Drainage Study

for the

Johnson Brothers Warehouse

at

Lot 8020, Kapolei Business Park,
TMK 9-1-75:15

by

Hawaii Consulting Group, Inc.
Geoffrey B. Goeggel, PE December 11, 2006

Exp. Date: 4-30-08

This report was prepared by me or under my supervision.

A. Background

The project is a proposed warehouse, 42,794 SF, with an attached 2 storey office of 4,188 SF per floor. It will be built on an empty lot in the Kapolei Business Park in 2007. The project is being developed by Johnson Brothers of Hawaii and constructed by Maryl Pacific.

The site is relatively flat, with a uniform cross-slope of about 2%. It was built in 1994 as part of a 40 lot industrial sub-division. A 3 foot high landscape berm separates the lot from the fronting Munu and Opakapaka Street. The Kapolei owner is in the process of dedicating all the infrastructure to the City. A soils investigation of the project site by Hirata & Associates (*Report # W.O. 05-4118, July 21, 2005)* revealed a one to two foot surface layer of silty coralline sand, soil type "SM" (Table 14), overlaying a dense coral cap rock. The existing erosion hazard is slight.

The existing storm water run-off on this site sheet flows towards the southeast, deflecting at the landscape berm, then flows westward to the adjacent corner lot (# 8021), where a sump condition keeps this flow from entering the roadway. This ponding area gradually percolates into to soil or evaporates. A small 24" berm will be built to create a temporary sedimentation basin in this area. A temporary inlet pipe with filter screen will be installed to allow controlled drainage. The proposed site grading plan is attached.

B. Hydrologic Data

The annual rainfall at this site is estimated at 20 inches per year, with a peak 5 inches/month in December (*2nd Atlas of Hawaii*). Peak storm intensities are 1.80 inches/hour for a 10 year storm as shown in Figure 2. The **run-off coefficient** is estimated at 0.80-0.95 for the paved areas and the roof. The drainage areas are small, with the time-of-concentration ($T_{c)}$, less than 5 minutes and a correction factor of 2.8 will be used for the **design rainfall intensity**:

$$i_d = 2.8 \text{ CF} * 1.80 \text{ iph} = 5.04 \text{ inches/hour}$$

All peak run-off quantities will be estimated with the "*rational formula*":

$$Q = C * i_d * A$$

Q = peak run-off in cubic feet per second
C = run-off coefficient
i_d = design rainfall intensity, iph = 2.8 * 2.1 iph = 5.04
A = drainage area in acres

