was PGG-1i (located closest to Beltz Marsh), which exhibited a 0.01-feet higher predicted WLE toward the end of the "flood" period. All more distant wells (such as PGG-3s shown on Figure I-16) showed no predicted WLE difference between the 7- and 8-foot cutoff elevation configurations.



Note:
Steady-state calibration predictions of Shallow Aquifer groundwater level contours and calibration target residuals (observed minus simulated water-level elevations) developed for the enhanced marsh connectivity (EMC) sensitivity analysis. No significant difference is noted between the EMC calibration and the original model calibration. Target residuals are within 0.02 feet of residuals predicted for the original model calibration.

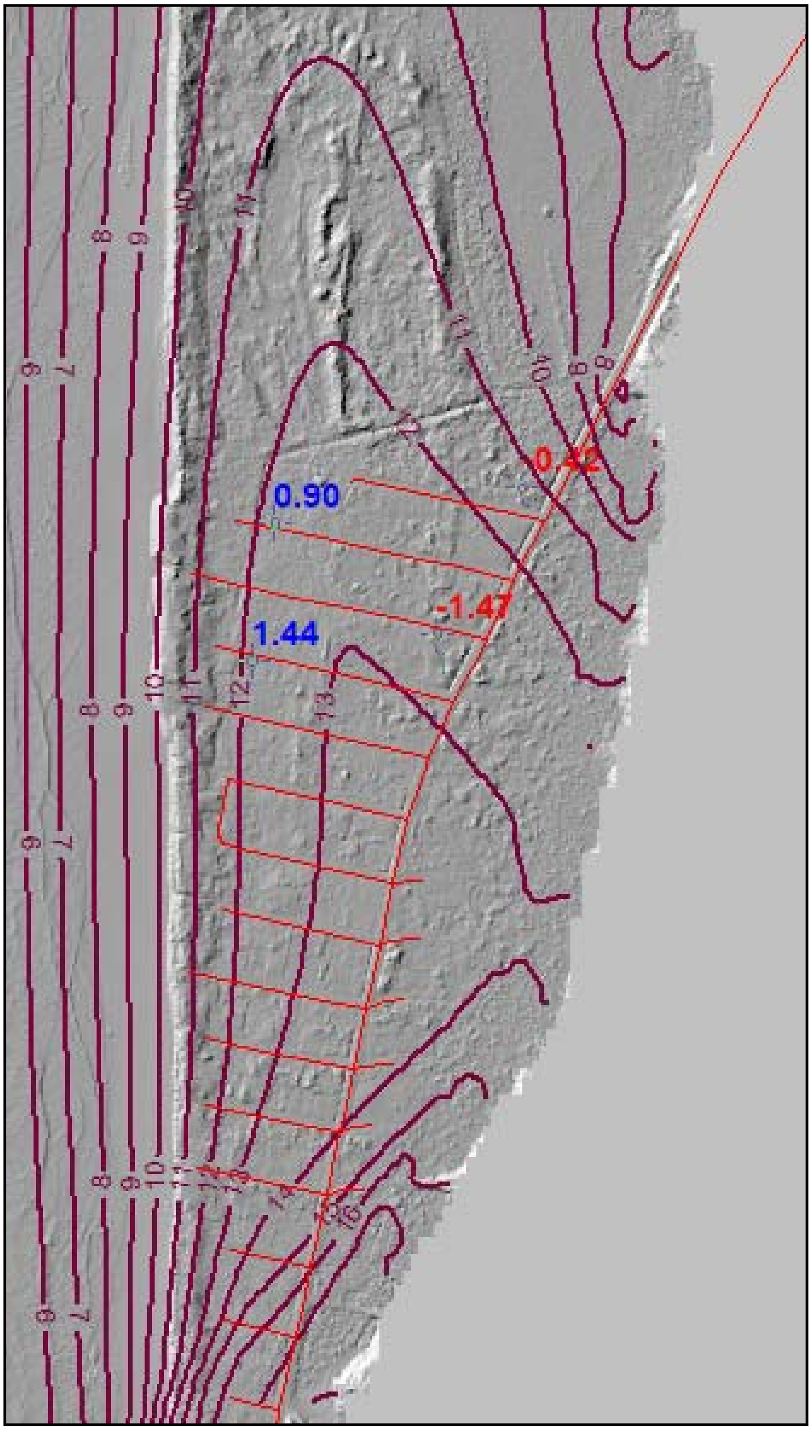
EMC model simulations utilize recharge values derived from Tillamook climate data.

Original model Shallow-Aquifer calibration residuals are shown on Figure 6-17 in the main report.

Figure I-1
Steady-State Calibration Residuals in Shallow Aquifer Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PGG



Note:
Steady-state calibration predictions of Deep Aquifer groundwater level contours and calibration target residuals (observed minus simulated water-level elevations) developed for the enhanced marsh connectivity (EMC) sensitivity analysis. No significant difference is noted between the EMC calibration and the original model calibration. Target residuals are within 0.15 feet of residuals predicted for the original model calibration.

EMC model simulations utilize recharge values derived from Tillamook climate data.

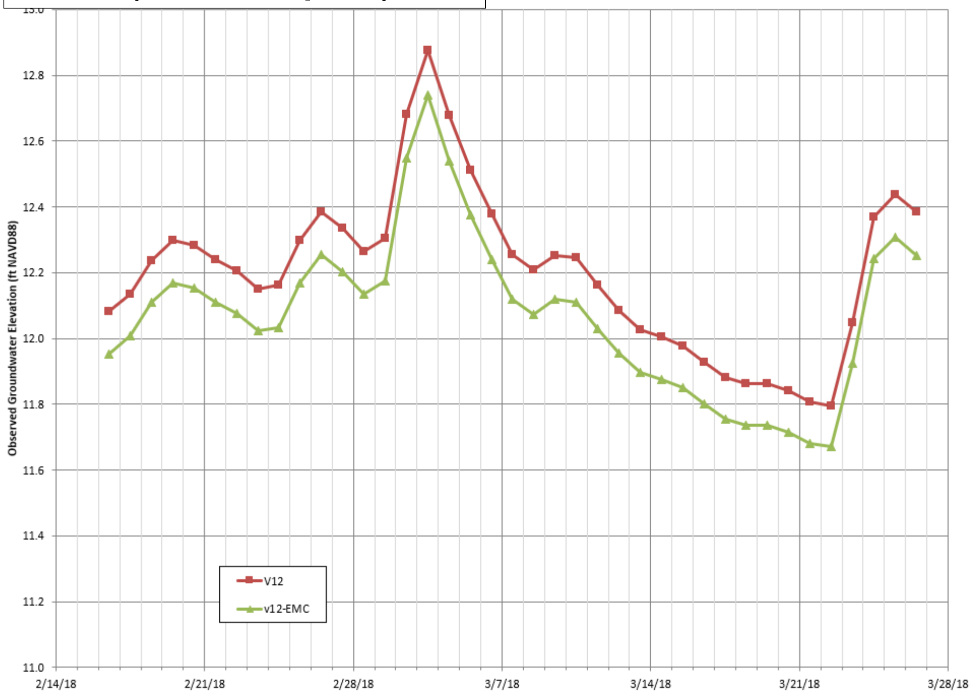
Original model Deep-Aquifer calibration residuals are shown on Figure 6-18 in the main report.

Figure I-2
Steady-State Calibration Residuals in Deep Aquifer Using the EMC Model

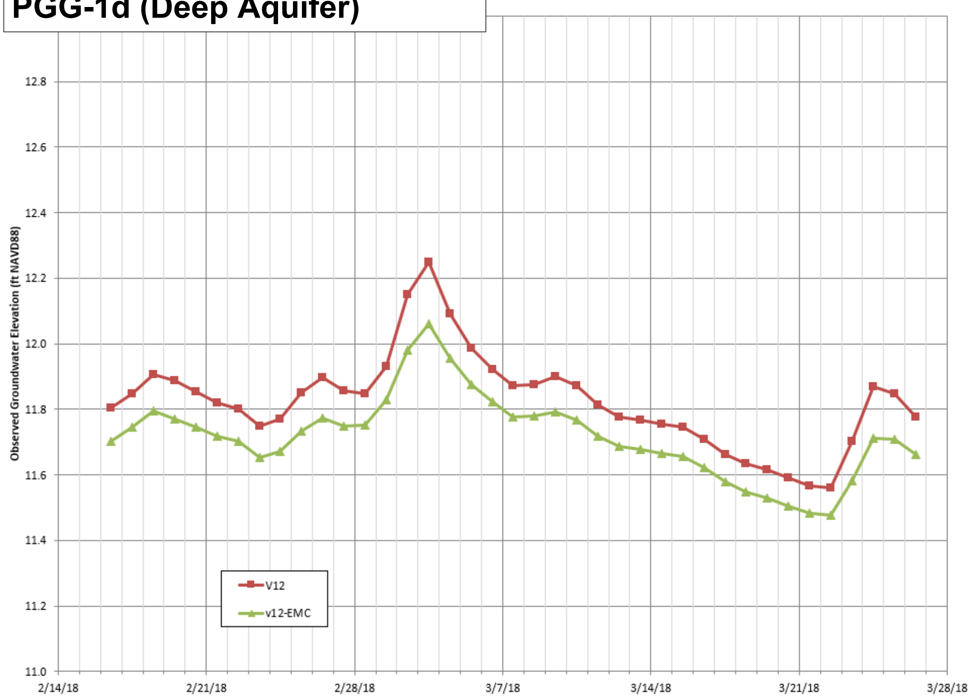
Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PGG

PGG-1i (Shallow Aquifer)



PGG-1d (Deep Aquifer)



Note:
This figure compares model-predicted groundwater elevation hydrographs developed for the original transient calibration and the "Enhanced Marsh Connectivity" (EMC) transient calibration.

