Former Georgia-Pacific Wood Products Facility
Fort Bragg, CA
Mill Pond Storm Water Summary
August 2017

- Storm water entering Pond 8 contains dioxins and furans at concentrations above the California Water Quality Objectives along with other pollutants such as metals and organics.

- A significant majority of the pollutants (80 to 95%) entering Pond 8 via storm water are from drainage areas outside the Mill Site.

- Pond 8 provides extremely effective storm water treatment for these compounds removing approximately 20 to 97% of pollutants. Most of the removed compounds are recalcitrant and are removed by settling rather than by destruction or transformation and are retained in Pond 8 sediments.

- The concentrations of dioxins and furans, a key community concern, observed in Pond 8 sediment are lower than concentrations in suspended solids in storm water, neither of which pose an unacceptable risk to human health or ecological receptors.

A summary of storm water evaluations completed for the Mill Pond (Pond 8) at the Former Georgia-Pacific Wood Products Facility in Fort Bragg, California is presented herein, with a focus on dioxins and furans. The Mill Pond drainage basin is approximately 417 acres. Approximately 54.5 percent of the drainage basin is in two urban watershed catchments located within the City of Fort Bragg that drain to Mill Pond through the culverted Maple and Alder Creeks (offsite). The remainder of the drainage basin (approximately 45.5 percent) is located at the former Georgia-Pacific Wood Products Facility and either drains to the pond through sheet flow or in concentrated flows through established storm water management features (onsite), including former wastewater treatment Ponds 1 through 4 (South Ponds). The individual drainage basins are described in detail in the Mill Pond Storm Water Sampling Report and are presented in Figure 1-2 of that report (Arcadis 2012).

Storm water quality within the Mill Pond drainage basin has been evaluated over two sampling efforts. The first sampling effort was conducted in 2011 to support the design of an alternate surface water conveyance feature for the Mill Pond. The results of this evaluation were summarized in the Mill Pond Storm Water Sampling Report (Arcadis 2012). Water quality, storm flow, and rainfall data were collected immediately before and during two storm events in February and March 2011. Six sampling stations were established (Figure 1-2), with Station CE primarily representing offsite flows from Maple Creek and Station D representing offsite flows from Alder Creek. The remaining four sampling stations represented onsite flows. Grab samples were collected prior to the storm event to characterize water quality before substantial runoff generation. Composite samples[1] were collected incrementally throughout the storm using automated samplers and combined to provide an integrated estimate of the constituent concentrations throughout the storm event. Discrete samples were also collected, but were not analyzed for dioxins/furans. One pre-event grab sample and one composite sample was

[1] Because composite samples collect an equal volume of media at each sample interval, composite sample results may be biased over the long term and skewed toward samples collected after the first flush of storm water.

collected from each of the six sampling stations and analyzed for dioxins/furans for each of the two storms, for a total of 12 pre-event grab samples and 12 composite samples.

Dioxin and furan congeners have been converted to 2,3,7,8-TCDD TEQ using toxicity equivalency factors (TEFs) adopted by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA; OEHHA 2011) for comparison purposes. The 2,3,7,8-TCDD TEQ exceeded the Water Quality Objective[2] (WQO) in two of four pre-event grab samples and four of four composite samples from Stations D and CE (offsite), and two of four pre-event grab samples and two of four composite samples from Stations E and S (onsite). For both storm events, the 2,3,7,8-TCDD TEQ did not exceed the WQO in the pre-event grab samples from the Mill Pond or the Mill Pond Dam Spillway but did exceed the WQO in the composite samples collected during the storm event at these two locations. Results are presented in Table 1.