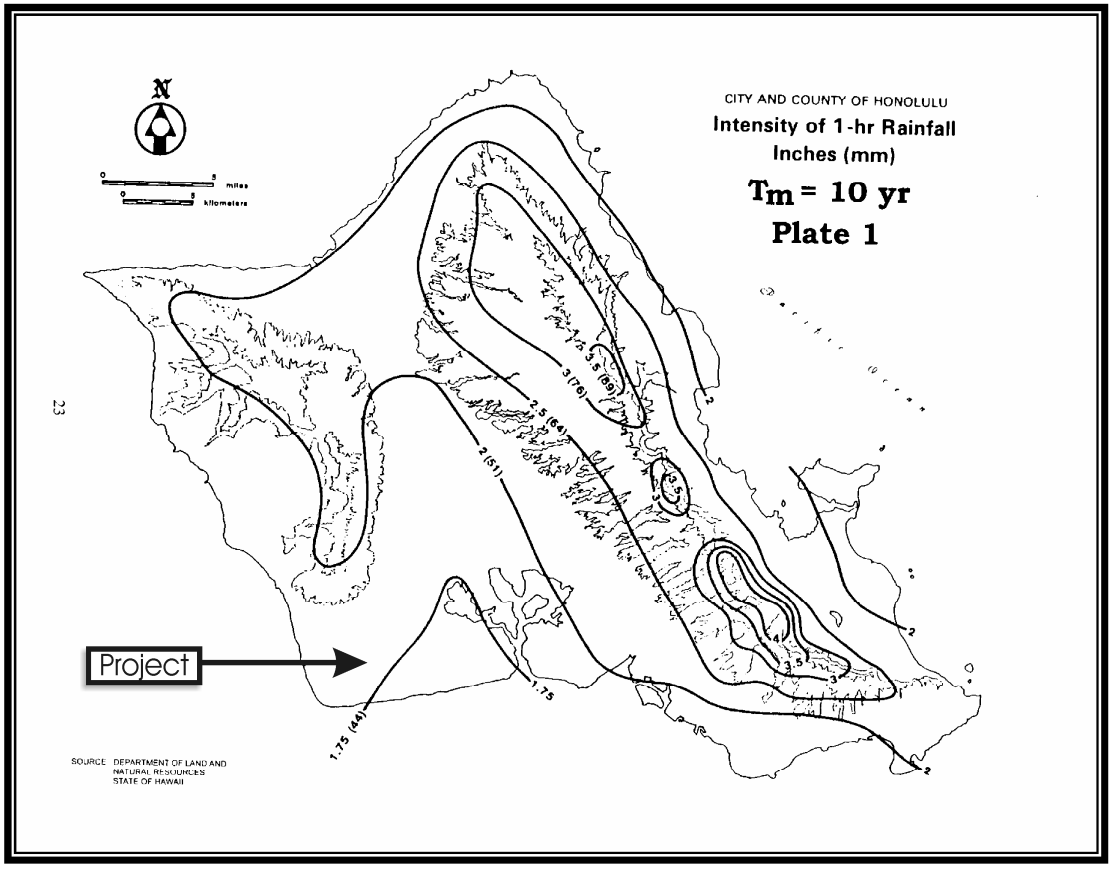


Figure 2 – Rainfall Intensity

2000 C&C Storm Drainage Standards, Plate 1

C. Existing Drainage System

The existing drainage system was determined from the KPB "as-built" construction plans and field surveys. A 48" line runs down Munu Street, connecting into a storm drain manhole on Opakapaka Street. There are two curb inlets along the northwest side of the property. A 72" pipe runs down Opakapaka Street where there are three curb inlets.

The existing storm water run-off on this site sheet flows towards the southwest, deflecting at the landscape berm, then flows westward to the adjacent corner lot (# 8021), where a sump condition keeps this flow from entering the roadway. This ponding area gradually percolates into to soil or evaporates. Each individual lot in the ***KBP*** must, by the ***KBD Design Guidelines***, drain into an underground system or onto the street. No drainage is allowed onto adjacent lots.

D. Proposed Drainage System

The site will be leveled for the new warehouse and the adjacent parking areas sloped towards a centralized slotted drain inlet. The major underground drainage system will be ADS "Dura-Slot" lines, centered in the AC parking areas, level at the surface and the invert about 6" to 18" below the finish pavement, with a variable height slot, and discharging into the an existing 24" stub-out at the southeast corner of the lot. The "L" shaped slot drain system identified as Drain Line A is proposed to capture most of the water from the parking areas. The system begins with a clean-out (for maintenance purposes) and has three junction boxes, with Junction Box # 3 connected to the existing 24 inch drain stub out for this lot. The Utility Plan for the project is attached.

The second drain line system, identified as Drain Line "B", will capture water from the truck pit and the warehouse roof drains and flow towards a connection with Junction Box # 2. Between junction box to junction box 3, an 18" drain line be will run directly below the slot drain fronting the office. Drain Line "C" will capture storm water from the 5 foot backyard through an 18 inch square drain inlet, discharging into Junction Box # 3.

The site perimeter will be heavily landscape, with tree wells and planting mounds. The run-off from these areas will be very small and will generally sheet flow towards the new parking or the existing sidewalk. The portion of flows onto the sidewalk will not be significantly changed by this work.

The runoff for the site had been divided into 18 areas as shown in Figure 3. Areas 1, 10 and 16 are the proposed driveways and will discharge onto the city street. Areas 2 and 3 will drain towards a new six-inch slot drain in front of the office. Areas 4, 7, 9, 12, 15 and 18 will flow into the proposed slot drain along the front face of the warehouse. Area 14 is the truck pit which will discharge into Drain Line B. The roof drains from areas 6, 8, 11, 13 and 17 will also discharge into Drain Line "B". The estimated drainage quantities for these areas are shown in Table 1. For the hydraulic calculations presented in Appendix A, the pipe number used for the hydraulic model calculation is identified for each drain area.