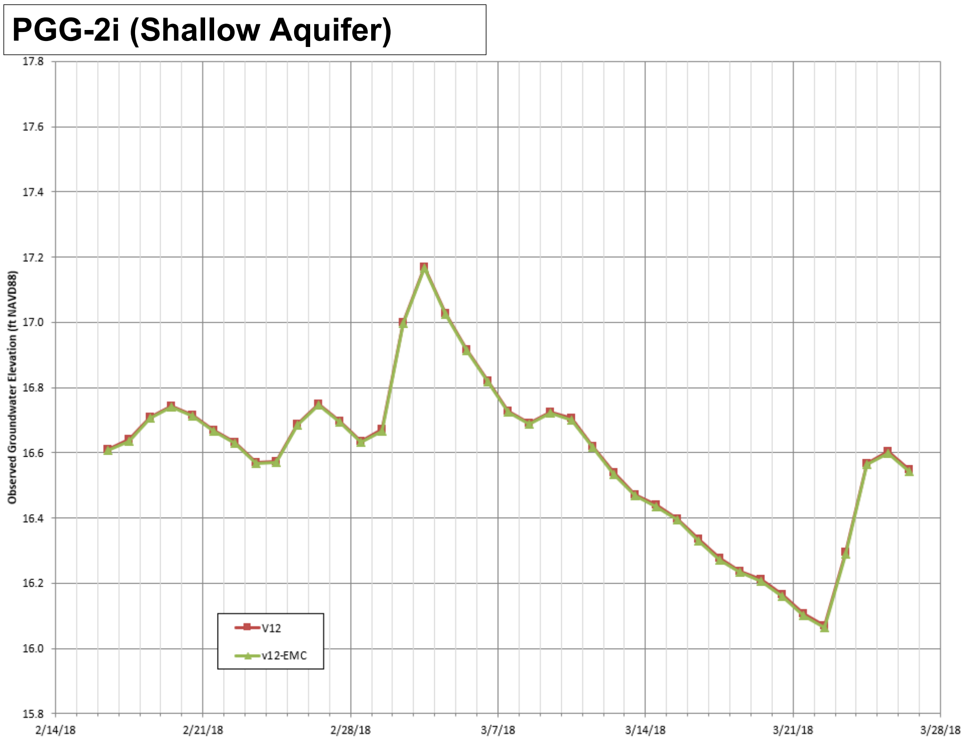
The transient calibration period is 38 days and employs recharge values based on Tillamook precipitation. Model results were extracted for shallow and deep monitoring wells at the PGG-1 site.

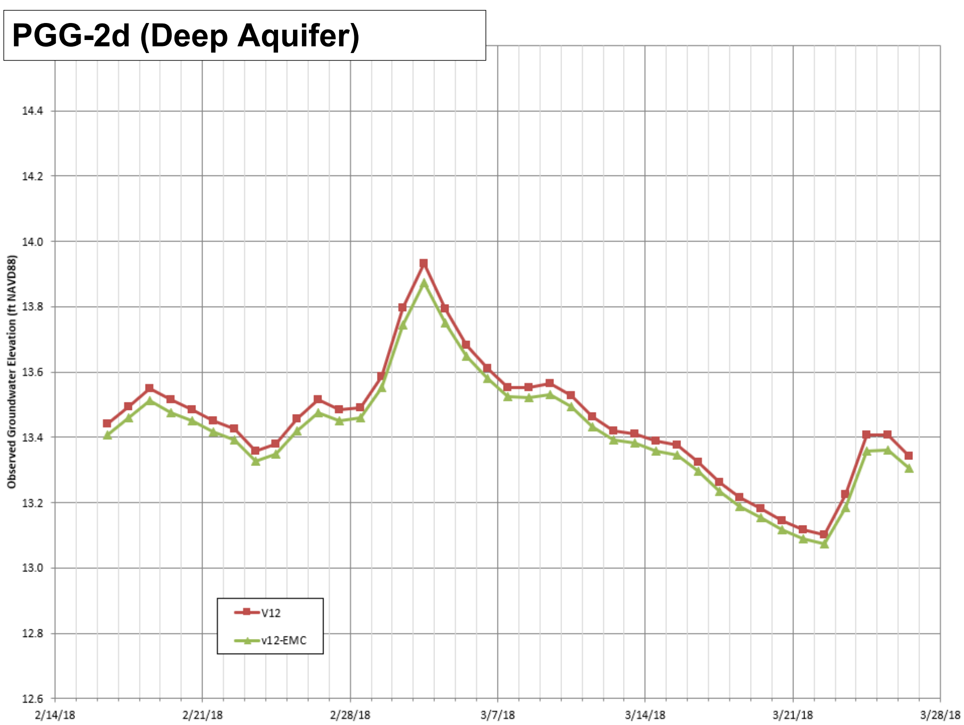
Although there is a small (0.1 foot) absolute head difference between the two calibrations, the main goal of transient calibration is to reasonably simulate observed trends. There is no significant difference between the trends simulated by the two calibrations.

Figure I-3
Transient Calibration Comparison for Well PGG-1 Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG





Note:
This figure compares model-predicted groundwater elevation hydrographs developed for the original transient calibration and the "Enhanced Marsh Connectivity" (EMC) transient calibration.

The transient calibration period is 38 days and employs recharge values based on Tillamook precipitation. Model results were extracted for shallow and deep monitoring wells at the PGG-2 site.

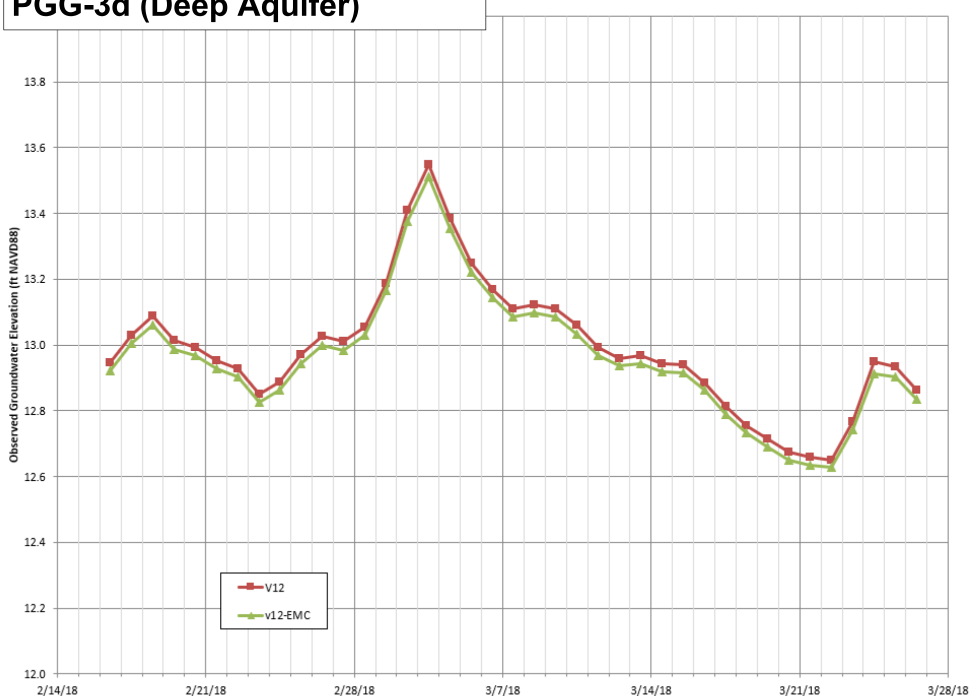
The main goal of transient calibration is to reasonably simulate observed trends. There is no significant difference between the trends simulated by the two calibrations.

