

III. Building Load Analysis

A. General Discussion

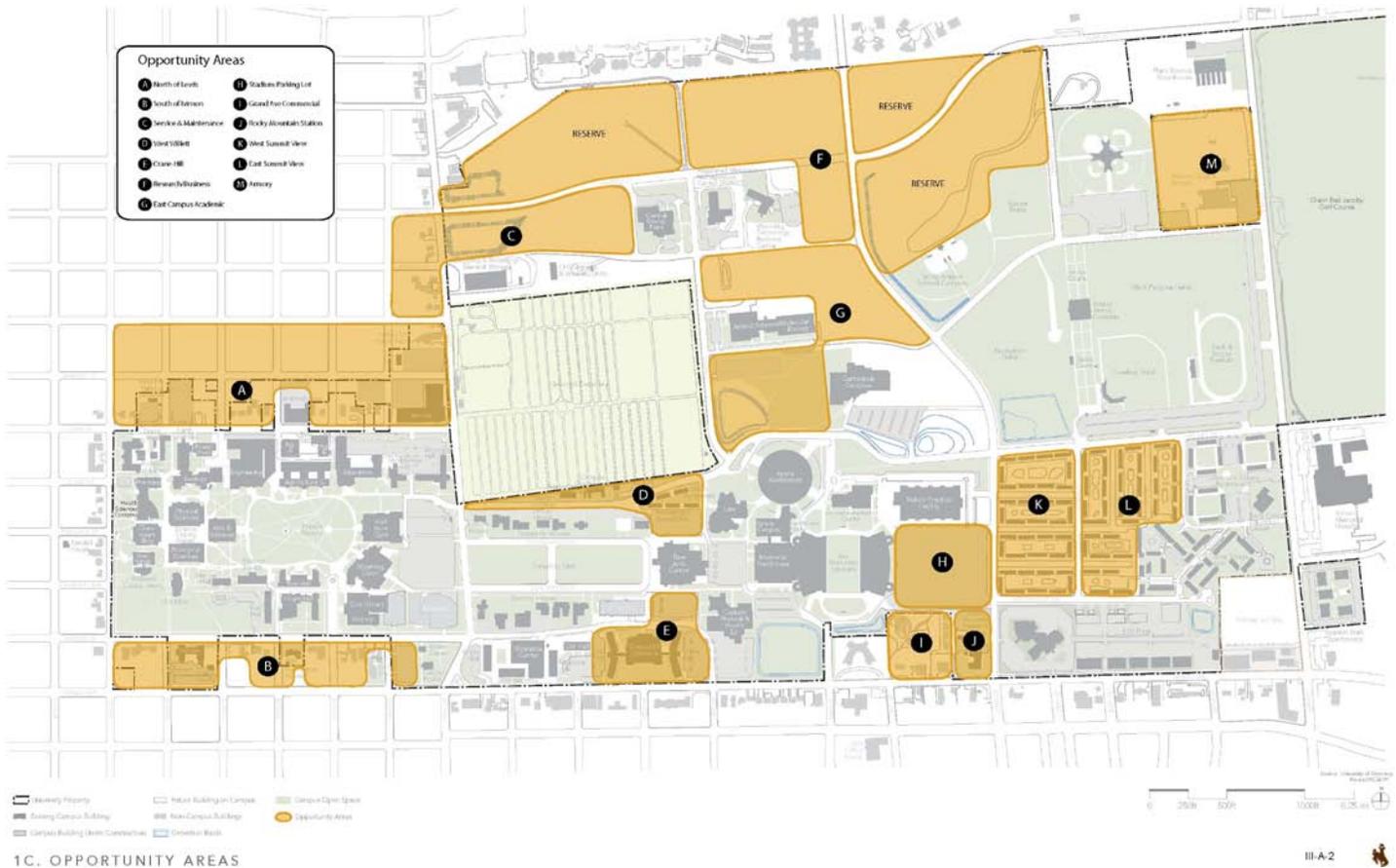
Affiliated Engineers, Inc. (AEI) evaluated the current and future load growth of the campus through existing building data, flow data, UW Staff input, and projected building growth defined by a separate consulting firm performing a long range development plan (LRDP) for the UW. The LRDP growth numbers and development area locations utilized for this evaluation are provided as Table III-A-1 and shown in Figure III-A-2. Each of these items are also included as an enlarged version in Appendix III-A along with a preliminary future building layout plan Figure III-A-3 that was utilized for developing utility corridor configurations.

Table III-A-1 Development Opportunity Site Capacity

Location	Proposed Use	Total Area (sf)	Proposed Building Footprints (sf)	Site Coverage Rate	Low Estimate		High Estimate		
					Average Floors	GSF Capacity	Average Floors	GSF Capacity	
OPPORTUNITY AREAS									
A	North of Lewis	Academic, Research, Residential	1,368,323	297,327	22%	2	594,654	4	1,189,308
B	South of Ivinson	Administration, Academic, Residential	494,682	75,310	15%	2	150,620	4	301,240
C	Service & Maintenance	Service and Maintenance	655,603	151,997	23%	1	151,997	3	455,991
D	West Willett	Surface Parking	251,612	0	0%	0	0	0	0
E	Crane-Hill	Residential, Academic, Retail	327,016	78,485	24%	4	313,940	6	470,910
F	Research/Business	Research, Office, Light Industrial	746,348	138,213	19%	2	276,426	4	552,852
G	East Campus Academic	Academic, Research	931,345	222,186	24%	2	444,372	5	1,110,930
H	Stadium Parking Lot	Structure Parking	338,849	80,659	24%	3	241,977	5	403,295
I	Grand Avenue Commercial	Traditional Mixed-Use, Commercial	215,013	86,723	40%	2	173,446	4	346,892
J	Rocky Mountain	Office, Visitor Center	71,918	8,701	12%	2	17,402	4	34,804
K	West Summit View	Traditional Mixed-Use	459,527	141,932	31%	2	283,864	4	567,728
L	East Summit View	Multi-family Residential	508,136	98,379	19%	2	196,758	4	393,516
M	Armory	Service and Maintenance	487,368	37,202	8%	1	37,202	2	74,404
	Reserve 1	NA	765,418	NA	25%	NA	NA	NA	NA
	Reserve 2	NA	322,251	NA	25%	NA	NA	NA	NA
	Reserve 3	NA	937,533	NA	25%	NA	NA	NA	NA
		Subtotal	6,855,740	1,417,114	21%	NA	2,882,658	NA	5,901,870
ADDITIONAL NEW DEVELOPMENT AND EXPANSIONS SHOWN ON MASTER PLAN DIAGRAM:									
	Infill at Campus Core	Structured Parking, Academic, Support		65,320		3	195,960	5	326,600
	Infill at Fraternity Row	Academic, Living Learning		15,980		4	63,920	6	95,880
	Infill at Existing Service Area	Service and Maintenance		33,267		1	33,267	2	66,534
	Infill at UW Plaza	Mixed Use, Conference Center Expansion		37,337		2	74,674	3	112,011
	Fine Arts Expansion	Academic		55,687		2	111,374	3	167,061
	Law Building Expansion	Academic		12,032		2	24,064	2	24,064
	WTBC Expansion	Research, Office		16,261		2	32,522	4	65,044
	Centennial Complex Expansion	Civic, Museum		13,591		2	27,182	3	40,773
	Visual Arts Expansion	Academic		44,288		2	88,576	3	132,864
	Tennis Building Expansion	Recreation		29,551		1	29,551	1	29,551
		Subtotal	0	323,314	NA	NA	681,090	NA	1,060,382
		TOTAL	6,855,740	1,740,428			3,563,748		6,962,252

Each highlighted area in Figure III-A-2 correlates to an area defined within the LRDP that are projected for campus building expansion. Area locations with respect to the existing campus utilities can be observed from defining the highlighted areas on this map to maps located within Appendix III-B thru Appendix III-I. Each of these maps was produced and includes existing utility locations provided by the UW.

Figure III-A-2



The LRDP projections were identified through year 2050 which was recognized to be inconsistent in terms of projected growth in the next 20 years of the Utility Master Planning timeframe. Therefore the values were modified to represent what the UW Physical Plant Staff had anticipated being a realistic load growth for the UW campus through the year 2030 for the utilities and systems being evaluated.

The final approach of load growth is compared in Table III-A-4 below and included in Appendix III-A. The left of the table indicates LRDP numbers and the right indicates Utility Master Plan anticipated growth. Areas are summarized in kind to the areas presented and the modified projections include anticipated year ranges. Thermal utilities are included within each area and were determined from distribution approaches in relation to existing as well as growth densities.

Overall, the projected growth recognized for the next twenty years is approximately 500,000 sq ft per five year increment equaling approximately 2 million sq ft of projected building growth by the year 2030. Of that growth approximately 85% of the projected areas are added to the chilled water system and 100% to the remainder of the utilities. Areas added to the chilled water and steam systems are highlighted in the purple cells at the end of the table.

Table III-A-4 (Also provided in Appendix III-A)