Table 1 – Estimated Storm Water Run-off Quantities

Area	Area Acres	C - Run-off Coefficient	Q cfs	Discharges to	Model Line #
1	0.15	0.45	0.34	Roadway	--
2	0.10	0.85	0.43	Slot Drain "A"	17
3	0.09	0.90	0.40	Slot Drain "A"	16
4	0.07	0.65	0.22	Slot Drain "A"	4
5	0.05	0.60	0.14	Slot Drain "A"	2
6	0.19	0.90	0.84	Slot Drain "B"	9
7	0.10	0.65	0.32	Slot Drain "A"	5
8	0.19	0.90	0.87	Slot Drain "B"	10
9	0.15	0.80	0.59	Slot Drain "A"	6
10	0.02	0.95	0.09	Roadway	--
11	0.19	0.90	0.85	Slot Drain "B"	12
12	0.15	0.80	0.61	Slot Drain "B"	7
13	0.18	0.90	0.80	Slot Drain "B"	13
14	0.06	0.95	0.29	Slot Drain "B"	13
15	0.24	0.80	0.97	Slot Drain "A"	8
16	0.01	0.95	0.07	Roadway	--
17	0.22	0.90	1.02	Slot Drain "B"	14
18	0.13	0.80	0.51	Slot Drain "A"	8
TOTAL =	**2.28**		**9.37**		

Figure 3 – Proposed Drainage Run-off Areas

E. Hydraulics of Proposed Drain Lines

The hydraulic calculations for these systems are presented in Appendix A. Control elevation at Outlet 1 (pipe # 1 in the model) was the HGL elevation in the 1994 KPB plans. All calculations were done with the program *Storm Sewers 2005* by *itelisolve*. All hydraulic grade calculations resulted in the peak flows remaining in the underground system.