This data was used to calculate the net change (increase or decrease) between inflow and outflow constituent mass (Arcadis 2012). An overall reduction in mass at the Mill Pond outfall relative to the input mass was considered a net water quality benefit. Improvements in water quality are most likely attributed to constituent mass settling out along with suspended solids in the Mill Pond and accumulating in Mill Pond sediment. The distribution of 2,3,7,8-TCDD TEQ in Mill Pond sediment is presented in Figure 4-24a of the Operable Unit E Remedial Investigation Report. Results of the loading calculations for the constituents monitored indicated the majority (94 percent) of 2,3,7,8-TCDD TEQ mass influx to the Mill Pond was from Alder and Maple Creeks. This is supported by the composite sample results; as presented in Table 1, the 2,3,7,8-TCDD TEQ was highest at Stations D and CE during the storm events, and were often one to two orders of magnitude greater than the 2,3,7,8-TCDD TEQ calculated for onsite runoff. The results also indicated constituent loads at the Mill Pond outfall were generally lower than the inflow loading. The calculated removal efficiency of the Mill Pond ranged from 88 percent to 97 percent. These reductions suggest the Mill Pond provides a net water quality improvement of storm water inflows. These improvements are most significant for storm water entering the Mill Pond from offsite. Samples were also analyzed for Total Suspended Solids (TSS). Dioxin concentrations in incoming solids were estimated by dividing the 2,3,7,8-TCDD TEQ by the TSS concentration in the associated drainage basin. A summary of the mass balance calculations and estimated dioxin concentrations in incoming sediment is presented in Table 2.

The second sampling effort was completed in 2013 to further characterize the quality of storm water runoff entering the Mill Pond from the Maple and Alder Creeks at peak discharge (i.e., offsite sources); samples representative of onsite runoff were not collected. The Alder sampling location was Station D from the 2011 sampling events, and the Maple sampling location was near the location of Station CE from the 2011 sampling events (Figure 2 of the 2013 report). The results of this evaluation were summarized in the Wood Products Facility Storm Water Sampling Report (Arcadis 2013). Water quality and storm flow data were collected during one storm event in November 2013. A total of 8 grab samples were collected from 23:00 on November 18 to 05:15 on November 19, 2013 at approximately 45-minute intervals at each sampling location. Samples were selected for analysis at both locations based on the hydrograph generated at Alder Creek. A total of 4 grab samples from the Alder station and 3 grab samples from the Maple station were chosen for dioxin/furan analysis. All storm water runoff from offsite drainage basins (i.e. catchments located in the City of Fort Bragg) contained

[2] The Water Quality Objective (WQO) for 2,3,7,8-TCDD TEQ is the Public Health Goal (PHG) of 0.05 pg/L.

2,3,7,8-TCDD TEQ that exceeded the WQO by one to two orders of magnitude. Results are presented in Table 1.

Figure 4 shows a comparison of data from Pond 8 sediments with the estimated concentration of 2,3,7,8-TCDD TEQ in suspended solids collected during the storm water sampling. Concentrations in incoming storm water from Maple and Alder Creeks are higher than maximum concentrations in Pond 8 sediment, located near the storm water outfalls in the eastern section of Pond 8, and are on average eight-times higher than concentrations found near the treated industrial waste water discharge location on the west end of Pond 8.

References:

Arcadis. 2012. Mill Pond Storm Water Sampling Report, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California. April.

Arcadis. 2013. Wood Products Facility Storm Water Sampling Report, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California. December.

Office of Environmental Health Hazard Assessment. 2011. Use of the Toxicity Equivalency Factor (TEF_{WHO-05}) Scheme for Estimated Toxicity of Mixtures of Dioxin-Like Chemicals. January.