Adjusted Development Opportunity Site Capacity PROJECTED GROWTH THRU 2030 DEVELOPED BY THE LRDP PLANNERS										PROJECTED CORE CAMPUS GROWTH THRU 2030 DEVELOPED THROUGH THE UNIVERSITY OF WYOMING PHYSICAL PLANNING STAFF										Totals Across										
Location	Proposed Use	Total Area (sf)	Proposed Building Footprint (sf)	Site Coverage Rate	Low Estimate		High Estimate		Building Name	Study Name	Future Connected to CEP	Demo to CEP	Min Years Out	Max Years Out	Early Year	Late Year	Total SQFT	CEP Cooled SQFT	CEP Steam SQFT											
					Average Floors	GSF Capacity	Average Floors	GSF Capacity												UW Info	UW Info	UW Info	UW Info	UW Info	UW Info	UW Info				
OPPORTUNITY AREAS																														
A North of Lewis	Academic, Research, Residential	1,368,323	297,327	22%	2	594,654	4	1,189,300	School of Energy Resources	Office/Classroom/Laboratory (Light)	CEP	none	1	5	2,011	2,015	40,000	40,000	40,000											
A									Science Teaching Lab Facility	Office/Classroom/Laboratory (Medium)	CEP	none	1	5	2,011	2,015	100,000	100,000	100,000											
A									Long Term Development	Office/Classroom	CEP	none	5	10	2,015	2,020	315,000	315,000	315,000											
B South of Johnson	Administration, Academic, Residential	494,682	75,310	15%	2	160,620	4	301,240	Foundation House	Office/Classroom	CEP	none	1	5	2,011	2,015	10,000	0	10,000											
B									Long Term Development	Office/Classroom	CEP	none	10	20	2,020	2,025	130,000	130,000	130,000											
C Service & Maintenance	Service and Maintenance	855,603	151,967	23%	1	151,967	3	455,691	Service and Maintenance	Service/Grounds/Facility	CEP	none	5	15	2,015	2,020	151,967	151,967	151,967											
D West Willett	Surface Parking	291,612	0	0%	0	0	0	0	Surface Parking	Surface Parking	CEP	none	0	20	2,010	2,030	0	0	0											
E Crane Hill	Residential, Academic, Retail	327,016	78,485	24%	4	313,040	6	470,010	Crane Hill Demo and Rebuild of 250 beds	Residence Hall	CEP	227,482	1	5	2,011	2,015	227,482	227,482	227,482											
F Research/Business	Research, Office, Light Industrial	746,348	138,213	18%	2	278,426	4	552,852	Business Incubator	Office/Classroom/Laboratory (Light)	CEP	none	5	10	2,015	2,020	30,000	30,000	30,000											
G East Campus Academic	Academic, Research	931,345	222,185	24%	2	444,372	5	1,110,930	Animal Science	Office/Classroom/Laboratory (Light)	CEP	none	5	15	2,020	2,025	200,000	200,000	200,000											
G									Addition to CC	Museum/Office	CEP	none	5	10	2,015	2,020	30,000	30,000	30,000											
G									Visual Arts East of CCC	Office/Classroom/Auditorium	CEP	none	1	5	2,011	2,015	80,000	80,000	80,000											
G									Long Term Development	Office/Classroom	CEP	none	10	20	2,025	2,030	80,000	80,000	80,000											
H Stadium Parking Lot	Structure Parking	338,849	80,659	24%	3	241,977	5	403,295	Stadium Suites	Office	MAYBE CEP	none	1	2	2,011	2,012	20,000	0	20,000											
I Grand Avenue Commercial	Traditional Mixed-Use, Commercial	215,012	88,723	40%	2	173,449	4	349,892	Office Space, Classroom	Office/Library	MAYBE CEP	none	10	20	2,025	2,030	85,000	0	85,000											
J Rocky Mountain	Office, Visitor Center	71,618	8,703	12%	2	17,402	4	34,804	250 Beds for Housing	Office/Library	MAYBE CEP	none	10	20	2,025	2,030	28,327	0	28,327											
K West Summit View	Traditional Mixed-Use	458,527	141,935	31%	2	283,894	4	567,738	250 Beds for Housing	Residence Hall	MAYBE CEP	none	10	20	2,025	2,030	185,822	0	185,822											
L East Summit View	Multi-family Residential	508,136	88,373	19%	2	196,756	4	393,516	Residence Hall	Residence Hall	MAYBE CEP	none	10	20	2,025	2,030	118,730	0	118,730											
M Armory	Service and Maintenance	487,268	37,202	8%	1	37,202	2	74,404	Service and Maintenance	Service/Grounds/Facility	na	na	na	na	2,031	2,031	na	0	na											
Reserve 1	NA	746,418	NA	25%	NA	NA	NA	NA	Reserve 1	na	na	na	na	2,031	2,031	na	0	na												
Reserve 2	NA	322,251	NA	25%	NA	NA	NA	NA	Reserve 2	na	na	na	na	2,031	2,031	na	0	na												
Reserve 3	NA	937,533	NA	25%	NA	NA	NA	NA	Reserve 3	na	na	na	na	2,031	2,031	na	0	na												
		Subtotal	6,835,740	1,417,114	21%	NA	2,882,658	NA	5,901,870							Subtotal	1,713,985	1,494,480	1,713,985											
ADDITIONAL NEW DEVELOPMENT AND EXPANSIONS SHOWN ON MASTER PLAN DIAGRAM:																														
Infill at Campus Core	Structured Parking, Academic, Support	65,320			3	195,960	5	320,600	Berry Building	Office/Classroom	CEP	none	1	2	2,011	2,012	40,000	40,000	40,000											
Infill at Campus Core									Half Acre Gymnasium	Gymnasium	CEP	none	2	5	2,012	2,015	30,000	30,000	30,000											
Infill at Campus Core									Child Care Addition	Office	MAYBE CEP	none	5	15	2,020	2,025	10,000	10,000	10,000											
Infill at Campus Core									College of Business Addition	Office/Classroom	CEP	none	0	0	2,010	2,010	100,000	0	100,000											
Infill at Campus Core	Academic, Living Learning	15,980			4	63,920	8	95,880	Information Library & Learning Center (ILLC)	Office/Library	CEP	none	0	0	2,026	2,026	89,913	89,913	89,913											
Infill at Friendly Row	Service and Maintenance	33,267			1	33,267	2	66,534	na	na	na	na	na	na	na	na	0	na												
Infill at Extending Service Area	Service and Maintenance	37,327			2	74,654	3	111,981	na	na	na	na	na	na	na	na	0	na												
Infill at UW Plaza	Mixed Use, Conference Center Expansion	55,987			2	111,974	3	167,961	na	na	na	na	na	na	na	na	0	na												
Fine Arts Expansion	Academic	12,032			2	24,064	2	24,064	Fine Arts Expansion	Office	CEP	none	3	5	2,013	2,015	111,374	111,374	111,374											
Law Building Expansion	Academic	12,032			2	24,064	2	24,064	Law Moot Court	Office	CEP	none	0	0	2,010	2,010	24,000	24,000	24,000											
WTBC Expansion	Research, Office	16,261			2	32,522	4	65,044	Included in F	Included in F	-	-	-	-	-	Included in F	Included in F	Included in F												
Centennial Complex Expansion	Civic, Museum	13,561			2	27,122	3	40,773	Included in G	Included in G	-	-	-	-	-	Included in G	Included in G	Included in G												
Visual Arts Expansion	Academic	44,289			2	88,578	3	132,867	Included in G	Included in G	-	-	-	-	-	Included in G	Included in G	Included in G												
Tennis Building Expansion	Recreation	20,551			1	20,551	1	20,551	na	na	na	na	na	na	na	na	0	na												
		Subtotal	0	323,314	NA	NA	681,680	NA	1,060,382	na	na	na	na	na	na	Subtotal	318,374	215,374	318,374											
TOTAL												6,835,740	1,740,428	25%	NA	3,563,748	NA	6,962,752												
												Demolish and Replace New Recent Completions																		
												TOTAL ADDITIONS THRU YEAR 2030		2,022,206	1,769,843															

The adjusted data was then utilized by AEI, CES and ESC to perform an evaluation of the existing utilities to determine if the utilities in each approximate area are adequate to support the existing load as well as future growth. This data enabled recommendations to be performed to potentially renovate, upgrade or install new utilities to sustain the current and future load growth conditions.

B. Heating System Profiles

1. Current and Annual Load Growth and Consumption Profiles

The UW does not currently incorporate individual building metering to determine steam consumption and peaks. There is however multiple meters at the CEP to measure the total steam output of the plant and individual boilers. The existing building loads were developed by comparison to a database of similar building types and their historic peak and diversified load values. The diversified loads were then adjusted to reflect the peak steam output of the plant.

Peak loads were developed from existing building gross sq ft (GSF) numbers provided by the UW and then applied to load density values per building function (classroom, residence hall, research lab, etc.). The loads were next diversified according to building function. For example, based on how the buildings operate, research labs are not heavily diversified (diversity of $\pm 90\%$) while libraries and museums are on the other end of the spectrum (diversity of 60% to 70%). These diversity factors were then applied across the campus facilities to develop the total steam output of the CEP. Table III-B-1 indicates the load densities and diversities selected for use on the campus based on building function. These values were then applied to each campus building to develop the values illustrated in Table III-B-2 and III-B-3.

The future projected loads were developed using the same methodology and are shown in Table III-B-4 and III-B-5.

A summary of the load totals is illustrated in Table III-B-6. To further represent the existing load in combination with the projected loads the values defined above were included graphically in Figure III-B-1. The figure also shows the development in relation to the firm, overall, and coal capacities of the CEP. This enables further evaluation of system upgrades and additions necessary to satisfy the campus projected heat loads.

Tables III-B-2 through B-6 identifies a column number that are in relation to the information below and where this information was generated from.

1. Building Numbers: Provided by the UW.
2. Building Name: Provided by the UW.
3. Year Built: Provide by the UW.
4. Building Gross Square Foot: Provided by the UW.
5. Building Type: Assumed per Building Type and per UW input.
6. Building Peak Loads: Based on building type in comparison to Table III-B-1 historic load data.
7. Building Diversified Loads: Based on building type in comparison to Table III-B-1 historic load data, and adjusted to approximate peak campus capacity.

Table III-B-1

LOAD AND DIVERSITY FACTORS BY BUILDING TYPE (LARGE PLANTS)			
Building Type	Building Gross Btu/GSF	Steam Density	
		Steam Density Diversity	Building Diversified BTU/GSF
Agricultural/Greenhouse	22	0.67	13
Animal/Veterinary	40	0.85	29
Art Studio	50	0.76	33
Auditorium	32	0.67	18
Classroom	35	0.67	20
Classroom/Library	35	0.67	20
Clinic	35	0.64	19
Data Center	88	0.90	68
Food Service	40	0.67	23
Greek Residence Housing	27	0.67	15
Greenhouse/Laboratory (Light)	33	0.70	20
Gymnasium	32	0.67	18
Gymnasium w/ Spectators	32	0.67	18
Gymnasium/Pool	60	0.79	40
Hotel	27	0.60	14
Laboratory (Light)	65	0.85	48
Laboratory (Medium)	88	0.90	68
Laboratory (Heavy)	110	0.95	90
Library	35	0.67	20
Museum	35	0.60	18
Museum/Office	35	0.64	19
Office	35	0.67	20
Office/Classroom	35	0.67	20
Office/Classroom/Clinic	35	0.67	20
Office/Classroom/Auditorium	34	0.67	19
Office/Classroom/Laboratory (Light)	45	0.73	28
Office/Classroom/Laboratory (Medium)	52	0.75	34
Office/Classroom/Library	35	0.67	20
Office/Classroom/Gymnasium/Pool	47	0.73	30
Office/Clinical	37	0.67	22
Office/Data Center	61	0.79	41
Office/Food Service	37	0.67	22
Office/Laboratory (Light)	50	0.76	33
Office/Library	35	0.67	20
Office/Sports Training	33	0.67	19
Pool	88	0.90	68
Residence Hall	27	0.67	15
Service/Grounds Facility	25	0.67	14
Sports Training	32	0.67	18
Sports Arena	32	0.67	18
Sports Arena - Outdoor	32	0.67	18
Student Center/Union	40	0.67	23