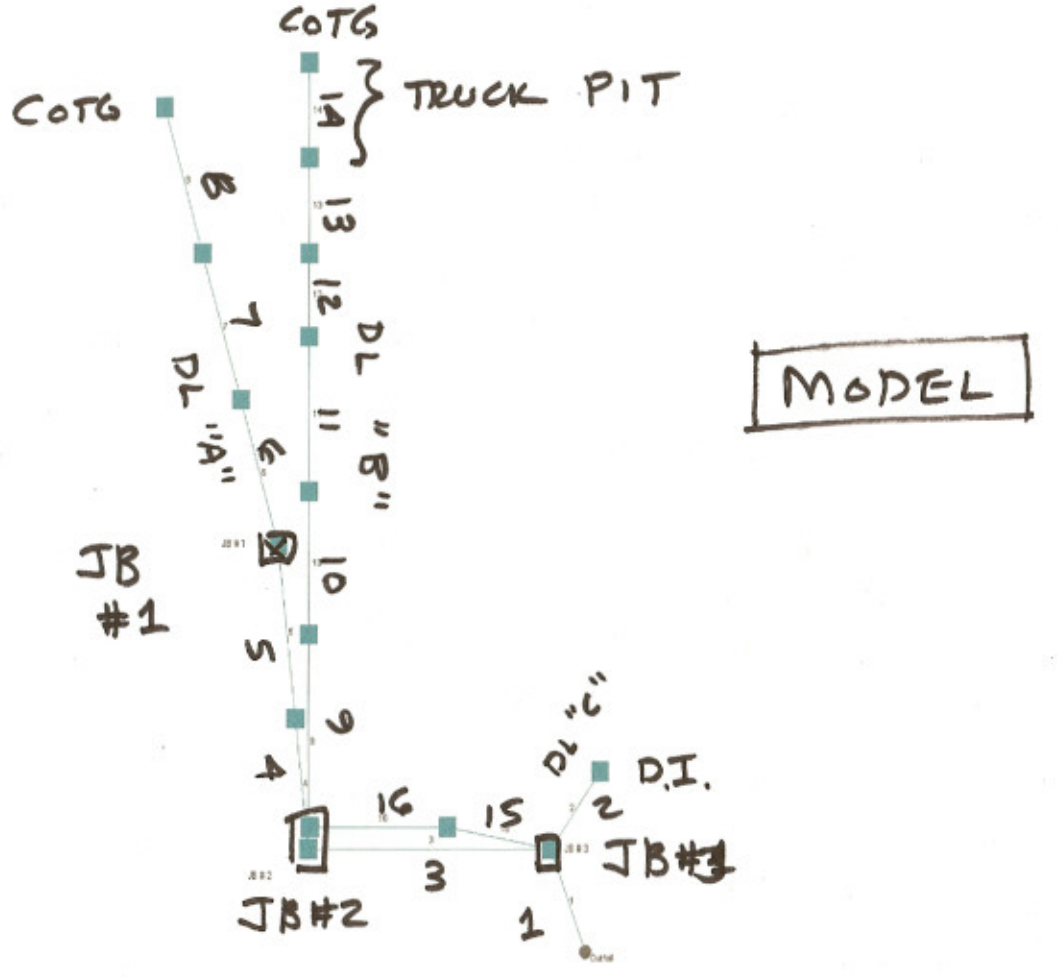
F. Conclusions

The proposed drainage system will effectively carry run-off into the street drainage system. No significant impacts are expected in the existing ***KBP*** drainage system due to this design.

Appendix A

Proposed Construction Plans – Grading Plan and Utility Plan
Hydraulic Calculations

Hydraflow Plan View



Project File: Johnson Hydraulics.stm	No. Lines: 16	12-10-2006

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line type	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	46.0	-110.8	DrGrt	0.00	0.00	0.00	0.0	24.00	2.17	25.00	24	Cir	0.012	1.98	37.00	
2	1	40.0	56.2	DrGrt	0.14	0.00	0.00	0.0	32.20	1.25	32.70	6	Cir	0.012	1.00	35.00	
3	1	115.0	-69.2	DrGrt	0.00	0.00	0.00	0.0	29.73	1.00	30.88	18	Cir	0.012	1.50	37.00	
4	3	55.0	83.5	DrGrt	0.22	0.00	0.00	0.0	34.35	0.45	34.60	15	Cir	0.012	0.00	37.00	
5	4	73.0	0.0	DrGrt	0.32	0.00	0.00	0.0	34.60	0.49	34.96	15	Cir	0.012	0.50	37.00	
6	5	64.0	-10.0	DrGrt	0.59	0.00	0.00	0.0	34.96	0.53	35.30	12	Cir	0.012	0.00	37.00	
7	6	64.0	0.0	DrGrt	0.61	0.00	0.00	0.0	35.30	0.56	35.66	12	Cir	0.012	0.00	37.20	
8	7	64.0	0.0	DrGrt	1.48	0.00	0.00	0.0	35.66	0.53	36.00	12	Cir	0.012	0.00	37.40	
9	3	90.0	90.0	DrGrt	0.84	0.00	0.00	0.0	30.88	0.78	31.58	12	Cir	0.012	0.00	37.00	
10	9	60.0	0.0	DrGrt	0.87	0.00	0.00	0.0	31.58	0.73	32.02	12	Cir	0.012	0.00	38.00	
11	10	65.0	0.0	DrGrt	0.85	0.00	0.00	0.0	32.02	0.80	32.54	12	Cir	0.012	0.00	38.20	
12	11	35.0	0.0	DrGrt	0.00	0.00	0.00	0.0	32.54	0.63	32.76	12	Cir	0.012	0.00	38.40	
13	12	40.0	0.0	DrGrt	1.09	0.00	0.00	0.0	32.76	0.78	33.07	12	Cir	0.012	0.50	34.92	
14	13	40.0	0.0	DrGrt	1.02	0.00	0.00	0.0	33.07	2.50	34.07	12	Cir	0.012	1.00	38.40	
15	1	50.0	-58.6	DrGrt	0.97	0.00	0.00	0.0	35.35	0.70	35.70	8	Cir	0.012	0.00	37.00	
16	15	65.0	-10.7	DrGrt	0.40	0.00	0.00	0.0	35.70	0.77	36.20	6	Cir	0.012	1.00	37.00	