Figure I-4
Transient Calibration Comparison for Well PGG-2 Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PGG-3s (Shallow Aquifer)

PGG-3d (Deep Aquifer)



Note:
This figure compares model-predicted groundwater elevation hydrographs developed for the original transient calibration and the "Enhanced Marsh Connectivity" (EMC) transient calibration.

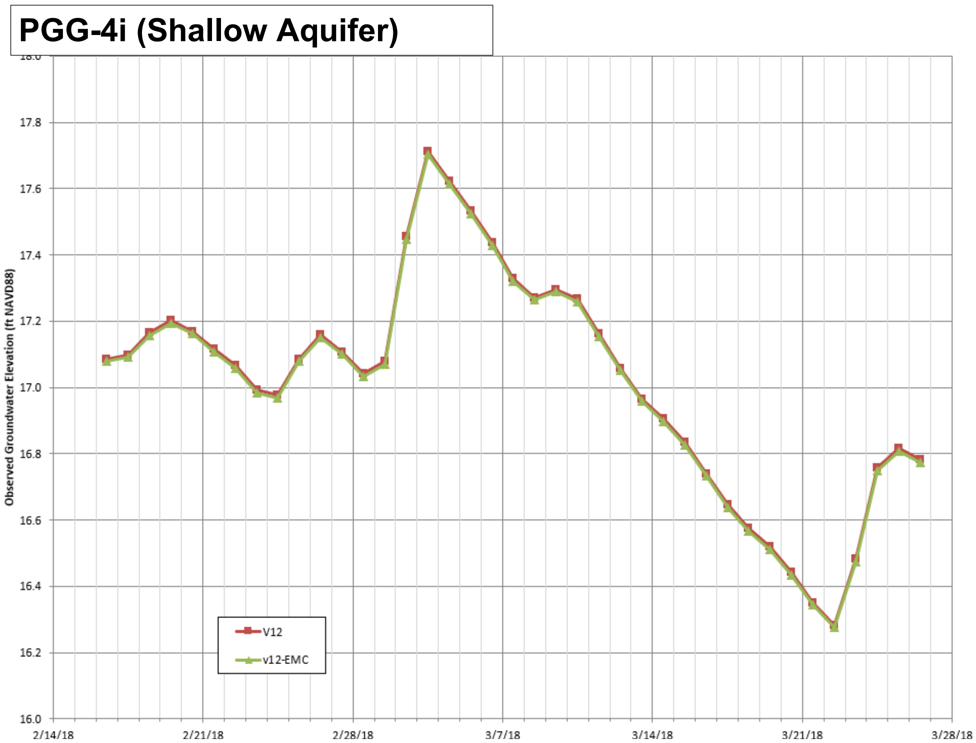
The transient calibration period is 38 days and employs recharge values based on Tillamook precipitation. Model results were extracted for shallow and deep monitoring wells at the PGG-3 site.

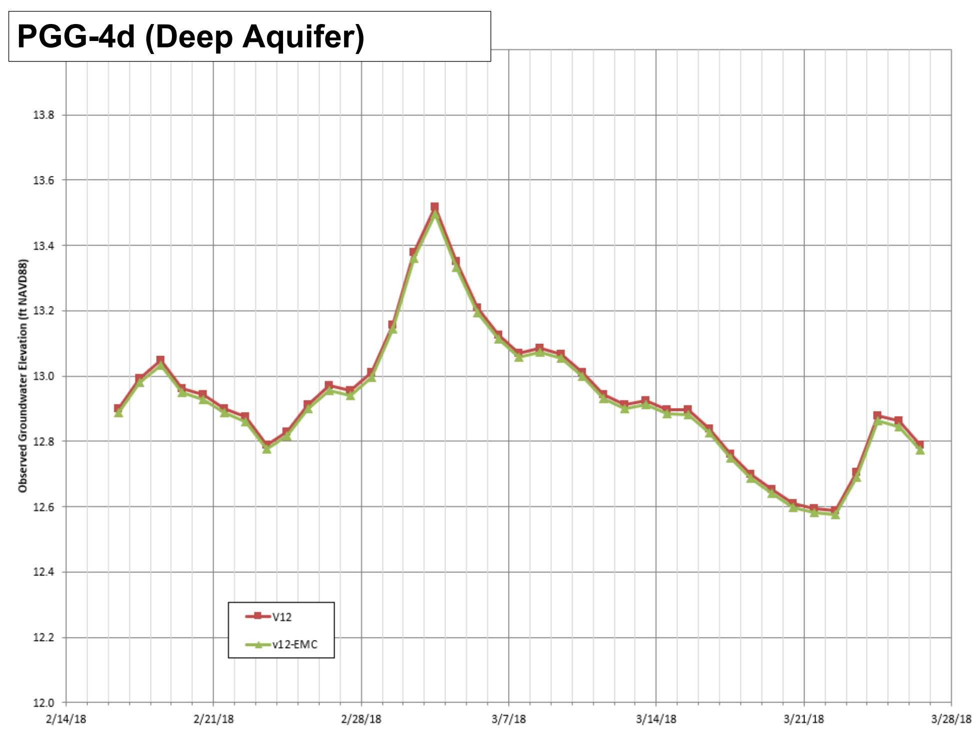
The main goal of transient calibration is to reasonably simulate observed trends. There is no significant difference between the trends simulated by the two calibrations.

Figure I-5
Transient Calibration Comparison for Well PGG-3 Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PGG





Note:
This figure compares model-predicted groundwater elevation hydrographs developed for the original transient calibration and the "Enhanced Marsh Connectivity" (EMC) transient calibration.

The transient calibration period is 38 days and employs recharge values based on Tillamook precipitation. Model results were extracted for shallow and deep monitoring wells at the PGG-4 site.

The main goal of transient calibration is to reasonably simulate observed trends. There is no significant difference between the trends simulated by the two calibrations.

Figure I-6
Transient Calibration Comparison for Well PGG-4 Using the EMC Model

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TDM-2 (Shallow Aquifer)

TDM-4 (Shallow Aquifer)

Note:
This figure compares model-predicted groundwater elevation hydrographs developed for the original transient calibration and the "Enhanced Marsh Connectivity" (EMC) transient calibration.

The transient calibration period is 38 days and employs recharge values based on Tillamook precipitation. Model results were extracted for two shallow monitoring wells installed by TDM.

The main goal of transient calibration is to reasonably simulate observed trends. There is no significant difference between the trends simulated by the two calibrations.

Figure I-7
Transient Calibration Comparison for TDM Wells Using the EMC Model

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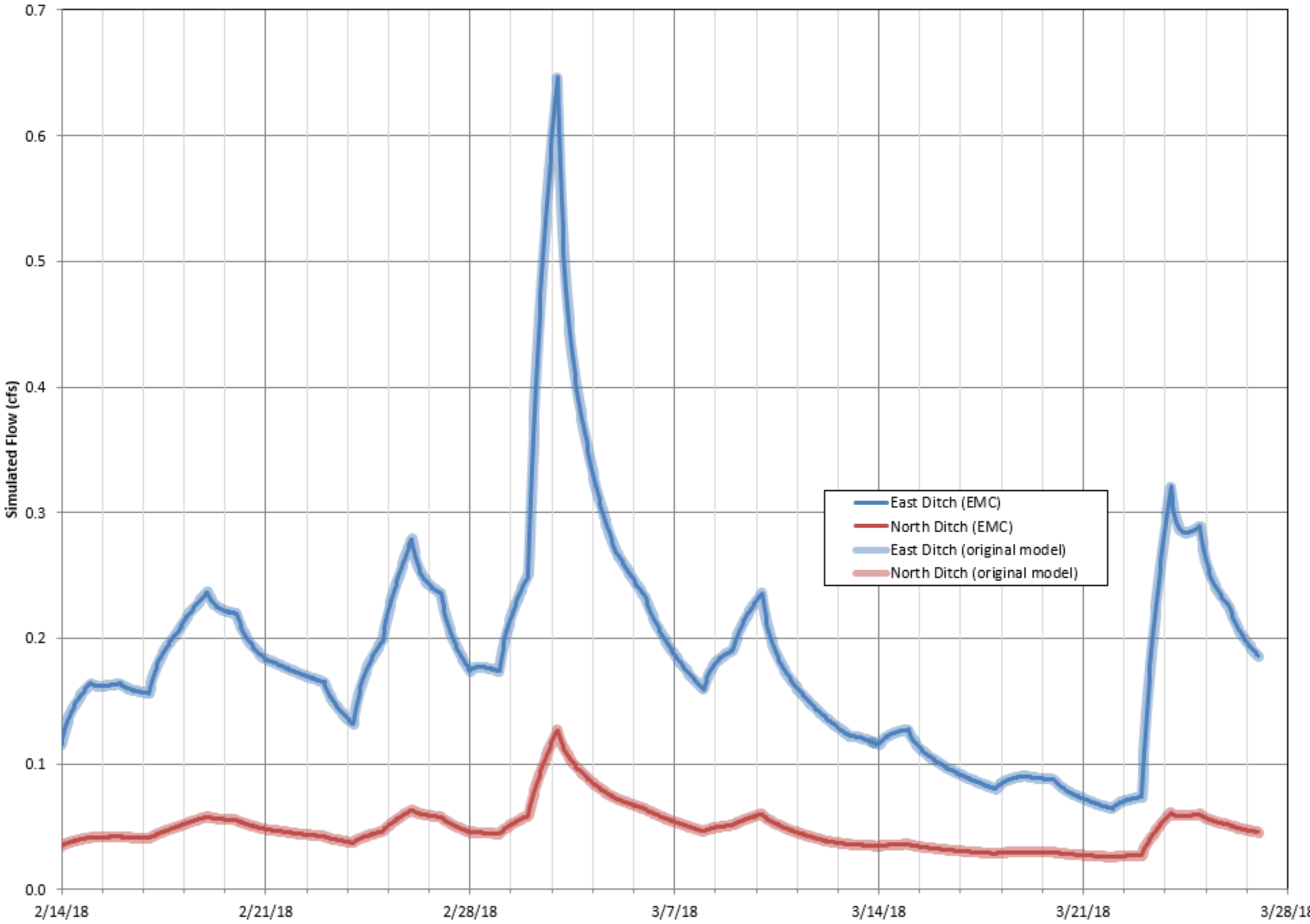
Supplemental Groundwater Modeling Analysis