Table III-B-2

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Existing Core Campus Building Steam Load Estimate						
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Peak Load (Lb/Hr)	Building Diversified Load (Lb/Hr)
Northwest Campus						
1	Engineering (Old)	1927	80,010	Office/Classroom/Laboratory (Light)	3,734	2,344
1	Engineering (Petro/Aero)	1959	65,834	Office/Classroom/Laboratory (Light)	3,072	1,929
1	Engineering (Addition)	1983	185,136	Office/Classroom/Laboratory (Light)	8,640	5,424
2	Ag C (Old)	1949	107,053	Classroom	3,854	2,221
2	Ag C (Addition)	1982	114,726	Office/Classroom/Laboratory (Light)	5,354	3,361
3	Ag A	1949	29,291	Classroom/Library	1,054	608
4 & 5	Ag B & D	1949	8,980	Office/Laboratory (Light)	467	305
6	Vocational Education	1966	27,840	Office/Classroom	1,002	577
14	Education	1950	123,674	Classroom/Library	4,452	2,565
19	McWhinnie Hall	1928	26,625	Office	959	552
22	Half Acre Gymnasium	1925	112,906	Gymnasium/Pool	7,038	4,751
22	Half Acre (Raquetball Courts)	1980	6,400	Gymnasium	211	122
25	Anthropology	2007	52,499	Office/Classroom	1,890	1,089
36	Service Building (Old)	1954	9,211	Service/Grounds Facility	240	138
36	Service Building (Auto)	1980	57,592	Service/Grounds Facility	1,500	864
36	Service Building (Shops)	1956	14,485	Service/Grounds Facility	377	217
38	Wyoming Hall	1950	69,579	Office	2,505	1,443
91	Earth Sciences	1995	65,000	Office/Classroom/Laboratory (Light)	3,033	1,904
93	Bureau of Mines	1950	62,628	Office/Laboratory (Light)	3,257	2,129
2013&2014	Bee Lab	1956	2,480	Office/Laboratory (Light)	129	84
Subtotal			1,221,929		52,767	32,628
North & Northeast Campus						
80	Animal Science/Molecular Biology	1985	93,631	Office/Classroom/Laboratory (Light)	4,369	2,743
90	Central Energy Plant	1982	57,803	Service/Grounds Facility	1,505	867
111	Regulated Materials Management Center	1993	19,000	Office	684	394
125	Centennial Complex	1993	126,200	Museum/Office	4,543	2,481
150	WY Tech Business Center	2007	31,000	Office/Data Center	1,979	1,336
Subtotal			327,634		13,081	7,822
West & Southwest Campus						
7	Arts & Sciences	1934	66,186	Office/Classroom/Auditorium	2,317	1,335
9	Biological Sciences	1969	205,350	Office/Classroom/Laboratory (Light)	9,583	6,016
11	Health Sciences (Old Biochemistry)	1914	42,951	Office/Classroom/Laboratory (Light)	2,004	1,258
12	Classroom	1968	78,836	Classroom	2,838	1,635
12	Classroom (Addition)	2007	17,225	Classroom	620	357
13	College of Business	1960	62,000	Office/Classroom	2,232	1,286
18	Geology (Old)	1902	20,280	Office/Classroom	730	421
18	Geology (Addition)	1956	37,491	Office/Classroom/Library	1,350	778
23	Student Health	1960	30,513	Office/Classroom/Clinic	1,098	633
23	Student Health (Addition)	2008	1,500	Office/Classroom	54	31
24	Hoyt Hall	1916	29,939	Office/Classroom	1,078	621
26	Coe Library (Am Studies)	1958	119,390	Library	4,298	2,477
26	Coe Library (Addition)	1978	85,676	Library	3,084	1,777
27	Merica Hall	1908	17,651	Office	635	366
30	Aven Nelson	1924	32,832	Office/Classroom	1,182	681
31	Old Main	1887	34,089	Office	1,227	707
32	Pharmacy	1969	52,397	Office/Classroom/Laboratory (Light)	2,445	1,535
32	Health Sciences (Biochem & Pharm Add.)	2005	29,000	Office/Classroom/Laboratory (Light)	1,353	850
33	Physical Sciences	1968	179,777	Office/Classroom/Laboratory (Medium)	9,798	6,292
39	Wyoming Union (Old+79 addn)	1939	137,418	Student Center/Union	5,772	3,326
39	Wyoming Union (Addition)	2001	25,000	Student Center/Union	1,050	805
44	Knight Hall (Old)	1941	65,704	Office	2,365	1,363
44	Knight Hall (Food Service)	1950	12,723	Office	458	264
44	Knight Hall (Addition)	1946	3,244	Office	117	67
50	Ross Hall	1980	90,685	Office/Food Service	3,536	2,037
82	Williams Conservatory	1994	8,633	Greenhouse/Laboratory (Light)	301	181
84	Iverson Hospital	1939	46,902	Office/Data Center	2,994	2,021
920	Geo Survey Building	1975	23,171	Office	834	481
Subtotal			1,556,543		65,354	39,401
SHEET SUBTOTAL EXISTING			3,106,106		131,202	79,851

Table III-B-3

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Existing Core Campus Building Steam Load Estimate						
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Peak Load (Lb/Hr)	Building Diversified Load (Lb/Hr)
East Campus						
21	Campus Greenhouse	1961	5,737	Agricultural/Greenhouse	132	76
64	Information Technology	2008	84,241	Office/Data Center	5,377	3,630
77	Law School	1977	48,463	Office/Classroom	1,745	1,005
77	Law Library (Addition)	1993	17,000	Classroom	612	353
78	Fine Arts	1972	175,598	Office/Classroom/Auditorium	6,146	3,541
78	Fine Arts (Addition)	1999	5,000	Art Studio	260	170
79	Corbett Physical Education	1975	83,646	Office/Classroom/Gymnasium/Pool	4,113	2,573
123 & 124	Wainwright/Willett Bungalows	1950	3,500	Art studio	182	119
Subtotal			423,185		18,567	11,467
King Row						
40	Crane Hall	1962	88,935	Residence Hall	2,490	1,435
41	Crane Hill Cafeteria	1962	49,622	Food Service	2,084	1,201
42	Downey Hall	1965	85,361	Residence Hall	2,390	1,377
43	Hill Hall	1962	88,935	Residence Hall	2,490	1,435
46	McIntyre Hall	1966	132,226	Residence Hall	3,702	2,133
48	Orr Hall	1966	85,361	Residence Hall	2,390	1,377
51	Washakie Center (Old)	1966	70,937	Food Service	2,979	1,717
51	Washakie Center (Addition)	2004	10,579	Food Service	444	256
52	White Hall	1967	132,054	Residence Hall	3,698	2,131
Subtotal			744,010		22,668	13,061
Sorority Row						
56	Sigma Phi Epsilon House	1952	16,634	Residence Hall	466	268
908	Pi Kappa Alpha	1963	16,750	Greek Residence Housing	469	270
909	Delta Delta Delta	1941	13,562	Greek Residence Housing	379	219
910	Chi Omega	1954	8,454	Greek Residence Housing	237	136
911	Kappa Kappa Gamma	1941	20,082	Greek Residence Housing	562	324
912	Pi Beta Phi (Old)	1949	12,395	Greek Residence Housing	347	200
912	Pi Beta Phi (Addition)	1994	3,363	Greek Residence Housing	94	54
Subtotal			91,230		2,554	1,472
Fraternity Row						
55	Honors House	1939	9,031	Residence Hall	253	146
61	Beta House	1966	12,567	Office/Classroom	452	261
902	Alpha Tau Omega	1957	9,154	Greek Residence Housing	256	148
904	HSL	1957	5,247	Residence Hall	147	85
905	Sigma Alpha Epsilon	1956	10,557	Greek Residence Housing	296	170
906	Sigma Chi	1957	10,881	Greek Residence Housing	305	176
907	Sigma Nu	1960	10,226	Greek Residence Housing	286	165
Subtotal			67,663		1,995	1,150
Athletics Campus						
16	Fieldhouse	1951	195,855	Gymnasium w/ Spectators	6,463	3,724
17	Fieldhouse North Addition	1984	71,694	Office	2,581	1,487
73	Rochele Athletics Center	2001	47,450	Office/Sports Training	1,637	943
74	Indoor Practice Facility	2007	83,759	Sports Training	2,764	1,593
89	Arena Auditorium	1982	260,990	Sports Arena	8,613	4,963
Subtotal			659,748		22,058	12,710
Current Additions						
26	Information Library & Learning Center (ILLC)	2009	85,913	Office/Library	3,093	1,782
Subtotal			85,913		3,093	1,782
SHEET SUBTOTAL EXISTING			2,071,749		70,935	41,642
TOTALS EXISTING			5,177,855		202,137	121,493

Table III-B-4

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Projected Core Campus Building Steam Load Estimate						
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	Building Peak Load (Lb/Hr)	Building Diversified Load (Lb/Hr)
Immediate Future Additions						
13	College of Business Addition	2010	103,000	Office/Classroom	3,708	2,137
77	Law - Moot Court Addition	2010	24,000	Classroom	864	498
Subtotal			127,000		4,572	2,634
North of Lewis						
A	School of Energy Resources	2011-2015	40,000	Office/Classroom/Laboratory (Light)	1,867	1,172
A	Science Teaching Lab Facility	2011-2015	100,000	Office/Classroom/Laboratory (Medium)	5,450	3,500
A	Long Term Development	2015-2020	315,000	Office/Classroom	11,340	6,534
A	Long Term Development	2020-2025	100,000	Office/Classroom	3,600	2,074
Subtotal			555,000		22,257	13,280
South of Ivinson						
B	Foundation House	2011-2015	10,000	Office/Classroom	360	207
B	Long Term Development	2020-2025	130,000	Office/Classroom	4,680	2,697
Subtotal			140,000		5,040	2,904
Service & Maintenance						
C	Service and Maintenance	2015-2020	151,997	Service/Grounds Facility	3,958	2,281
Subtotal			151,997		3,958	2,281
West Willett						
D	Surface Parking	2010-2030	0	Office/Classroom/Auditorium	0	0
Subtotal			0		0	0
Crane-Hill						
E	Crane Hill Demo and Rebuild of 250 Beds	2011-2015	227,492	Residence Hall	0	0
Subtotal			0		0	0
Research/Business						
F	Business Incubator	2015-2020	30,000	Office/Classroom/Laboratory (Light)	1,400	879
Subtotal			30,000		1,400	879
East Campus Academic						
G	Animal Science	2020-2025	200,000	Office/Classroom/Laboratory (Light)	9,333	5,859
G	Addition to CC	2015-2020	30,000	Museum/Office	1,080	590
G	Visual Arts East of CCC	2011-2015	80,000	Office/Classroom/Auditorium	2,800	1,613
G	Long Term Development	2025-2030	90,000	Office/Classroom	3,240	1,867
Subtotal			400,000		16,453	9,930
Stadium Parking Lot						
H	Stadium Suites	2011-2012	20,000	Office	720	415
Subtotal			20,000		720	415
Grand Avenue Commercial						
I	Office Space, Classroom	2025-2030	85,000	Office/Library	3,060	1,763
Subtotal			85,000		3,060	1,763
Rocky Mountain						
J	Office Space, Classroom	2025-2030	26,327	Office/Library	948	546
Subtotal			26,327		948	546
West Summit View						
K	250 Beds for Housing	2025-2030	185,822	Office/Library	6,690	3,855
Subtotal			185,822		6,690	3,855
East Summit View						
L	250 Beds for Housing	2025-2030	119,739	Residence Hall	3,353	1,932
Subtotal			119,739		3,353	1,932
Armory						
M	Service and Maintenance	POST 2030	0	Service/Grounds Facility	0	0
Subtotal			0		0	0
SHEET SUBTOTAL PROJECTED			1,840,885		68,450	40,418