Project File: Johnson Hydraulics.stm | Number of lines: 16 | Date: 12-10-2006

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
	(in)	(cfs)									(ft)											(K)	(ft)
1	24	9.40	24.00	25.93	1.93	3.11	3.03	0.14	26.07	0.129	46.0	25.00	26.09 j	1.09**	1.74	5.39	0.45	26.54	0.447	0.288	n/a	1.98	0.90
2	6	0.14	32.20	32.70	0.50*	0.20	0.71	0.01	32.71	0.053	40.0	32.70	32.89 j	0.19**	0.07	2.04	0.06	32.96	0.565	0.309	n/a	1.00	n/a
3	18	7.89	29.73	31.23	1.50*	1.77	4.47	0.31	31.54	0.481	115	30.88	31.95 j	1.07**	1.35	5.84	0.53	32.48	0.650	0.566	n/a	1.50	0.79
4	15	3.22	34.35	35.60	1.25*	1.23	2.62	0.11	35.71	0.212	55.0	34.60	35.69	1.09	1.14	2.83	0.12	35.82	0.192	0.202	0.111	0.00	0.00
5	15	3.00	34.60	35.85	1.25*	1.23	2.45	0.09	35.94	0.184	73.0	34.96	35.95	0.99	1.05	2.87	0.13	36.08	0.195	0.190	0.138	0.50	0.06
6	12	2.68	34.96	36.02	1.00	0.79	3.41	0.18	36.20	0.483	64.0	35.30	36.30	1.00	0.79	3.41	0.18	36.48	0.457	0.470	0.301	0.00	0.00
7	12	2.09	35.30	36.37	1.00	0.79	2.66	0.11	36.48	0.294	64.0	35.66	36.53	0.87	0.72	2.89	0.13	36.66	0.269	0.281	0.180	0.00	0.00
8	12	1.48	35.66	36.66	1.00*	0.79	1.88	0.06	36.72	0.147	64.0	36.00	36.73	0.73	0.62	2.40	0.09	36.82	0.188	0.167	0.107	0.00	0.00
9	12	4.67	30.88	31.95	1.00	0.79	5.95	0.55	32.50	1.466	90.0	31.58	33.27	1.00	0.79	5.95	0.55	33.82	1.465	1.466	1.319	0.00	0.00
10	12	3.83	31.58	33.45	1.00	0.79	4.88	0.37	33.82	0.986	60.0	32.02	34.04	1.00	0.79	4.88	0.37	34.41	0.986	0.986	0.591	0.00	0.00
11	12	2.96	32.02	34.19	1.00	0.79	3.77	0.22	34.41	0.589	65.0	32.54	34.57	1.00	0.79	3.77	0.22	34.80	0.589	0.589	0.383	0.00	0.00
12	12	2.11	32.54	34.68	1.00	0.79	2.69	0.11	34.80	0.299	35.0	32.76	34.79	1.00	0.79	2.69	0.11	34.90	0.299	0.299	0.105	0.00	0.00
13	12	2.11	32.76	34.79	1.00	0.79	2.69	0.11	34.90	0.299	40.0	33.07	34.91	1.00	0.79	2.69	0.11	35.02	0.299	0.299	0.120	0.50	0.06
14	12	1.02	33.07	35.05	1.00	0.79	1.30	0.03	35.08	0.070	40.0	34.07	35.07	1.00	0.79	1.30	0.03	35.10	0.069	0.070	0.028	1.00	0.03
15	8	1.37	35.35	36.02	0.67*	0.35	3.93	0.24	36.26	1.097	50.0	35.70	36.57	0.67	0.35	3.92	0.24	36.80	1.096	1.097	0.548	0.00	0.00
16	6	0.40	35.70	36.74	0.50	0.20	2.04	0.06	36.80	0.434	65.0	36.20	37.02	0.50	0.20	2.04	0.06	37.09	0.434	0.434	0.282	1.00	0.06