PGG

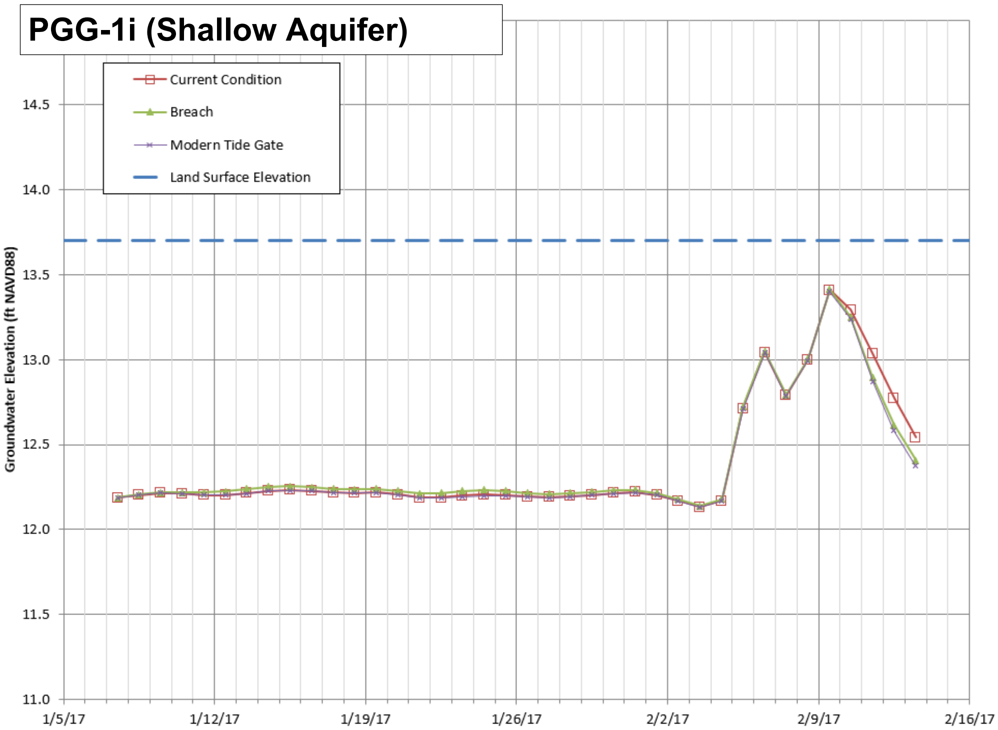


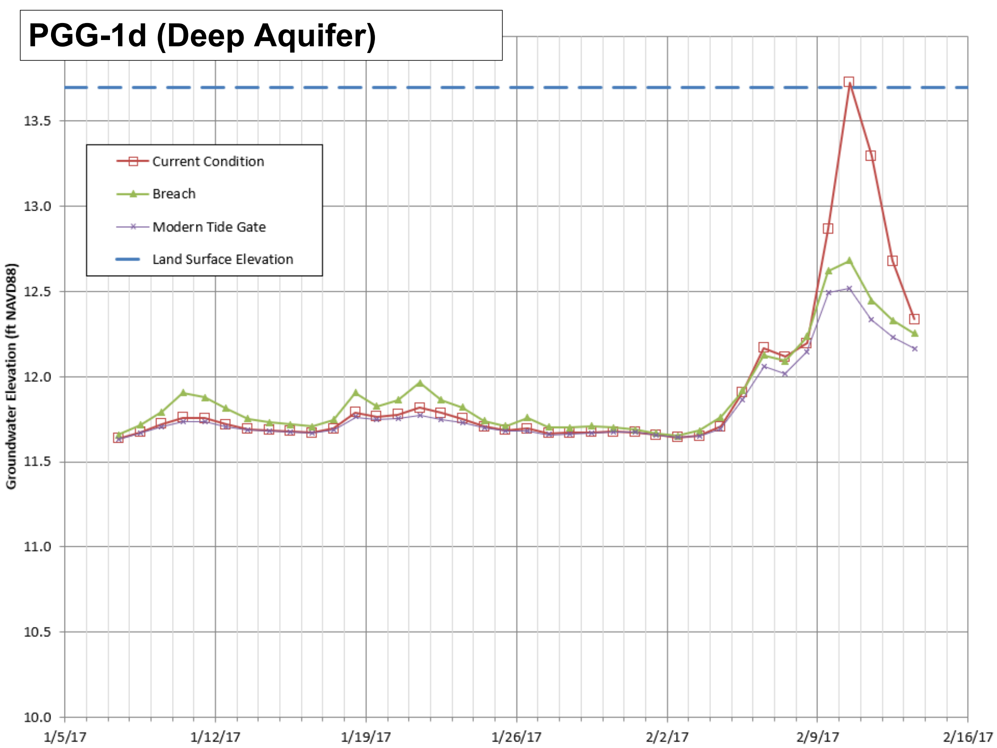
Note:
This figure presents groundwater model predictions of flow hydrographs for the East Ditch and the North Ditch extracted from both the original model calibration and the "Enhanced Marsh Connectivity" (EMC) calibration. There is no significant difference between the two sets of predictions.

Figure I-8
Transient Calibration Prediction of Ditch Flows Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG





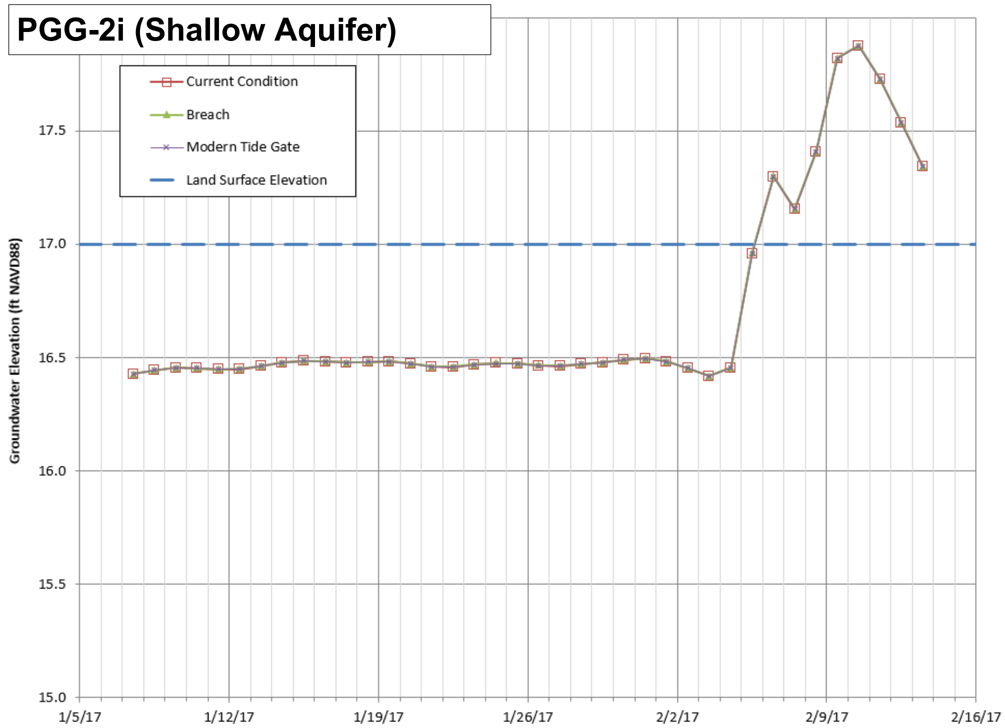
Note:
This figure compares groundwater model predictions of water-level hydrographs in Monitoring Wells PGG-1i and PGG-1d for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). The hydrographs were developed using the "Enhanced Marsh Connectivity" (EMC) version of the model, which employs recharge derived from Tillamook precipitation data.