Table 1: Summary of Grab and Composite Sample Dioxin/Furan Results

Sample Location:	Sample Name:	Representative of Onsite or Offsite Runoff?	2,3,7,8-TCDD TEQ (Human/Mammal) (pg/L) (a)	Exceed WQO? (b)
February 2011 (Storm 1)				
2012 - Pre-Event Grab Samples	Station D	Offsite Only (Alder Creek)	0.04	N
	Station CE	Onsite and Offsite (Maple Creek)	**0.17**	Y
	Station E	Onsite, Subbasin of Station CE	**0.06**	Y
	Station S	Onsite	0.03	N
	Pond 8	-	0.04	N
	Spillway	-	0.003	N
2012 - Composite Samples	Station D	Offsite Only (Alder Creek)	**11.09**	Y
	Station CE	Onsite and Offsite (Maple Creek)	**7.11**	Y
	Station E	Onsite, Subbasin of Station CE	**0.14**	Y
	Station S	Onsite	**0.12**	Y
	Pond 8	-	**1.67**	Y
	Spillway	-	**0.68**	Y
March 2011 (Storm 2)				
2012 - Pre-Event Grab Samples	Station D	Offsite Only (Alder Creek)	**8.12**	Y
	Station CE	Onsite and Offsite (Maple Creek)	**0.05**	Y
	Station E	Onsite, Subbasin of Station CE	**0.06**	Y
	Station S	Onsite	0.002	N
	Pond 8	-	0.00	N
	Spillway	-	0.005	N
2012 - Composite Samples	Station D	Offsite Only (Alder Creek)	**2.94**	Y
	Station CE	Onsite and Offsite (Maple Creek)	**3.40**	Y
	Station E	Onsite, Subbasin of Station CE	0.01	N
	Station S	Onsite	0.01	N
	Pond 8	-	**0.43**	Y
	Spillway	-	**0.07**	Y
November 2013				
Alder Creek Storm Drain	Alder-R1	Offsite Only (Alder Creek)	**5.93**	Y
	Alder-P1	Offsite Only (Alder Creek)	**14.28**	Y
	Alder-P3a	Offsite Only (Alder Creek)	**28.84**	Y
	Alder-F1	Offsite Only (Alder Creek)	**3.67**	Y
Maple Creek Storm Drain	Maple-R1	Offsite Only (Maple Creek)	**4.82**	Y
	Maple-R3	Offsite Only (Maple Creek)	**20.02**	Y
	Maple-P3	Offsite Only (Maple Creek)	**1.84**	Y

Notes:
(a) The 2,3,7,8-TCDD TEQ was calculated using toxic equivalency factors adopted by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA; OEHHA 2011)
(b) The Water Quality Objective (WQO) for 2,3,7,8-TCDD TEQ is the Public Health Goal (PHG) of 0.05 pg/L.

Table 2: Summary of Estimated Influent and Effluent Dioxin/Furan Loads and Dioxin/Furan Concentration in Suspended Sediment

Sample Name:	Representative of Onsite or Offsite Runoff?	Total Volume (Liters x 10^6)	2,3,7,8-TCDD TEQ (Human/Mammal) (µg)	2,3,7,8-TCDD TEQ/TSS (pg/g)
February 2011 (Storm 1)				
Station D	Offsite Only (Alder Creek)	13.2	130	345
Station CE	Onsite and Offsite (Maple Creek)	11.8	93.9	254
Station E (a)	Onsite, Subbasin of Station CE	4.5	0.085	7.9
Station S	Onsite	9.9	0.518	9.6
O-1 & O-2	Onsite	0.6	1.14	-
Inflow	-	39.3	237	-
Outflow	-	40.2	27.2	-
Removal Efficiency of Pond		-	88%	-
Proportion of Influent from Offsite Drainage Basin (Stations D and CE)		-	94%	-
Proportion of Influent from Onsite Drainage Basins		-	6%	-
March 2011 (Storm 2)				
Station D	Offsite Only (Alder Creek)	4.9	14.6	594
Station CE	Onsite and Offsite (Maple Creek)	4	13.6	426
Station E (a)	Onsite, Subbasin of Station CE	0.2	0.001	0.5
Station S	Onsite	1.3	0.011	1.7
O-1 & O-2	Onsite	1.4	0.012	-
Inflow	-	11.6	30.1	-
Outflow	-	12	0.792	-
Removal Efficiency of Pond		-	97%	-
Proportion of Influent from Offsite Drainage Basin (Stations D and CE)		-	94%	-
Proportion of Influent from Onsite Drainage Basins		-	6%	-

TSS = Total Suspended Solids

Notes:

(a) Station E is a subbasin of Station CE, and therefore was not included in the loading calculations.

(b) Calculations based on composite samples.