Project File: Johnson Hydraulics.stm | Number of lines: 16 | Run Date: 12-10-2006

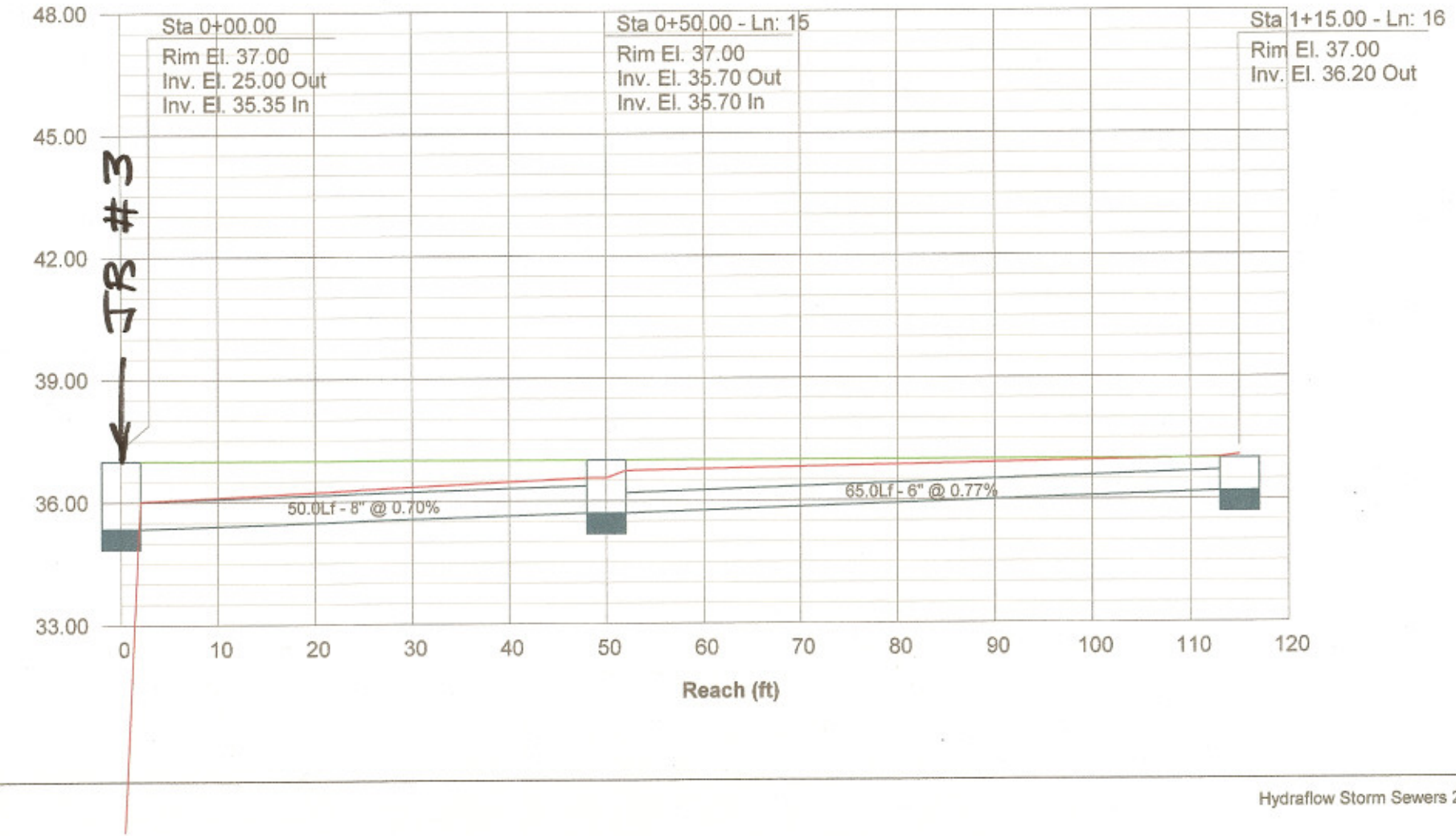
Notes: * Crown depth assumed.; ** Critical depth.; j-Line contains hyd. jump.