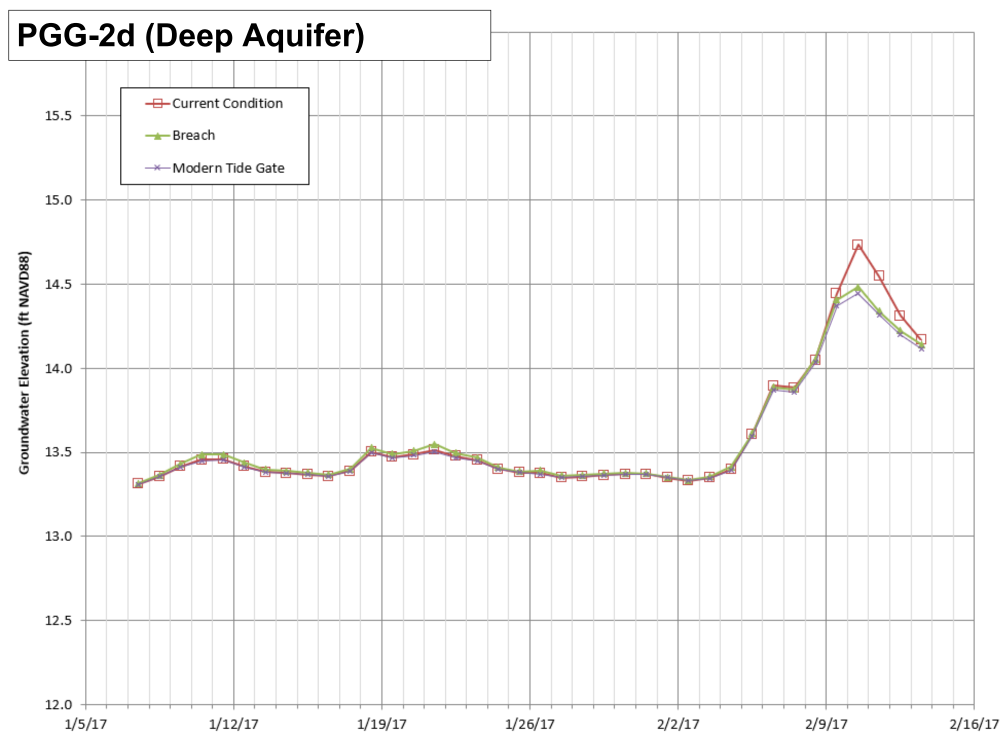
Conditions in the shallow aquifer (PGG-1i) are most relevant to groundwater concerns at TDM. Compared to the predictions developed for the original calibrated model (top of Figure 7-5, main report), differences among changes predicted between the current tide gate and the two alternative configurations are negligible (≤ 0.01 feet) during the 28-day "average" period and exhibit lower WLE's (by as much as 0.1 feet) during the 10-day "flood" period.

Figure I-9
Predicted Effect of Dike Configuration on Groundwater Levels in PGG-1 Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG





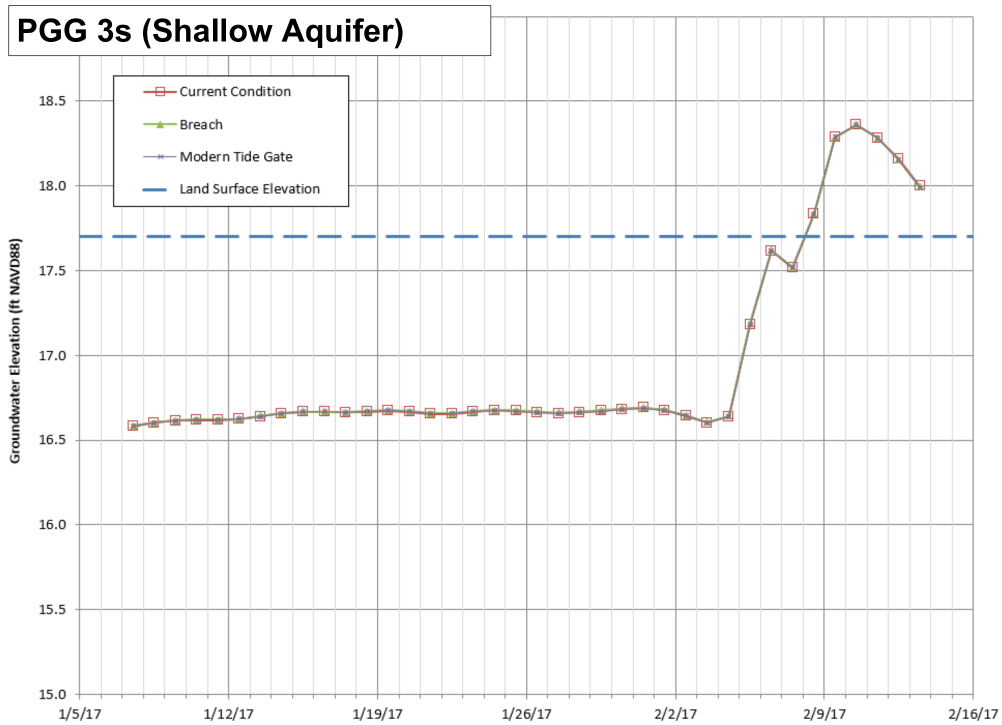
Note:
This figure compares groundwater model predictions of water-level hydrographs in Monitoring Wells PGG-2i and PGG-2d for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). The hydrographs were developed using the "Enhanced Marsh Connectivity" (EMC) version of the model, which employs recharge derived from Tillamook precipitation data.

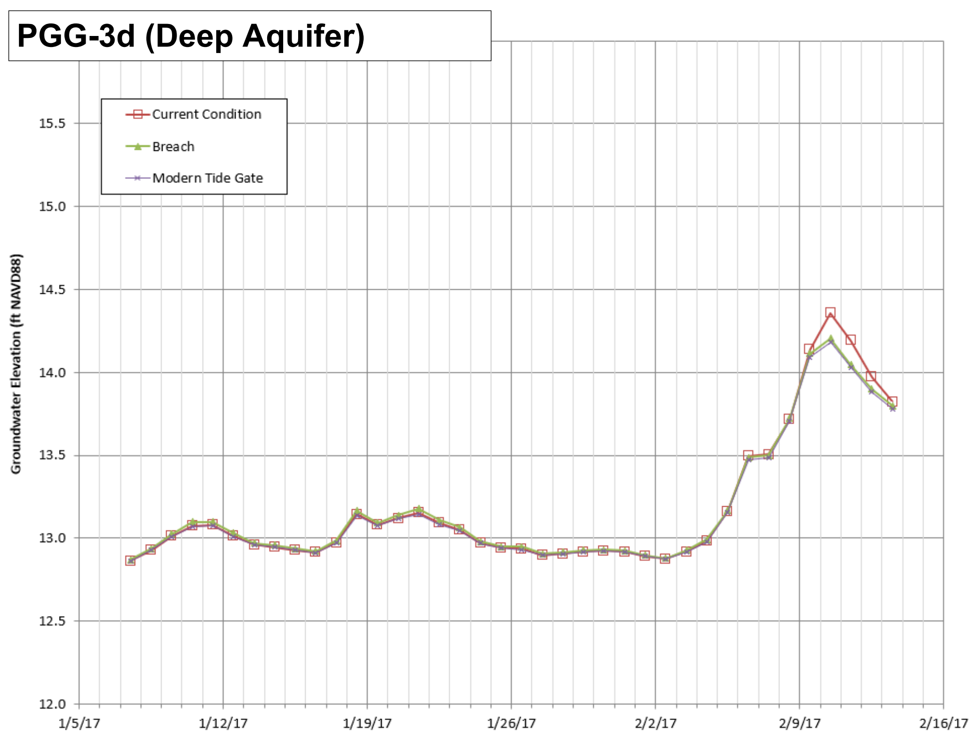
Conditions in the shallow aquifer (PGG-2i) are most relevant to groundwater concerns at TDM. Compared to the predictions developed for the original calibrated model (top of Figure 7-7, main report), differences among changes predicted between the current tide gate and the two alternative configurations are negligible (≤ 0.01 feet) during both the 28-day "average" and the 10-day "flood" periods.