CITY: HR DIV/GROUP: IM GIS DB: BCG
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LEGEND

- ISCO SAMPLER
- FLOW DIRECTION
- PIPE LOCATION (APPROX.)
- CONTOURS
- SUBCATCHMENT BOUNDARY
- PONDS

NOTE: PIPE LOCATIONS ARE APPROXIMATE
AND NOT ALL SURFACE WATER FLOW PATHS ARE SHOWN

0 400 800 Feet
GRAPHIC SCALE

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FORT BRAGG, CALIFORNIA

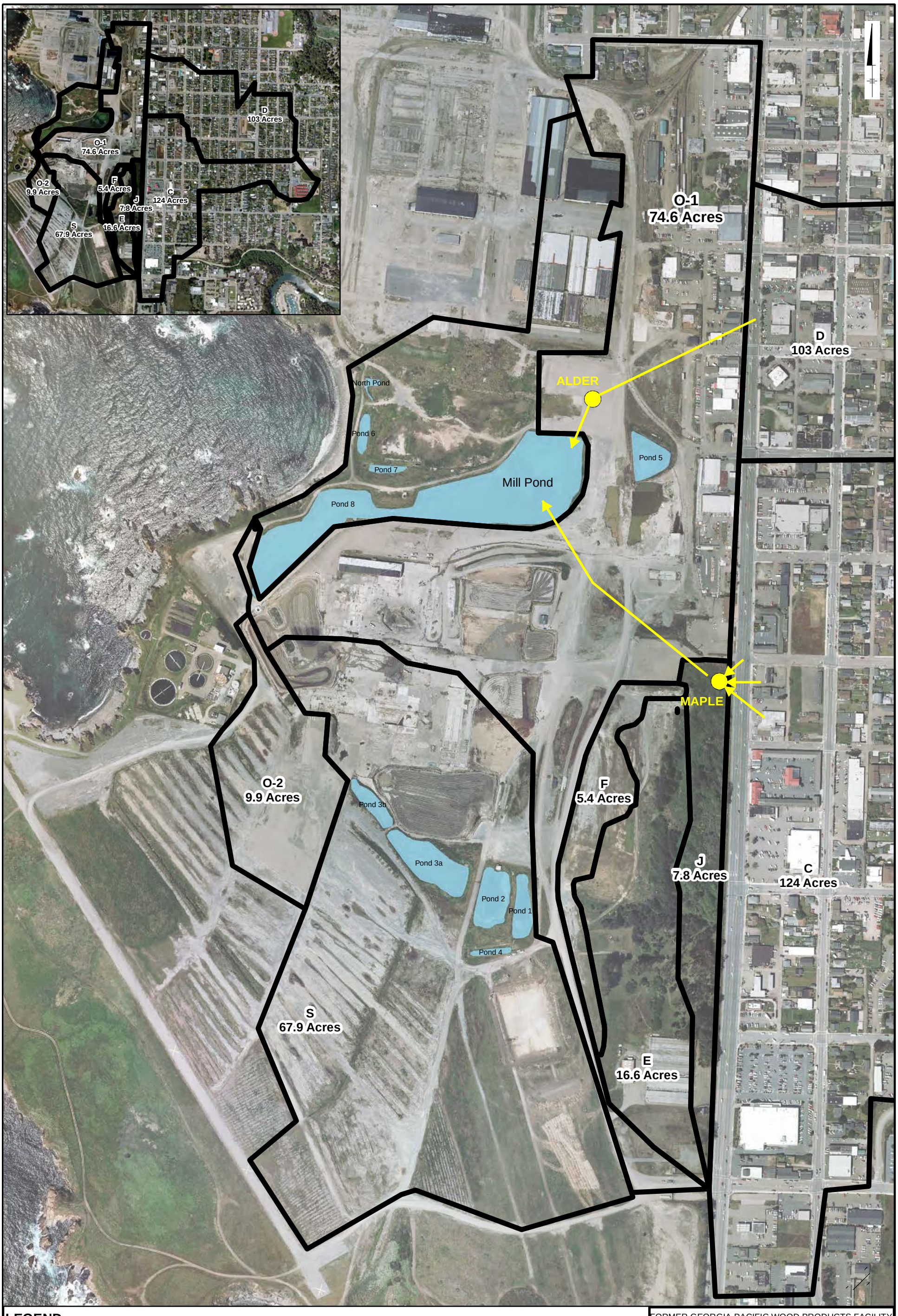
Mill Pond Storm Water Sampling Report

SITE HYDROLOGY AND SUBCATCHMENTS