Storm Sewer Profile

Proj. file: Johnson Hydraulics.stm

DL "A"

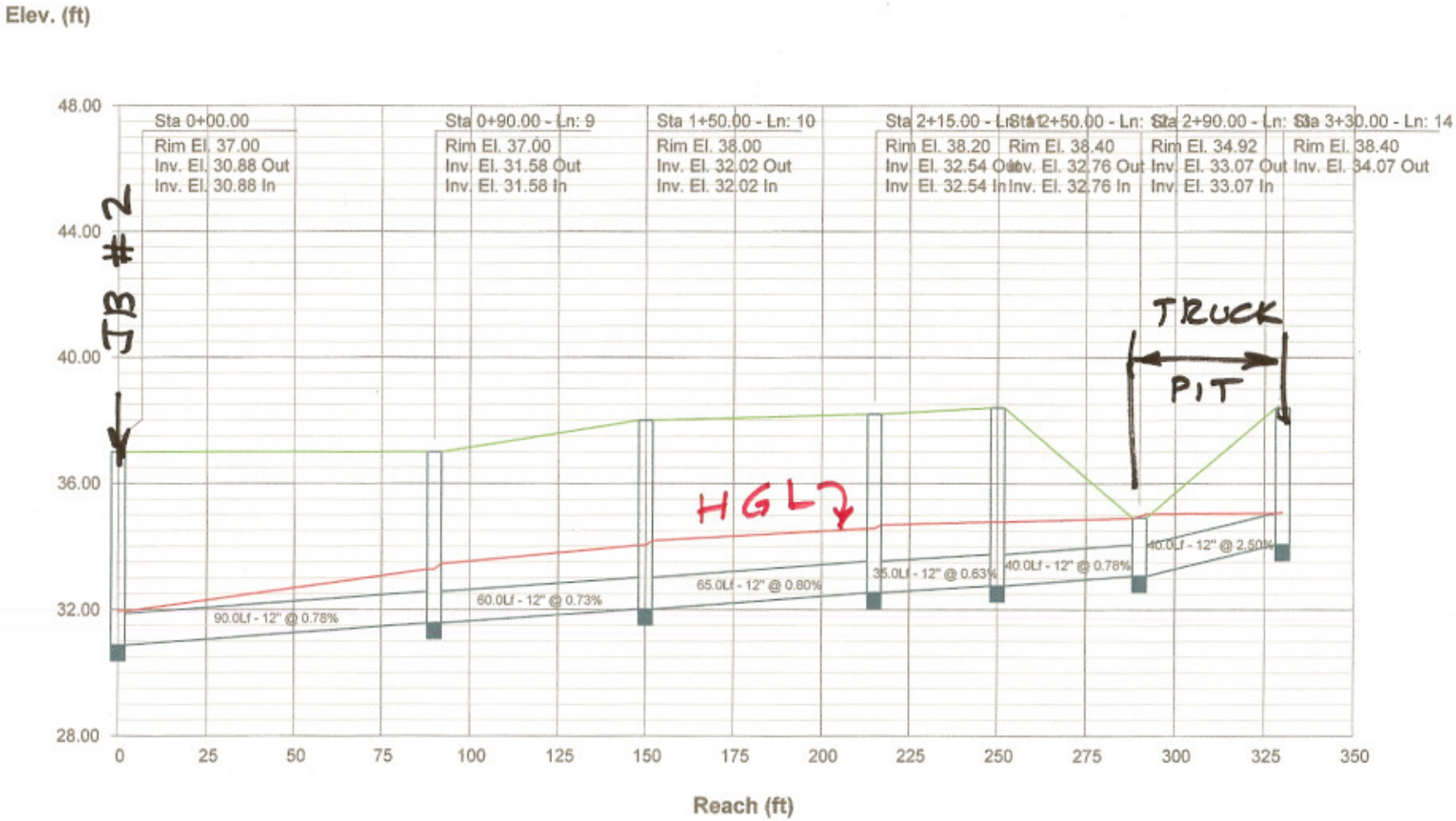
SLOT DRAIN
IN FRONT OF OFFICE



Storm Sewer Profile

Proj. file: Johnson Hydraulics.stm

DL "B"