Figure I-10
Predicted Effect of Dike Configuration on Groundwater Levels in PGG-2 Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG





Note:
This figure compares groundwater model predictions of water-level hydrographs in Monitoring Wells PGG-3s and PGG-3d for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). The hydrographs were developed using the "Enhanced Marsh Connectivity" (EMC) version of the model, which employs recharge derived from Tillamook precipitation data.

Conditions in the shallow aquifer (PGG-3s) are most relevant to groundwater concerns at TDM. Compared to the predictions developed for the original calibrated model (top of Figure 7-9, main report), differences among changes predicted between the current tide gate and the two alternative configurations are negligible (≤ 0.01 feet) during both the 28-day "average" and the 10-day "flood" periods.

Figure I-11
Predicted Effect of Dike Configuration on Groundwater Levels in PGG-3 Using the EMC Model

Sitka Sedge Natural Area
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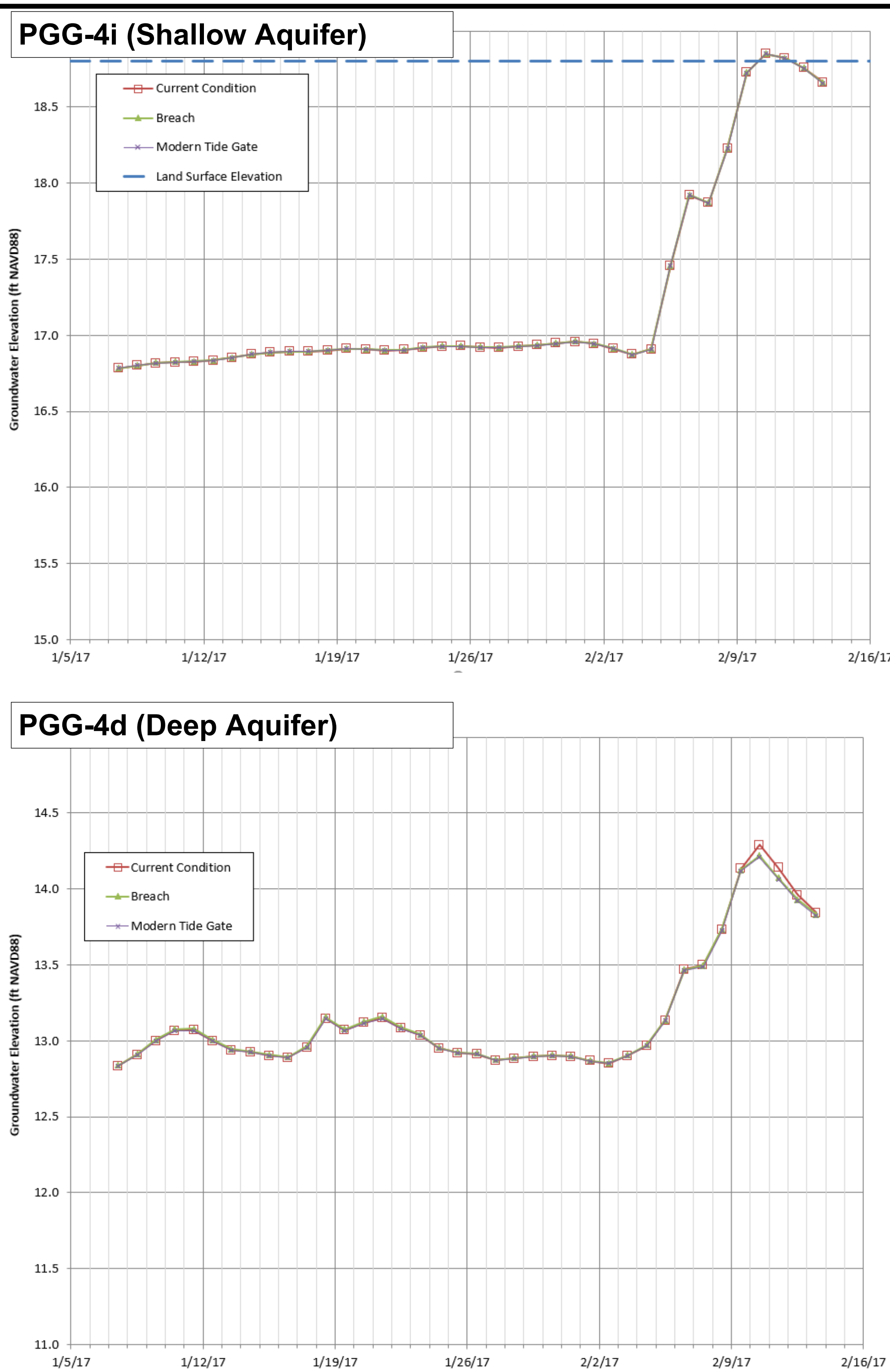
PgG



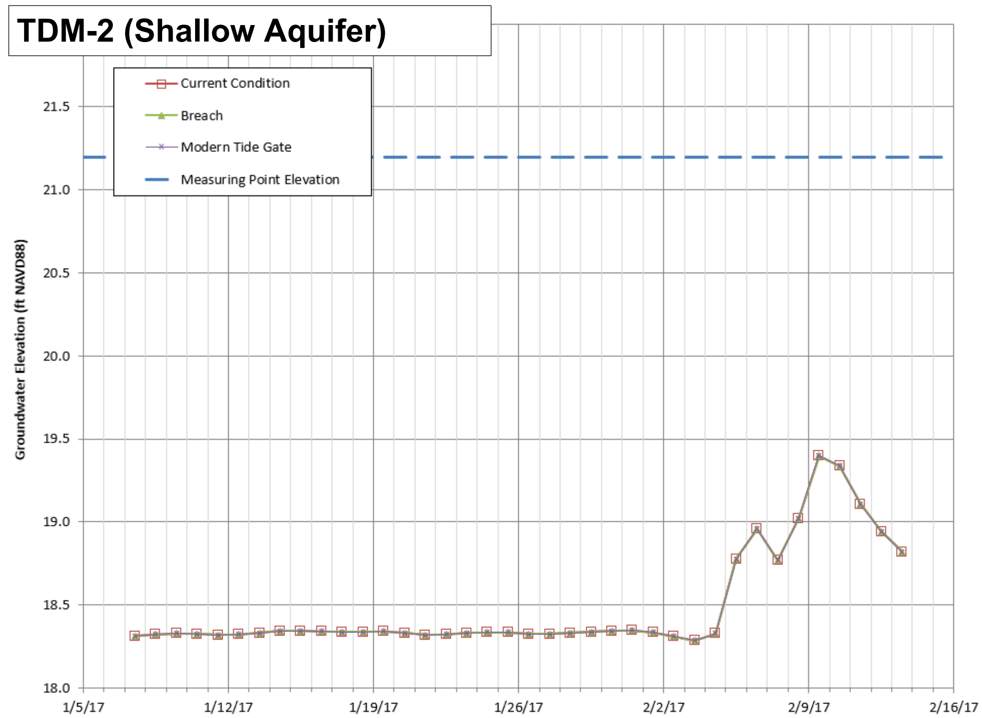
Note:
This figure compares groundwater model predictions of water-level hydrographs in Monitoring Wells PGG-4i and PGG-4d for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). The hydrographs were developed using the "Enhanced Marsh Connectivity" (EMC) version of the model, which employs recharge derived from Tillamook precipitation data.