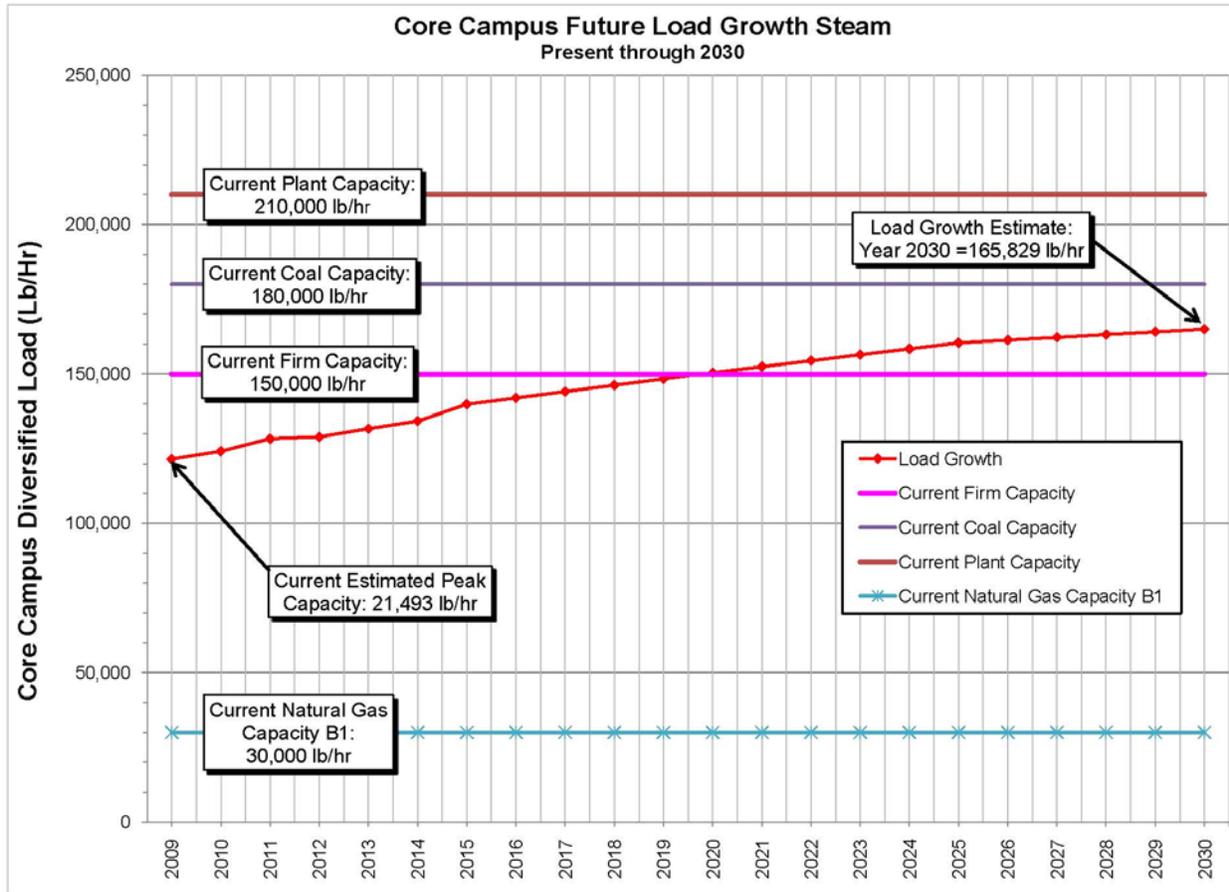
Table III-B-5

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Projected Core Campus Building Steam Load Estimate						
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	Building Peak Load (Lb/Hr)	Building Diversified Load (Lb/Hr)
Reserve 1	<u>Undefined</u> Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0	0
	Subtotal		FUTURE		0	0
Reserve 2	<u>Undefined</u> Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0	0
	Subtotal		FUTURE		0	0
Reserve 3	<u>Undefined</u> Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0	0
	Subtotal		FUTURE		0	0
Berry Building	<u>Campus North West</u> Berry, Office Space, Academics	2011-2012	40,000	Office/Classroom	1,440	830
	Subtotal		40,000		1,440	830
Half Acre Addition	<u>Campus South West</u> Half Acre Gymnasium	2012-2015	30,000	Gymnasium	990	570
	Subtotal		30,000		990	570
Fine Arts Addition	<u>Campus East</u> Fine Arts Addition	2013-2015	111,374	Office	4,009	2,310
	Subtotal		111,374		4,009	2,310
Child Care	<u>Campus East</u> Office Space	2020-2025	10,000	Office	360	207
	Subtotal		10,000		360	207
SHEET SUBTOTAL PROJECTED			191,374		6,799	3,918
TOTALS PROJECTED			2,032,259		75,250	44,336

Table III-B-6

(1)	(4)	(6)	(7)
Core Campus Steam Load Estimate Summary			
	Building Gross SF	Campus Peak Load (Lb/Hr)	Campus Diversified Load (Lb/Hr)
TOTAL EXISTING	5,177,855	202,137	121,493
TOTAL PROJECTED	2,032,259	75,250	44,336
TOTAL EXISTING AND PROJECTED	7,210,114	277,387	165,829

Figure III-B-1



Current and future flow rates were also evaluated through the use of a load duration curve. A load duration curve represents the existing system capacity in relation to operational hours of the year that a capacity occurs. By comparing this curve to equipment capacities it allows the user to understand the timeframes and risk associated from inadequate equipment capacities.

Flow metering data provided by the UW was used to develop a load duration curve represented in Figure III-B-2. The curve indicates loads vary from peak to minimum loads with no real base load on campus, typically representing a consistent flat load at the end of the curve. A base load typically consists of a constant heat or process loads seen on campus. It is noted that the equipment firm and plant capacity is well above the current campus loads.

A second load duration curve was created to closely match the existing campus loads as shown in Figure III-B-3. This graph allows a second curve to be added to define future load conditions in year 2030 that aid in sizing equipment within the CEP for options later defined in Section IV. Within this graph a base load was estimated at approximately 23,000 lb/hour. It is noted that the estimated 2030 loads appear to exceed equipment firm capacity for approximately 60 hours of the year.

Figure III-B-2

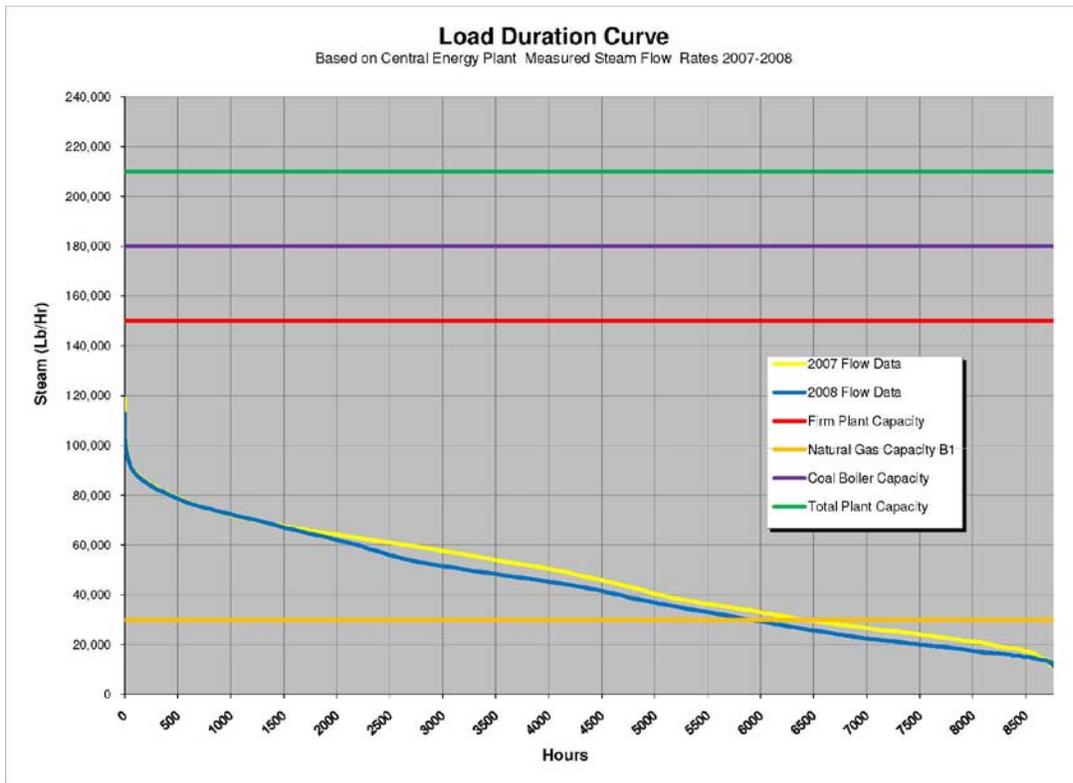
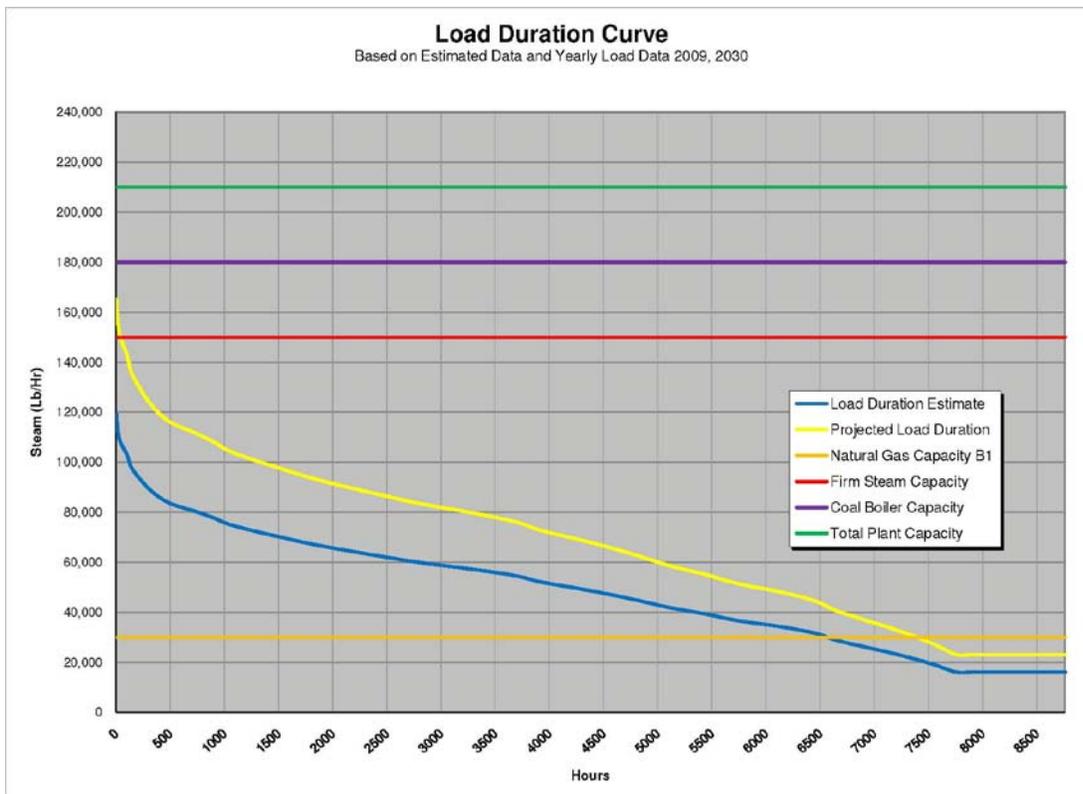