Storm Sewer Profile

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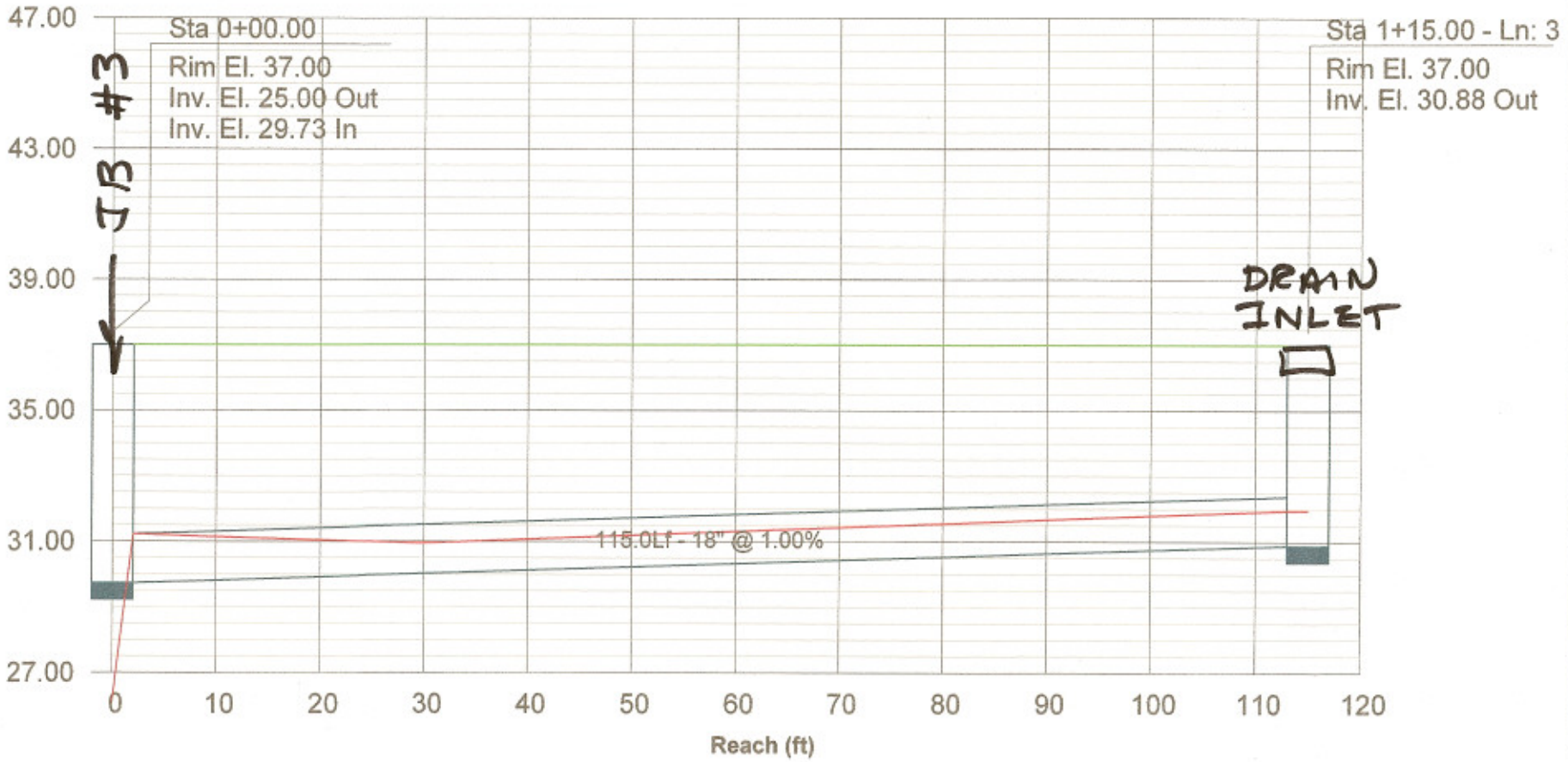

Storm Sewer Profile

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