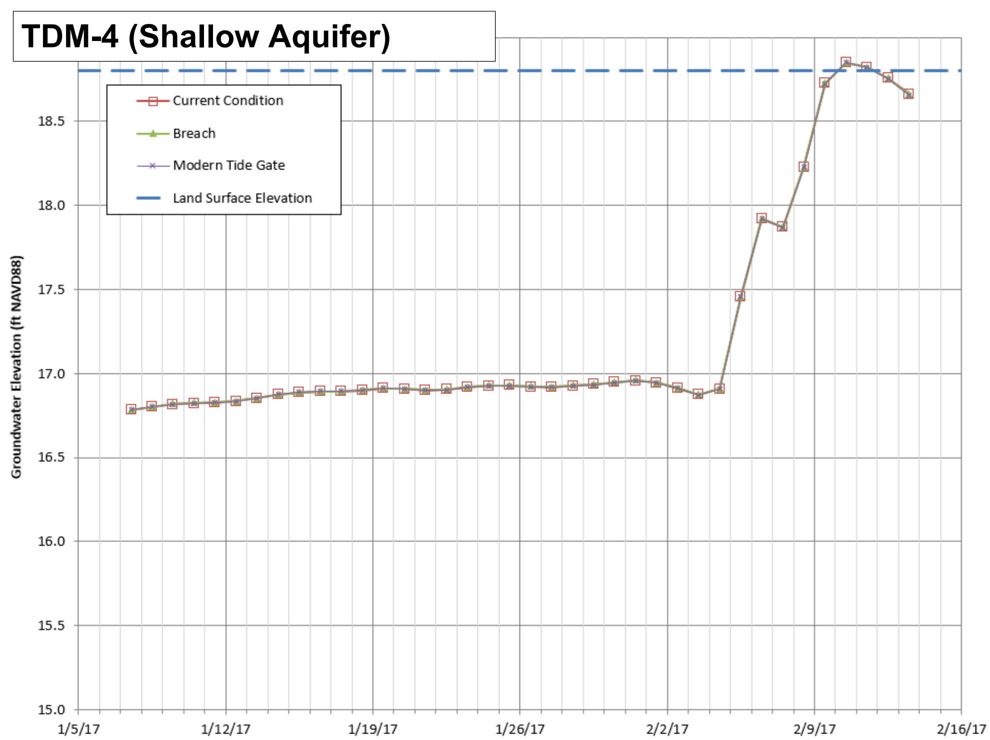
Conditions in the shallow aquifer (PGG-4i) are most relevant to groundwater concerns at TDM. Compared to the predictions developed for the original calibrated model (top of Figure 7-11, main report), differences among changes predicted between the current tide gate and the two alternative configurations are negligible (≤ 0.01 feet) during both the 28-day "average" and the 10-day "flood" periods.

Figure I-12
Predicted Effect of Dike Configuration on Groundwater Levels in PGG-4 Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG





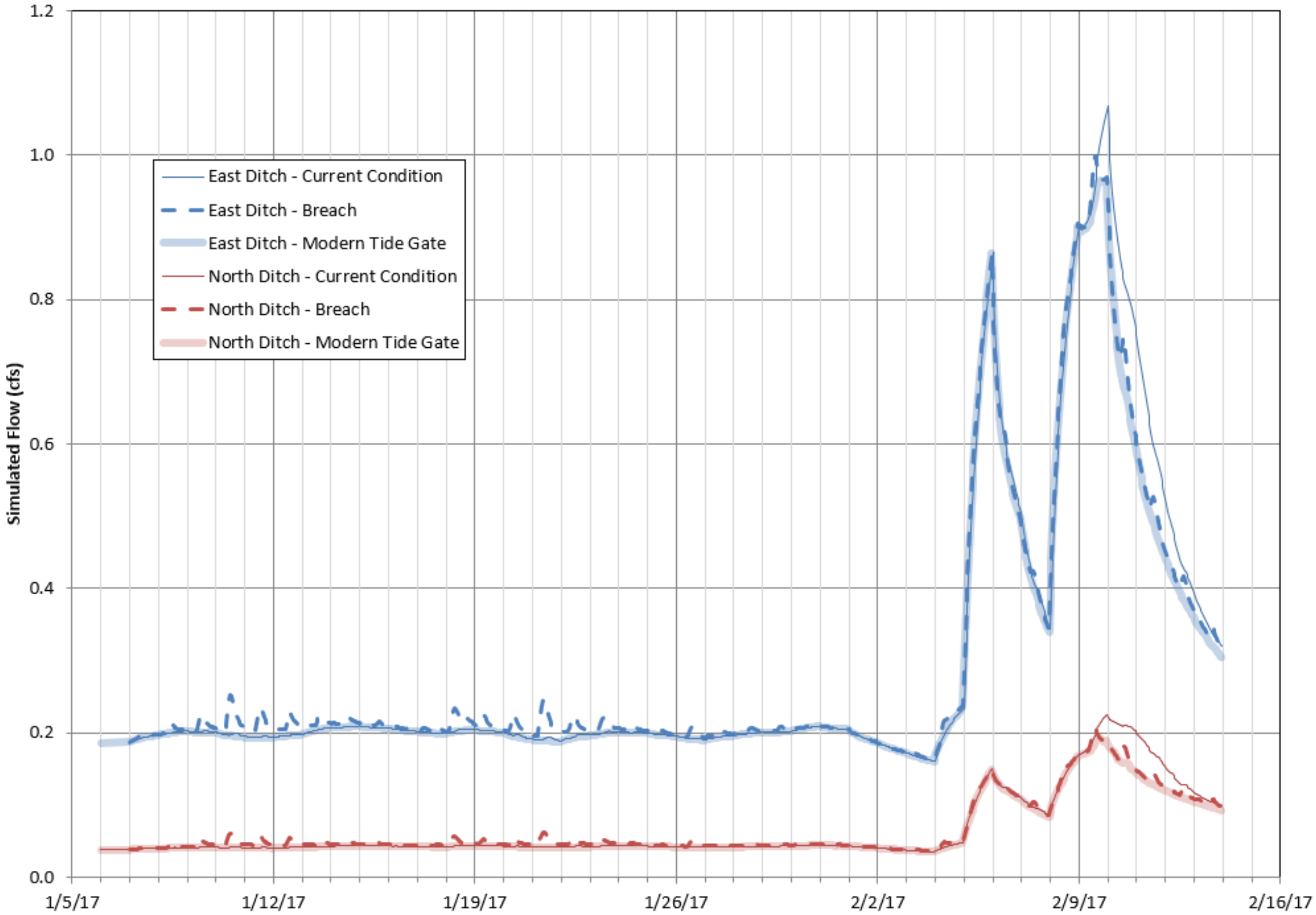
Note:
This figure compares groundwater model predictions of water-level hydrographs in Shallow-Aquifer Monitoring Wells TDM-2 and TDM-4 for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). The hydrographs were developed using the "Enhanced Marsh Connectivity" (EMC) version of the model, which employs recharge derived from Tillamook precipitation data.

Conditions in the shallow aquifer are most relevant to groundwater concerns at TDM. Compared to the predictions developed for the original calibrated model (tops of Figures 7-13 and 7-14, main report), differences among changes predicted between the current tide gate and the two alternative configurations are negligible (≤ 0.01 feet) during both the 28-day "average" and the 10-day "flood" periods.

Figure I-13
Predicted Effect of Dike Configuration on Groundwater Levels in TDM Wells Using the EMC Model

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PGG



Note:
This figure compares groundwater model predictions of flow hydrographs for the East Ditch and the North Ditch over a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13) derived using the "Enhanced Marsh Connectivity" (EMC) version of the model.

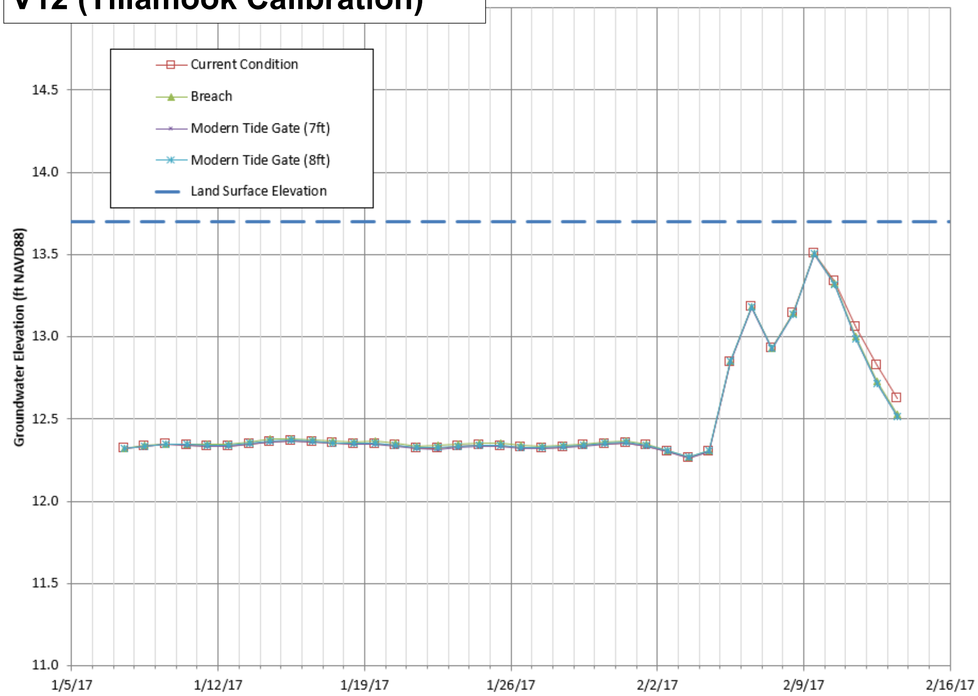
Compared to the predictions developed for the original calibrated model (top of Figure 7-15, main report), differences among changes predicted between the current tide gate and the two alternative configurations are negligible during both the 28-day "average" and the 10-day "flood" periods.