Figure III-B-3



2. Distribution Evaluation

The steam and condensate distribution system was evaluated based on its physical condition and flow capacity limitations. The physical condition was evaluated by conducting a field survey of the UW utility tunnels. The results of that survey are in Section II, Existing Conditions. The flow capacity limitations were evaluated by using flow modeling software. The results of the flow modeling with current building loads are located in Section II, Existing Conditions. The results of the flow modeling with future building loads are located below.

Fluid modeling of the steam system was performed for a 30 year estimated build out of the campus. A campus steam distribution map, developed in AFT, with pipe number designations is shown in Drawing III-B-2-1a of Appendix III-B referencing specific pipe locations. A complete output report including pipe flow and pressure data is included in Figure III-B-2-1b of Appendix III-B. The following is a description of the information obtained from the fluid modeling performed.

After analyzing the steam distribution system with the existing building heating loads, it was determined the 70 psig and 12 psig steam services on the west side of campus could not accommodate any additional substantial heating loads without boosting the pressure. The 125 psig main on the east side of the campus can accommodate additional loads including the loads proposed by the 30 year build out located on the east side of campus. Options were then developed to accommodate future loads on the west side of campus, provide practical locations for utility corridors, alleviate existing limitations on the existing system, and provide redundancy. The following options were analyzed:

Option 1 – Replace the Following Existing Steam Mains:

- Replace the 10" piping at P37, outside of the Law Building with a larger pipe or installing a parallel line.
- Replace the 10" direct buried piping running west, north of the fraternities with a larger pipe or installing a parallel line.
- Replace the 70 psig piping in the tunnel running west to McWhinnie Hall and College of Engineering Library with a larger pipe or installing a parallel line.

Option 2 – Install a New Steam Main to West Campus:

- Install a 10" diameter new high pressure steam main from the CEP to the west side of campus. The new piping main routes underground to the west, north of the cemetery and Lewis St., and ultimately connects to the existing system at the Lewis St. Alcove. The new line also serves the "Section A" new development region.

The second option was chosen because of the ability to provide redundancy, use practical utility corridors, and boost the existing steam system pressure on the west campus with a connection to the existing

steam system at the Lewis St. Alcove. This option also reduced the amount of total piping installed, reducing the amount that needed to be replaced or have a parallel line installed. The fluid model indicates the new steam main would add capacity for the future build out on the west side of campus and reduce the velocity of the steam in the existing distribution piping that would allow further expansion on this piping.

Fluid modeling of the condensate system was performed for a 30 year predicted build-out of the campus. A campus condensate distribution map, developed in AFT, with pipe number designations is shown in Drawing III-B-2-2a in Appendix III-B referencing specific pipe locations. A complete output report including pipe flow and pressure data and pump data is included in Appendix III-B in Figure III-B-2-2b.

After analyzing the condensate distribution system with the existing and future building heating loads, it was determined the majority of the piping could accommodate additional load. The model also indicated the pumps at each building and pumping stations have adequate head to pump the condensate through the pipes to the condensate receivers. The only location found to be at or above capacity was the location found in the existing model before the Willet Pit condensate receiver. The piping ahead of the condensate receiver at Willet Pit has an increased flow of 317 gpm through it, resulting in an increased velocity of about 14 fps.

The following conclusions were made regarding the future expansion of the existing steam distribution system to accommodate future loads.

The flow model of the steam system indicated the existing piping on the west side of the main campus was at capacity and would not accommodate any more significant building loads. The solution that was developed was to install a second steam main from the CEP to serve the future loads on the west side of campus and supplement the existing installed system. The line would route west, north of the cemetery towards the west side of the campus. The fluid model of the condensate system indicated the piping is adequate except for the piping just north of the fraternities terminating at Willet Pit and the piping just north of Fieldhouse North. This conclusion is based on having 100% flow from all of the condensate pumps and gravity lines simultaneously, which is not really representative of the flow that is likely at one point in time. A diversified flow would be more realistic. The piping in these areas would be adequate for the future loads if only 40% of the load ever flowed through the pipes simultaneously.

A campus map with future areas of build out and potential steam utility corridors are shown on Drawing III-B-2-3 within Appendix III-B. The drawing shows approximately where new steam tunnels or direct buried piping would be located to serve future proposed loads. Table III-B-7 is provided to illustrate cost for the expansion of the distribution system through 2030 in current dollars. These corridors should also be compared to and coordinated to replacement tunnels recommended in Section II-B-2-c.

3. Summary

The CEP boilers appear to accommodate the current loads and projected growth until approximately year 2020 when the plant firm capacity is exceeded. Considerations to add capacity through additional equipment, revise equipment, or revise operations, will need to be evaluated prior to this timeframe. Preliminary evaluations are included within Section IV, Part B.

The existing steam distribution system accommodates the current loads, but cannot accommodate any more significant loads at the West end of campus in the near future.

An option for an additional utility route is recommended to accommodate the distribution deficiencies and supplement the existing system on the west side of campus. The route is proposed to be placed at the south edge of area C border, directly north of the cemetery limits. The proposed route accommodates projected growth, future and existing deficiencies, and a redundant line source of steam that can be installed with minimal utility upgrades and shutdowns. This recommended option along with projected growth utility corridor locations are shown in Drawing III-B-2-3 within the Appendix.

Estimates for each option recommendation and utility corridor installation is provided in Table III-B-7 as present value dollars. Each option and estimate is preliminary and values are recommended to be evaluated in detail at the time of installation.

Table III-B-7

Table III-B-7
Steam Distribution System Expansion Estimate

Description of Items	Quantity	Unit	Unit Cost	Total Cost
----------------------	----------	------	-----------	------------

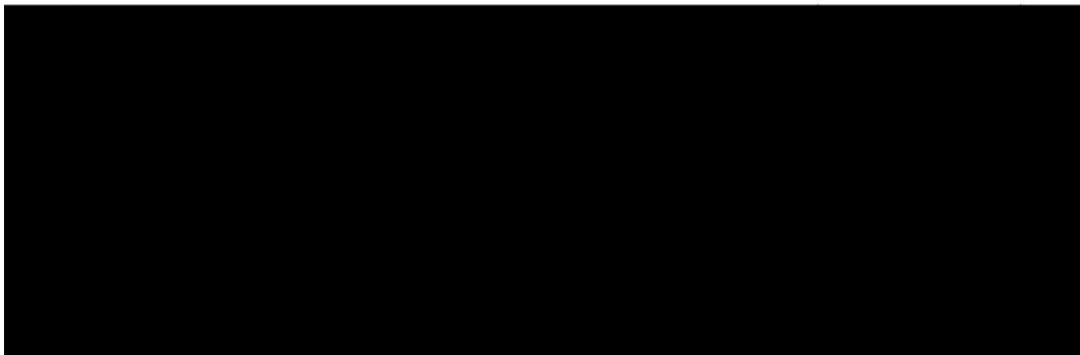
System Sizes and Configuration

Construction Period 2010-2015

Waterproof Walkable Tunnel w/ 10" HPS Sch. 80 Piping, 6" HPC Sch. 80 Piping, 2" CA, Pipe Insulation, Pipe Supports & Anchors, Lighting & Sumps (South and east of Anthropology)	1800	If	\$4,000	\$7,200,000
Waterproof Walkable Tunnel w/ 10" HPS Sch. 80 Piping, 6" HPC Sch. 80 Piping, 2" CA, Pipe Insulation, Pipe Supports & Anchors, Lighting & Sumps (From Lewis Street, North to New Direct Buried Piping from CEP)	365	If	\$4,000	\$1,460,000
Direct Buried w/ 4" HPS Sch. 80 Piping, 2" HPC Sch. 80 Piping, 1 1/2" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (From Existing Tunnel to Berry Building)	80	If	\$750	\$60,000
Direct Buried w/ 6" HPS Sch. 80 Piping, 3" HPC Sch. 80 Piping, 1 1/2" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (From Centennial Complex south to Rochele Athletic Center)	600	If	\$800	\$480,000
Direct Buried w/ 10" HPS Sch. 80 Piping, 6" HPC Sch. 80 Piping, 2" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (From the CEP to northeast of Anthropology)	2340	If	\$900	\$2,106,000
Direct Buried w/ 4" HPS Sch. 80 Piping, 2" HPC Sch. 80 Piping, 1 1/2" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (From Existing Tunnel to Development Area B)	400	If	\$750	\$300,000