ARCADIS

FIGURE
1-2

CITY: HR DIV/GROUP: IM GIS DB: BCG
Project # B0066138.0006.00003



LEGEND

- STORM WATER SAMPLE LOCATION
- PIPE LOCATION (APPROX.)
- SUBCATCHMENT BOUNDARY
- PONDS

NOTE: PIPE LOCATIONS ARE APPROXIMATE

0 400 800 Feet
GRAPHIC SCALE

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FORT BRAGG, CALIFORNIA

STORM WATER SAMPLING REPORT

STORMWATER SAMPLE LOCATIONS AND SUBCATCHMENTS

ARCADIS

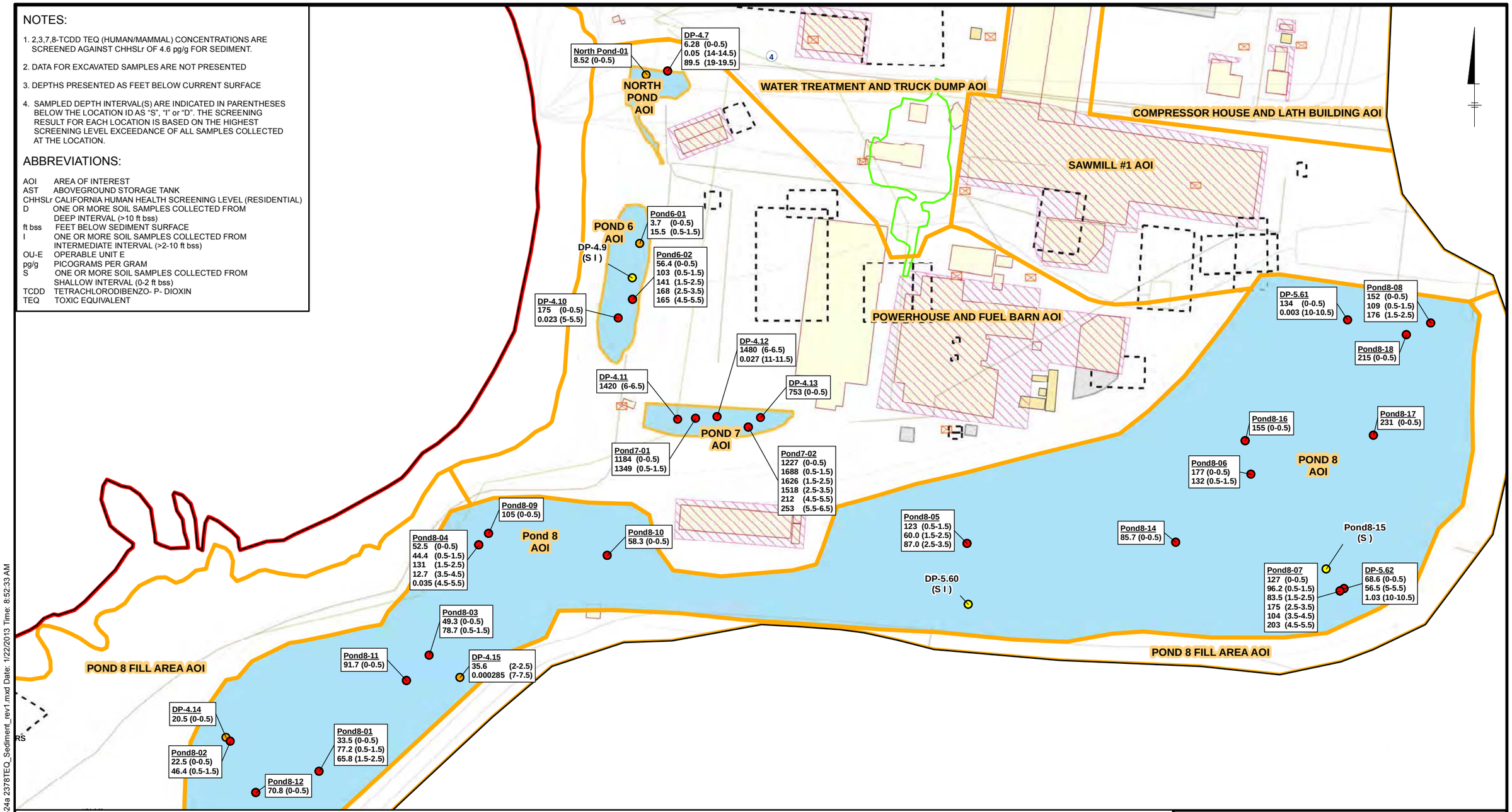
FIGURE 2

NOTES:

1. 2,3,7,8-TCDD TEQ (HUMAN/MAMMAL) CONCENTRATIONS ARE SCREENED AGAINST CHHSLr OF 4.6 pg/g FOR SEDIMENT.
2. DATA FOR EXCAVATED SAMPLES ARE NOT PRESENTED
3. DEPTHS PRESENTED AS FEET BELOW CURRENT SURFACE
4. SAMPLED DEPTH INTERVAL(S) ARE INDICATED IN PARENTHESES BELOW THE LOCATION ID AS "S", "I" or "D". THE SCREENING RESULT FOR EACH LOCATION IS BASED ON THE HIGHEST SCREENING LEVEL EXCEEDANCE OF ALL SAMPLES COLLECTED AT THE LOCATION.

ABBREVIATIONS:

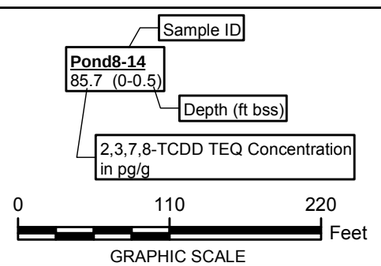
AOI	AREA OF INTEREST
AST	ABOVEGROUND STORAGE TANK
CHHSLr	CALIFORNIA HUMAN HEALTH SCREENING LEVEL (RESIDENTIAL)
D	ONE OR MORE SOIL SAMPLES COLLECTED FROM DEEP INTERVAL (>10 ft bss)
ft bss	FEET BELOW SEDIMENT SURFACE
I	ONE OR MORE SOIL SAMPLES COLLECTED FROM INTERMEDIATE INTERVAL (>2-10 ft bss)
OU-E	OPERABLE UNIT E
pg/g	PICOGRAMS PER GRAM
S	ONE OR MORE SOIL SAMPLES COLLECTED FROM SHALLOW INTERVAL (0-2 ft bss)
TCDD	TETRACHLORODIBENZO- P- DIOXIN
TEQ	TOXIC EQUIVALENT



LEGEND:

- NOT DETECTED
- DETECTED ≤ SCREENING LEVEL
- DETECTED > SCREENING LEVEL
- DETECTED > 10 X SCREENING LEVEL

- SITE BOUNDARY
- OU-E BOUNDARY
- AOI BOUNDARY
- EXISTING STRUCTURE
- FORMER STRUCTURE
- FORMER STRUCTURE - FOUNDATION INTACT
- POND
- FUEL LINE EXCAVATION BOUNDARY
- APPROXIMATE CAP BOUNDARIES
- FORMER INDUSTRIAL USE (APPROXIMATE LOCATION)
- PLANT DRAIN SYSTEM LINE
- SANITARY SEWER LINE
- UNPAVED ROADWAY
- PAVED ROADWAY
- FORMER RAIL LINES
- FORMER TRANSFORMER LOCATION (APPROXIMATE)