Figure I-14
Predicted Effect of Dike Configuration on Ditch Flows Using the EMC Model

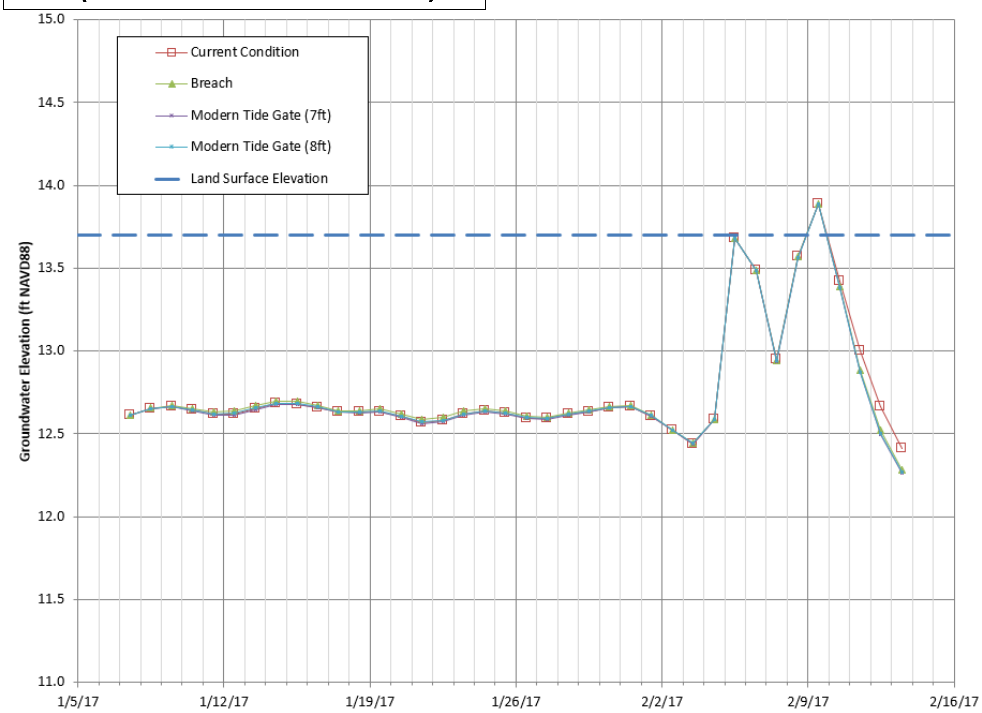
Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PGG

V12 (Tillamook Calibration)



V21 (Cloverdale Calibration)



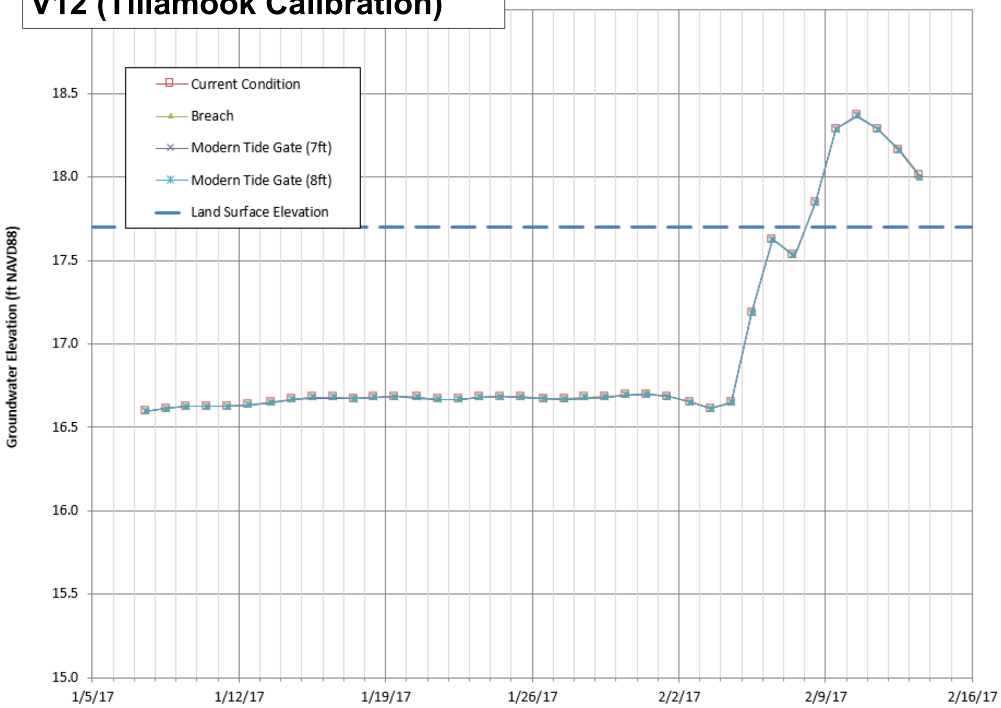
Note:
This figure updates Figure 7-5 of the main report by adding simulation of the modern tide gate with an 8-foot shutoff elevation to prior simulation with a 7-foot shutoff elevation. Results are presented for both the Tillamook and Cloverdale model realizations for the closest Shallow-Aquifer monitoring well to Beltz Marsh (Well PGG-1i). The predictive model was run for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). There is no significant difference in predicted WLE's between the 7– and 8-foot shutoff configurations. A 0.01-foot increase in predicted maximum WLE's was noted towards the end of the 10-day "flood" period.

Figure I-15
Predicted Effect of Dike Configuration on Groundwater Levels in PGG-1i (Shallow Aquifer - Including 8-ft Cutoff

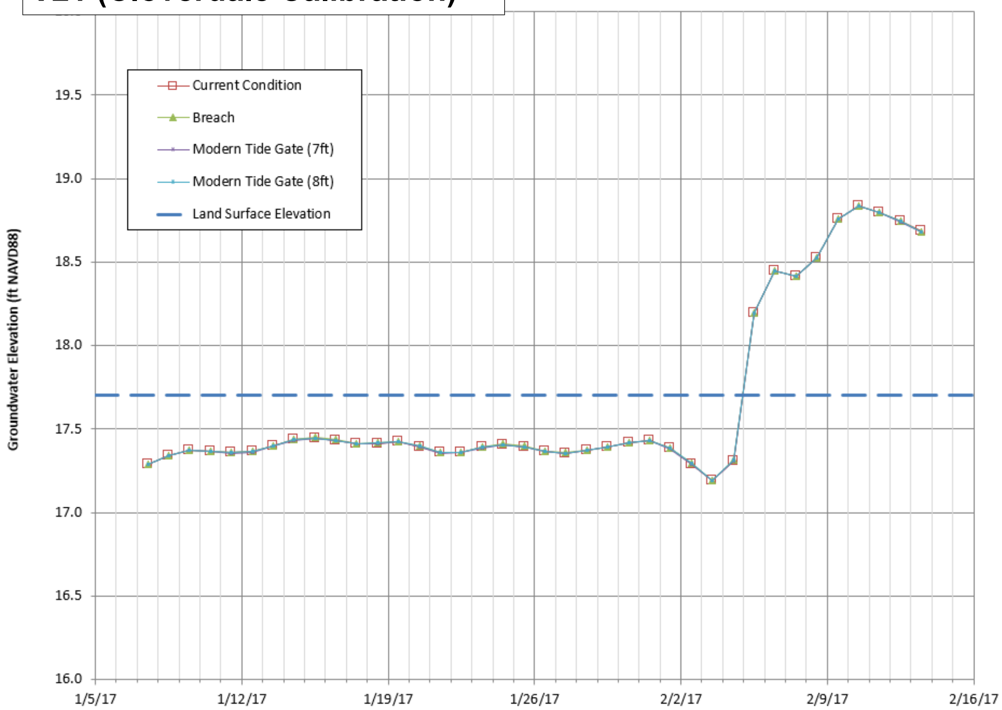
Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG

V12 (Tillamook Calibration)



V21 (Cloverdale Calibration)



Note:
This figure updates Figure 7-9 of the main report by adding simulation of the modern tide gate with an 8-foot shutoff elevation to prior simulation with a 7-foot shutoff elevation. Results are presented for both the Tillamook and Cloverdale model realizations for Shallow-Aquifer Well PGG-3s, located a moderate distance from Beltz Marsh. The predictive model was run for a hypothetical 28 days of average winter conditions (1/7—2/3) followed by 10 days of "flood" conditions (2/4—2/13). There is no significant difference in predicted WLE's between the 7– and 8-foot shutoff configurations.

Figure I-16
Predicted Effect of Dike Configuration on Groundwater Levels in PGG-3s (Shallow Aquifer - Including 8-ft Cutoff

Sitka Sedge Natural Area
Supplemental Groundwater Modeling Analysis

PgG