System Allowances & Costs

1% Connect to Existing System Allowance	1	Is	\$116,100	\$116,100
7% Fitting Allowance	1	Is	\$812,400	\$812,400



	1	Is	\$348,200	\$348,200	3% Valve Allowance
	1	Is	\$322,100	\$322,100	2.5% System Testing
	1	Is	\$322,068	\$322,068	2.5% Traffic/Road Barriers
	1	Is	\$322,068	\$322,068	2.5% Distribution Interference
	1	Is	\$322,068	\$322,068	2.5% Site Construction Requirements
	1	Is	\$3,542,751	\$3,542,751	25% Estimating Contingency
	1	Is	\$1,417,100	\$1,417,100	8% A/E Design Fees
			\$19,130,853	\$19,130,853	Total 2010-2015

2020

						<u>System Sizes and Configuration</u>	
						Construction Period 2015-	
Piping, 6" HPC Sch. 80 Anchors, Lighting & Sumps	1800	If	\$4,000	\$6,400,000	Waterproof Walkable Tunnel w/ 10" HPS Sch. 80 Piping, 2" CA, Pipe Insulation, Pipe Supports & Ar		(North and west of Anthropology)
Piping, 3" HPC Sch. 80 Anchors, Lighting & Sumps (East of Wyoming Business Technology Center)	365	If	\$3,250	\$1,186,250	Waterproof Walkable Tunnel w/ 6" HPS Sch. 80 Piping, 1 1/2" CA, Pipe Insulation, Pipe Supports & Sumps		(East of Wyoming Business Technology C
Piping, 4" HPC Sch. 80 Anchors, Lighting & Sumps (South and east of Wyoming Business Technology Center)	260	If	\$3,500	\$910,000	Waterproof Walkable Tunnel w/ 8" HPS Sch. 80 Piping, 1 1/2" CA, Pipe Insulation, Pipe Supports & Sumps		(South and east of Wyoming Business Te

Table III-B-7

<u>System Sizes and Configuration</u>					
Construction Period 2020-2030					
Waterproof Walkable Tunnel w/ 6" HPS Sch. 80 Piping, 3" HPC Sch. 80 Piping, 1 1/2" CA, Pipe Insulation, Pipe Supports & Anchors, Lighting & Sumps (North and east of the CEP)	1700	If	\$3,250		\$5,525,000
Waterproof Walkable Tunnel w/ 4" HPS Sch. 80 Piping, 2" HPC Sch. 80 Piping, 1" CA, Pipe Insulation, Pipe Supports & Anchors, Lighting & Sumps (North and east of the CEP)	965	If	\$3,000		\$2,895,000
Direct Buried w/ 4" HPS Sch. 80 Piping, 2" HPC Sch. 80 Piping, 1" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (Serves Development Areas I, J, K, and L)	3665	If	\$750		\$2,748,750
Direct Buried w/ 4" HPS Sch. 80 Piping, 2" HPC Sch. 80 Piping, 1" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (Serves Development Areas B)	490	If	\$750		\$367,500
In Existing Tunnel - 4" HPS Sch. 80 Piping, 2" HPC Sch. 80 Piping, 1" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (South and west of Law)	810	If	\$350		\$283,500
Direct Buried w/ 3" HPS Sch. 80 Piping, 1 1/2" HPC Sch. 80 Piping, 1" CA, Pipe Insulation, Pipe Anchors, Bedding & Backfill (South of Willett Drive Serving Development Areas K and L)	740	If	\$700		\$518,000
<u>System Allowances & Costs</u>					
1% Connect to Existing System Allowance	1	Is	\$123,400		\$123,400
7% Fitting Allowance	1	Is	\$863,600		\$863,600
3% Valve Allowance	1	Is	\$370,100		\$370,100
2.5% System Testing	1	Is	\$342,400		\$342,400
2.5% Traffic/Road Barriers	1	Is	\$342,371		\$342,371
2.5% Distribution Interference	1	Is	\$342,371		\$342,371
2.5% Site Construction Requirements	1	Is	\$342,371		\$342,371
25% Estimating Contingency	1	Is	\$3,766,091		\$3,766,091
8% A/E Design Fees	1	Is	\$1,506,436		\$1,506,436
Total 2020-2030					\$20,336,891
Total 2010-2030					\$53,980,108

C. Chilled Water System

1. Current and Annual Load Growth and Consumption Profiles

The UW does not currently incorporate building metering to determine individual building chilled water consumption and peaks. There is however, a newly added meter (2008) at the CEP to measure the total chilled water output of the plant. The existing building loads were developed by comparison to a database of similar building types and their historic peak and diversified load values. The diversified loads were then adjusted to reflect the peak steam output of the plant.

The peak loads were developed from existing building gross sq ft (GSF) numbers provided by the UW and were then applied to load density values per building function (classroom, residence hall, research lab, etc.). The loads were next diversified according to building function. For example, based on how the buildings operate, research labs are not heavily diversified (diversity of ± 90%) while libraries and museums are on the other end of the spectrum (diversity of 60% to 70%). These diversity factors were then applied across the campus facilities to develop the total chilled water output of the CEP. Table III-C-1 indicates the load densities and diversities selected for use on the campus based on building function. These values were then applied to each campus building to develop the values illustrated in Table III-C-2 and III-C-3.

The future projected and potential loads were developed using the same methodology and are shown in Table III-C-4, III-C-5 and III-C-6.

A summary of the load totals is illustrated in Table III-C-7. To further represent the existing load in combination with the projected loads the values defined above are included graphically in Figure III-C-1. The figure also shows the development in relation to the firm and overall chilled water capacities of the CEP. This enables further evaluation of system upgrades and additions necessary to satisfy the campus projected chilled water loads.

Table III-C-2 through C-6 identifies a column number that are in relation to the information below and where this information was generated from.

1. Building Numbers: Provided by the UW.
2. Building Name: Provided by the UW.
3. Year Built: Provided by the UW.
4. Building Gross Square Foot: Provided by the UW.
- 4a. Building Area Cooled by the Chilled Water System: Provided by the UW.
- 4b. Building Area Cooled by Local Chillers: Provided by the UW.
- 4c. Building Area Cooled by Evaporative Cooling Systems: Provided by the UW.
5. Building Type: Assumed per Building Type and per UW input.
6. Building Peak Loads: Based on building type in comparison to Table III-C-1 historic load data.
7. Building Diversified Loads: Based on building type in comparison to Table III-C-1 historic load data and adjusted to approximate peak campus capacity.

Table III-C-1

LOAD AND DIVERSITY FACTORS BY BUILDING TYPE (LARGE PLANTS)			
Chilled Water Density			
Building Type	Building Gross SF/Ton	Cooling Load Diversity	Building Diversified GSF/Ton
Agricultural/Greenhouse	500	0.60	833
Greenhouse/Laboratory (Light)	588	0.68	870
Animal / Veterinary	500	0.70	714
Art Studio	613	0.78	790
Auditorium	450	0.25	1800
Classroom	800	0.65	1231
Classroom/Library	675	0.65	1038
Clinic	800	0.68	1185
Data Center	300	0.90	333
Food Service	425	0.70	607
Greek Residence Housing	575	0.70	821
Gymnasium	550	0.70	786
Gymnasium/Pool	425	0.80	531
Gymnasium w/ Spectators	550	0.70	786
Hotel	550	0.70	786
Laboratory (Light)	425	0.90	472
Laboratory (Medium)	300	0.90	333
Laboratory (Heavy)	250	0.90	278
Library	550	0.65	846
Museum	550	0.60	917
Museum/Office	675	0.65	1038
Office	800	0.70	1143
Office/Classroom	800	0.68	1185
Office/Classroom/Auditorium	683	0.53	1281
Office/Classroom/Clinic	800	0.68	1185
Office/Classroom/Gymnasium/Pool	613	0.74	831
Office/Classroom/Laboratory (Light)	675	0.75	900
Office/Classroom/Laboratory (Medium)	633	0.75	844
Office/Classroom/Library	717	0.67	1075
Office/Clinic	475	0.73	651
Office/Data Center	550	0.80	688
Office/Food Service	613	0.70	875
Office/Laboratory (Light)	613	0.80	766
Office/Library	675	0.68	1000
Office/Sports Training	675	0.70	964
Pool	300	0.90	333
Residence Hall	575	0.70	821
Service/Grounds Facility	500	0.70	714
Sports Training	550	0.70	786
Sports Arena	550	0.25	2200
Sports Arena - Outdoor	0	N/A	-
Student Center/Union	450	0.70	643