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FORT BRAGG, CALIFORNIA

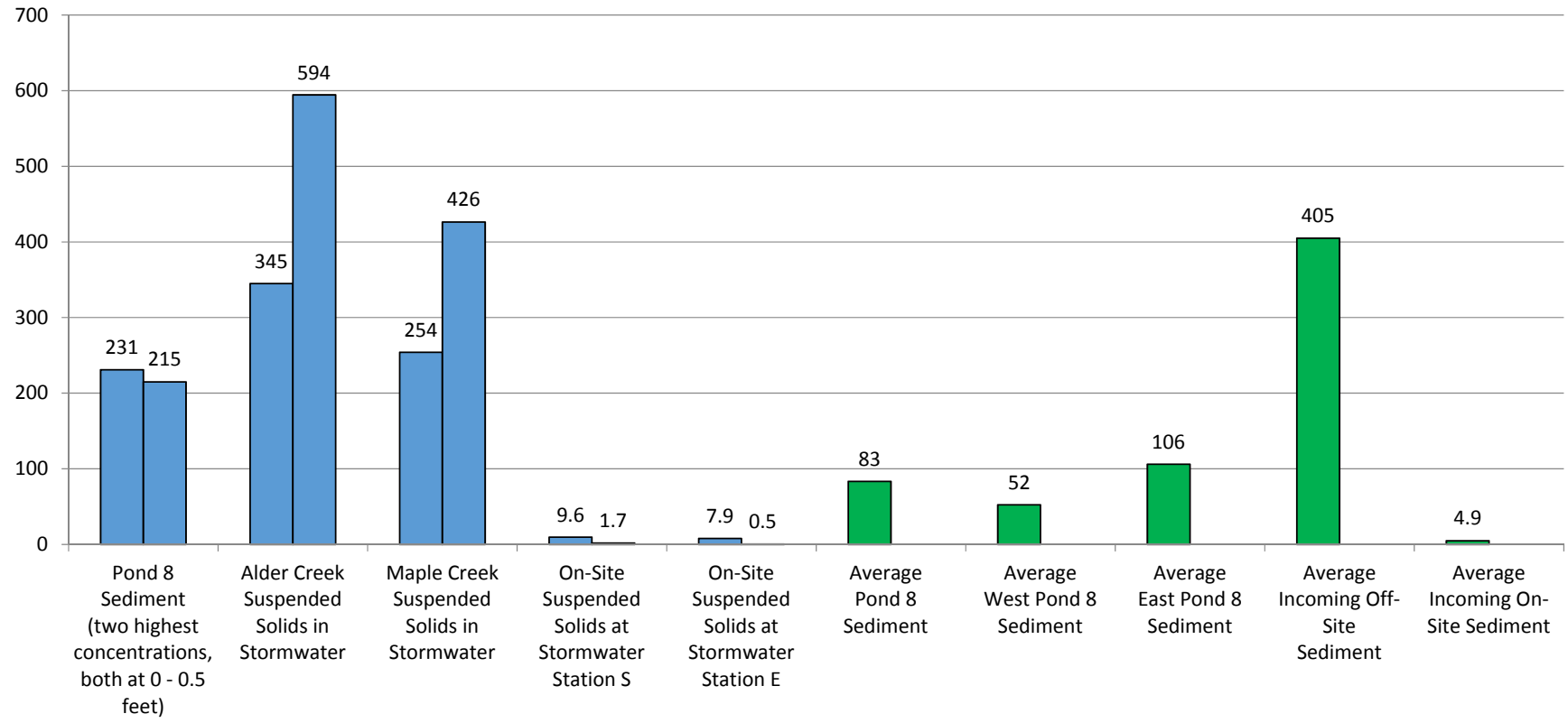
FINAL REMEDIAL INVESTIGATION REPORT OPERABLE UNIT E

2,3,7,8-TCDD TEQ (HUMAN/MAMMAL) CONCENTRATIONS IN SEDIMENT COMPARED WITH HUMAN HEALTH PSL

ARCADIS

FIGURE
4-24a

CITY: Highlands Ranch DIV/GROUP: IM GIS DB: Brianna Griffith
Project:B0066142.2012 Task:AS010
Path: I:\FortBragg\MXD\OUE_RI_FINAL\Fig 4-24a 2378TEQ_Sediment_rev1.mxd Date: 1/22/2013 Time: 8:52:33 AM



Notes:

1. Off-site and on-site storm water 2,3,7,8-TCDD TEQ concentrations in solids presented here are estimated based on data collected in February and March 2011. The Pond 8 sediment 2,3,7,8-TCDD TEQ concentrations are from the two highest concentration samples located near the off-site storm water outfalls at Pond 8 (see Figure 4-24a presented in the OU-E RI).
2. On a mass basis, off-site storm water contributed more than 90% of the 2,3,7,8-TCDD TEQ load entering Pond 8 during the February and March 2011 storm events.
3. The average concentration of 2,3,7,8-TCDD TEQ in solids in off-site stom water entering Pond 8 is approximately 5 times greater than the average concentration and twice the maximum concentration observed in Pond 8 sediment.
4. 2,3,7,8,-TCDD TEQ concentrations in off-site storm water exceeded the WQO in all samples collected during storm events.
5. Concentrations in pg/g.

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2,3,7,8-TCDD TEQ Concentrations in Suspended Solids and Sediment

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE 4