Table III-C-2

(1)	(2)	(3)	(4)	(4A)	(4B)	(4C)	(5)	(6)	(7)
Existing Core Campus Building Chilled Water Load Estimate									
Bldg #	Building Name	Year Built	Building Gross SF	CEP	Local Chiller	Evap. Cooling	Building Type	CEP Building Peak Load (Tons)	CEP Building Diversified Load (Tons)
Northwest Campus									
1	Engineering (Old)	1927	80,010				Office/Classroom/Laboratory (Light)	0	0
1	Engineering (Petro/Aero)	1959	65,834				Office/Classroom/Laboratory (Light)	0	0
1	Engineering (Addition)	1983	185,136				Office/Classroom/Laboratory (Light)	0	0
2	Ag C (Old)	1949	107,053				Classroom	0	0
2	Ag C (Addition)	1982	114,726	20,000			Office/Classroom/Laboratory (Light)	30	19
3	Ag A	1949	29,291				Classroom/Library	0	0
4 & 5	Ag B & D	1949	8,980				Office/Laboratory (Light)	0	0
6	Vocational Education	1966	27,840				Office/Classroom	0	0
14	Education	1950	123,674	20,000			Classroom/Library	30	16
19	McWhinnie Hall	1928	26,625				Office	0	0
22	Half Acre Gymnasium	1925	112,906				Gymnasium/Pool	0	0
22	Half Acre (Raquetball Courts)	1980	6,400				Gymnasium	0	0
25	Anthropology	2007	52,499	52,499			Office/Classroom	66	37
36	Service Building (Old)	1954	9,211				Service/Grounds Facility	0	0
36	Service Building (Auto)	1960	57,592				Service/Grounds Facility	0	0
36	Service Building (Shops)	1956	14,465				Service/Grounds Facility	0	0
38	Wyoming Hall	1950	69,579				Office	0	0
91	Earth Sciences	1995	65,000	65,000			Office/Classroom/Laboratory (Light)	96	61
93	Bureau of Mines	1950	62,628				Office/Laboratory (Light)	0	0
2013&2014	Bee Lab	1956	2,480				Office/Laboratory (Light)	0	0
Subtotal			1,221,929	157,499	0	0		221	133
North & Northeast Campus									
80	Animal Science/Molecular Biology	1985	93,631			93,631	Office/Classroom/Laboratory (Light)	0	0
90	Central Energy Plant	1982	57,803	2,000			Service/Grounds Facility	4	2
111	Regulated Materials Management Center	1993	19,000		19,000		Office	0	0
125	Centennial Complex	1993	126,200	126,200			Museum/Office	187	102
150	WY Tech Business Center	2007	31,000	31,000			Office/Data Center	56	38
Subtotal			327,634	159,200	19,000	93,631		247	142
West & Southwest Campus									
7	Arts & Sciences	1934	66,186				Office/Classroom/Auditorium	0	0
9	Biological Sciences	1969	205,350	205,350			Office/Classroom/Laboratory (Light)	304	192
11	Health Sciences (Old Biochemistry)	1914	42,951	42,951			Office/Classroom/Laboratory (Light)	64	40
12	Classroom	1968	78,836	78,836			Classroom	99	54
12	Classroom (Addition)	2007	17,225				Classroom	0	0
13	College of Business	1960	62,000	15,000			Office/Classroom	19	11
18	Geology (Old)	1902	20,280	7,700			Office/Classroom	10	5
18	Geology (Addition)	1956	37,491				Office/Classroom/Library	0	0
23	Student Health	1960	30,513				Office/Classroom/Clinic	0	0
23	Student Health (Addition)	2008	1,500				Office/Classroom	0	0
24	Hoyt Hall	1916	29,939				Office/Classroom	0	0
26	Coe Library (Am Studies)	1958	119,390	40,000			Library	73	40
26	Coe Library (Addition)	1978	85,676				Library	0	0
27	Menca Hall	1908	17,651				Office	0	0
30	Aven Nelson	1924	32,832				Office/Classroom	0	0
31	Old Main	1887	34,089				Office	0	0
32	Pharmacy	1969	52,397	52,397			Office/Classroom/Laboratory (Light)	78	49
32	Health Sciences (Biochem & Pharm Add.)	2005	29,000	29,000			Office/Classroom/Laboratory (Light)	43	27
33	Physical Sciences	1968	179,777	179,777			Office/Classroom/Laboratory (Medium)	284	179
39	Wyoming Union (Old+79 addn)	1939	137,418				Student Center/Union	0	0
39	Wyoming Union (Addition)	2001	25,000	25,000			Student Center/Union	56	33
44	Knight Hall (Old)	1941	65,704				Office	0	0
44	Knight Hall (Food Service)	1950	12,723	11,481			Office	14	8
44	Knight Hall (Addition)	1946	3,244				Office	0	0
50	Ross Hall	1960	90,665				Office/Food Service	0	0
82	Williams Conservatory	1994	8,633				Greenhouse/Laboratory (Light)	0	0
84	Ivinson Hospital	1939	46,902				Office/Data Center	0	0
920	Geo Survey Building	1975	23,171	23,171			Office	29	17
Subtotal			1,556,543	710,663	0	0		1,071	654
SHEET SUBTOTAL EXISTING			3,106,106	1,027,362	19,000	93,631		1,539	929

Table III-C-3

(1)	(2)	(3)	(4)	(4A)	(4B)	(4C)	(5)	(6)	(7)
Existing Core Campus Building Chilled Water Load Estimate									
Bldg #	Building Name	Year Built	Building Gross SF	CEP	Local Chiller	Evap. Cooling	Building Type	CEP Building Peak Load (Tons)	CEP Building Diversified Load (Tons)
East Campus									
21	Campus Greenhouse	1961	5,737				Agricultural/Greenhouse	0	0
64	Information Technology	2008	84,241	84,241			Office/Data Center	153	103
77	Law School	1977	48,463	48,463			Office/Classroom	61	34
77	Law Library (Addition)	1993	17,000	17,000			Classroom	21	12
78	Fine Arts	1972	175,598	46,582			Office/Classroom/Auditorium	68	31
78	Fine Arts (Addition)	1999	5,000	5,000			Art Studio	8	5
79	Corbett Physical Education	1975	83,646				Office/Classroom/Gymnasium/Pool	0	0
123 & 124	Wainwright/Willett Bungalows	1950	3,500				Art studio	0	0
Subtotal			423,185	201,286				311	185
King Row									
40	Crane Hall	1962	88,935				Residence Hall	0	0
41	Crane Hill Cafeteria	1962	49,622				Food Service	0	0
42	Downey Hall	1965	85,361				Residence Hall	0	0
43	Hill Hall	1962	88,935				Residence Hall	0	0
46	McIntyre Hall	1966	132,226				Residence Hall	0	0
48	Orr Hall	1966	85,361				Residence Hall	0	0
51	Washakie Center (Old)	1966	70,937			70,937	Food Service	0	0
51	Washakie Center (Addition)	2004	10,579			10,579	Food Service	0	0
52	White Hall	1967	132,054				Residence Hall	0	0
Subtotal			744,010	0				0	0
Sorority Row									
56	Sigma Phi Epsilon House	1952	16,634				Residence Hall	0	0
908	Pi Kappa Alpha	1963	16,750				Greek Residence Housing	0	0
909	Delta Delta Delta	1941	13,552				Greek Residence Housing	0	0
910	Chi Omega	1954	8,454				Greek Residence Housing	0	0
911	Kappa Kappa Gamma	1941	20,082				Greek Residence Housing	0	0
912	Pi Beta Phi (Old)	1949	12,395				Greek Residence Housing	0	0
912	Pi Beta Phi (Addition)	1994	3,363				Greek Residence Housing	0	0
Subtotal			91,230	0				0	0
Fraternity Row									
55	Honors House	1939	9,031				Residence Hall	0	0
61	Beta House	1966	12,567				Office/Classroom	0	0
902	Alpha Tau Omega	1957	9,154				Greek Residence Housing	0	0
904	HSL	1957	5,247				Residence Hall	0	0
905	Sigma Alpha Epsilon	1956	10,557				Greek Residence Housing	0	0
906	Sigma Chi	1957	10,881				Greek Residence Housing	0	0
907	Sigma Nu	1960	10,226				Greek Residence Housing	0	0
Subtotal			67,663	0				0	0
Athletics Campus									
16	Fieldhouse	1951	195,855				Gymnasium w/ Spectators	0	0
17	Fieldhouse North Addition	1984	71,694			71,694	Office	0	0
73	Rochele Athletics Center	2001	47,450			47,450	Office/Sports Training	0	0
74	Indoor Practice Facility	2007	83,759				Sports Training	0	0
89	Arena Auditorium	1982	260,990				Sports Arena	0	0
0	Subtotal		659,748	0				0	0
Current Additions									
26	Information Library & Learning Center (ILLC)	2009	85,913	85,913			Office/Library	127	72
0	Subtotal		85,913	85,913				127	72
SHEET SUBTOTAL EXISTING			2,071,749	287,199	0	0		439	257
TOTALS EXISTING			5,177,865	1,314,661				1,978	1,186

Table III-C-4

(1)	(2)	(3)	(4)	(4A)	(4B)	(4C)	(5)	(6)	(7)
Projected Core Campus Building Chilled Water Load Estimate									
Bldg #	Building Name	Outlook Year Built	Building Gross SF	CEP	Local Chiller	Evap. Cooling	Building Type	CEP Building Peak Load (Tons)	CEP Building Diversified Load (Tons)
Immediate Future Additions									
1	Engineering (Petro/Aero)	2009	65,834	6,000			Office/Classroom/Laboratory (Light)	9	7
23	Student Health	2009	30,513	30,513			Office/Classroom/Clinic	38	28
23	Student Health (Addition)	2009	1,500	1,500			Office/Classroom	2	1
13	College of Business Addition	2010	103,000			103,000	Office/Classroom	0	0
77	Law - Moot Court Addition	2010	24,000	24,000			Classroom	30	20
Subtotal			127,000	62,013	0	103,000		70	47
North of Lewis									
A	School of Energy Resources	2011-2015	40,000	40,000			Office/Classroom/Laboratory (Light)	59	44
A	Science Teaching Lab Facility	2011-2015	100,000	100,000			Office/Classroom/Laboratory (Medium)	158	118
A	Long Term Development	2015-2020	315,000	315,000			Office/Classroom	394	266
A	Long Term Development	2020-2025	100,000	100,000			Office/Classroom	125	84
Subtotal			555,000	555,000	0	0		736	513
South of Ivinson									
B	Foundation House	2011-2015	10,000	0	10,000		Office/Classroom	0	0
B	Long Term Development	2020-2025	130,000	130,000			Office/Classroom	163	110
Subtotal			140,000	130,000	10,000	0		163	110
Service & Maintenance									
C	Service and Maintenance	2015-2020	151,997	151,997			Service/Grounds Facility	304	213
Subtotal			151,997	151,997	0	0		304	213
West Willett									
D	Surface Parking	2010-2030	0	0			Office/Classroom/Auditorium	0	0
Subtotal			0	0	0	0		0	0
Crane-Hill									
E	Crane Hill Demo and Rebuild of 250 Beds	2011-2015	227,492	227,492			Residence Hall	396	277
Subtotal			227,492	227,492	0	0		396	277
Research/Business									
F	Business Incubator	2015-2020	30,000	30,000			Office/Classroom/Laboratory (Light)	44	33
Subtotal			30,000	30,000	0	0		44	33
East Campus Academic									
G	Animal Science	2020-2025	200,000	200,000			Office/Classroom/Laboratory (Light)	296	222
G	Addition to CC	2015-2020	30,000	30,000			Museum/Office	44	29
G	Visual Arts East of CCC	2011-2015	80,000	80,000			Office/Classroom/Auditorium	117	82
G	Long Term Development	2025-2030	90,000	90,000			Office/Classroom	113	76
Subtotal			400,000	400,000	0	0		570	389
Stadium Parking Lot									
H	Stadium Suites	2011-2012	20,000	0		20,000	Office	0	0
Subtotal			20,000	0	0	20,000		0	0
Grand Avenue Commercial									
I	Office Space, Classroom	2025-2030	85,000	0		85,000	Office/Library	0	0
Subtotal			85,000	0	0	85,000		0	0
Rocky Mountain									
J	Office Space, Classroom	2025-2030	26,327	0		26,327	Office/Library	0	0
Subtotal			26,327	0	0	26,327		0	0
West Summit View									
K	250 Beds for Housing	2025-2030	185,822	0		185,822	Office/Library	0	0
Subtotal			185,822	0	0	185,822		0	0
East Summit View									
L	250 Beds for Housing	2025-2030	119,739	0		119,739	Residence Hall	0	0
Subtotal			119,739	0	0	119,739		0	0
Armory									
M	Service and Maintenance	POST 2030	0	0			Service/Grounds Facility	0	0
Subtotal			0	0	0	0		0	0
SHEET SUBTOTAL PROJECTED			2,068,377	1,556,502	10,000	539,888		2,283	1,582

Table III-C-5

(1)	(2)	(3)	(4)	(4A)	(4B)	(4C)	(5)	(6)	(7)
Projected Core Campus Building Chilled Water Load Estimate									
Bldg #	Building Name	Outlook Year Built	Building Gross SF	CEP	Local Chiller	Evap. Cooling	Building Type	CEP Building Peak Load (Tons)	CEP Building Diversified Load (Tons)
0	<u>Undefined</u>								
Reserve 1	Office Space, Classroom	POST 2030	0	0			Office/Classroom/Laboratory (Light)	0	0
	Subtotal		FUTURE	0	0	0		0	0
	<u>Undefined</u>								
Reserve 2	Office Space, Classroom	POST 2030	0	0			Office/Classroom/Laboratory (Light)	0	0
	Subtotal		FUTURE	0	0	0		0	0
	<u>Undefined</u>								
Reserve 3	Office Space, Classroom	POST 2030	0	0			Office/Classroom/Laboratory (Light)	0	0
	Subtotal		FUTURE	0	0	0		0	0
	<u>Campus North West</u>								
Berry Building	Berry, Office Space, Academics	2011-2012	40,000	40,000	0	0	Office/Classroom	50	34
	Subtotal		40,000	40,000	0	0		50	34
	<u>Campus South West</u>								
Half Acre Addition	Half Acre Gymnasium	2012-2015	30,000	30,000	0	0	Gymnasium	55	38
	Subtotal		30,000	30,000	0	0		55	38
	<u>Campus East</u>								
Fine Arts Addition	Fine Arts Addition	2013-2015	111,374	111,374	0	0	Office	139	97
	Subtotal		111,374	111,374	0	0		139	97
	<u>Campus East</u>								
Child Care	Office Space	2020-2025	10,000	10,000	0	0	Office	13	9
	Subtotal		10,000	10,000	0	0		13	9
SHEET SUBTOTAL PROJECTED			80,000	191,374	0	0		266	178
TOTALS PROJECTED			2,032,259	1,747,876	10,000	539,988		2,539	1,760

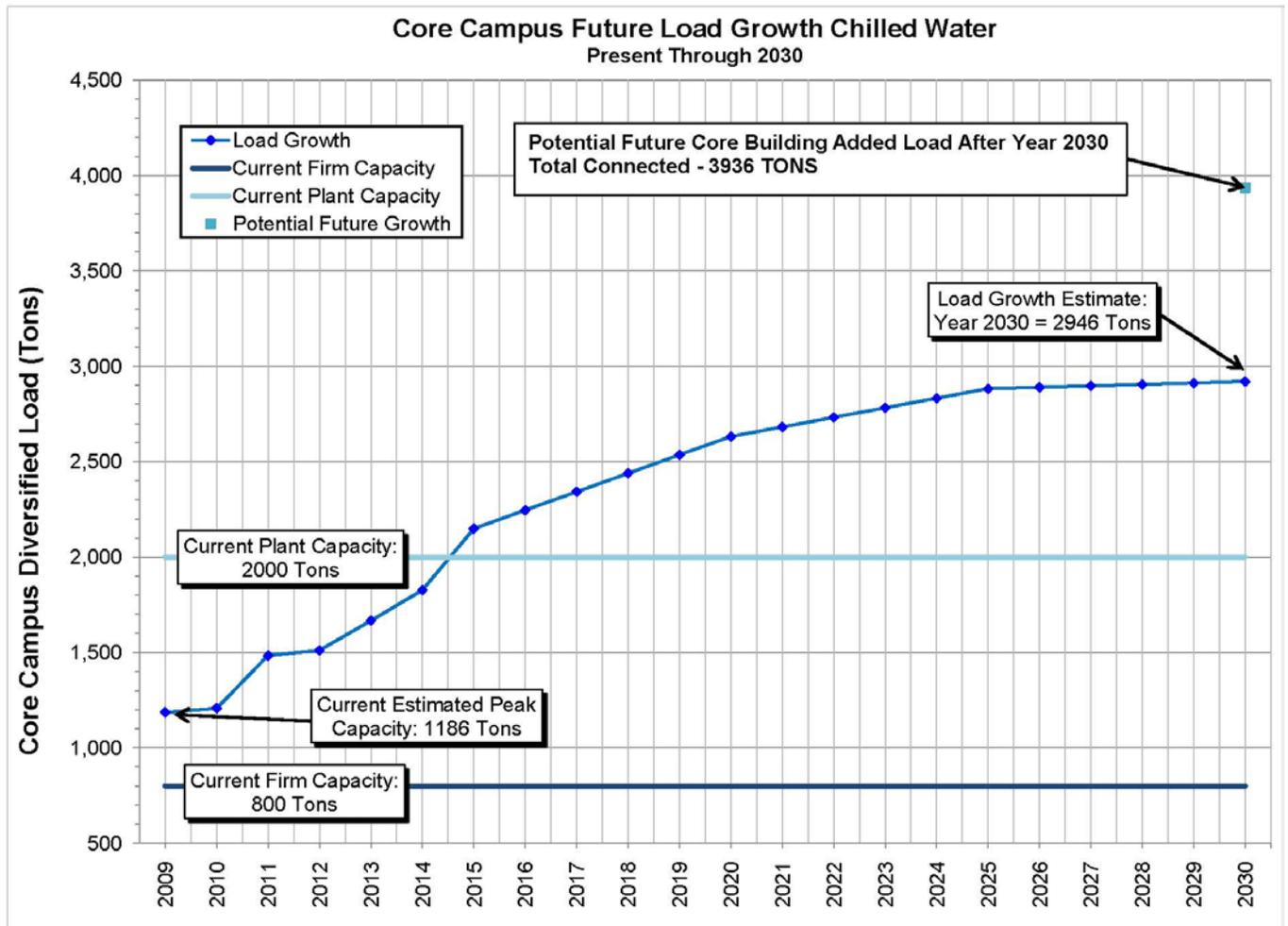
Table III-C-6

(1)	(2)	(3)	(4)	(4A)	(4B)	(4C)	(5)	(6)	(7)
Potential Existing Core Campus Building Chilled Water Load Addition Estimate									
Bldg #	Building Name	Outlook Year Built After Year	Building Gross SF	CEP	Local Chiller	Evap. Cooling	Building Type	CEP Building Peak Load (Tons)	CEP Building Diversified Load (Tons)
Northwest Campus									
1	Engineering (Petro/Aero)	2030	65,834	65,834			Office/Classroom/Laboratory (Light)	98	61
1	Engineering (Addition)	2030	185,136	185,136			Office/Classroom/Laboratory (Light)	274	173
22	Half Acre Gymnasium		112,906	33,872			Gymnasium/Pool	80	54
93	Bureau of Mines	2030	62,628	62,628			Office/Laboratory (Light)	102	69
2013&2014	Bee Lab		2,480				Office/Laboratory (Light)	0	0
Subtotal			428,984	347,470	0	0		554	357
North & Northeast Campus									
Subtotal			0	0	0	0		0	0
West & Southwest Campus									
18	Geology (Old)	2030	20,280	12,580			Office/Classroom	16	9
30	Aven Nelson	2030	32,832	32,832			Office/Classroom	41	23
31	Old Main	2030	34,089	34,089			Office	43	25
39	Wyoming Union (Old 1-4)	2030	137,418	50,000			Student Center/Union	111	65
44	Knight Hall (Old)	2030	65,704	65,704			Office	82	48
44	Knight Hall (Addition)	2030	3,244	3,244			Office	4	2
50	Ross Hall	2030	90,665	90,665			Office/Food Service	148	87
Subtotal			384,232	289,114	0	0		445	260
East Campus									
78	Fine Arts		175,598	129,016			Office/Classroom/Auditorium	189	85
79	Corbett Physical Education		83,646	83,646			Office/Classroom/Gymnasium/Pool	137	85
Subtotal			259,244	212,662	0	0		325	169
King Row									
41	Crane Hill Cafeteria	2030	49,622	49,622			Food Service	117	69
52	White Hall	2030	132,054	132,054			Residence Hall	230	135
Subtotal			181,676	181,676	0	0		346	204
Sorority Row									
Subtotal			0	0	0	0		0	0
Fraternity Row									
Subtotal			0	0	0	0		0	0
Athletics Campus									
Subtotal			0	0	0	0		0	0
TOTALS POTENTIAL EXISTING ADDITION			1,254,136	1,030,922	0	0		1,670	990

Table III-C-7

(1)	(4)	(4A)	(4B)	(4C)	(6)	(7)
Core Campus Chilled Water Load Estimate Summary						
	Building Gross SF	Area Cooled By CEP	Local Chiller	Evap. Cooling	CEP Campus Peak Load (Tons)	CEP Campus Diversified Load (Tons)
TOTAL EXISTING	5,177,855	1,314,561	0	0	1,978	1,186
TOTAL PROJECTED	2,032,259	1,747,876	10,000	539,888	2,539	1,760
TOTAL POTENTIAL EXISTING ADDITION	1,254,136	1,030,922	0	0	1,670	990
TOTAL EXISTING AND PROJECTED	7,210,114	3,062,437	10,000	539,888	4,517	2,946
TOTAL FUTURE	8,464,250	4,093,359	10,000	539,888	6,187	3,936

Figure III-C-1



2. Distribution Evaluation

The chilled distribution system was evaluated based on its physical condition and flow capacity limitations. The physical condition was evaluated by gathering information from the UW regarding the age of the direct buried piping. The information regarding age of the pipe is located in Section II, Existing Conditions. The flow capacity limitations were evaluated by using flow modeling software. The results of the flow modeling with current building loads are located in Section II, Existing Conditions. The results of the flow modeling with future building loads are located below.

Fluid modeling was performed for build-outs of the campus. The campus was modeled for build-out through year 2015 and again through year 2030. One model was developed for the build-out through year 2015. Two models were developed for the build-out through year 2030, including a model with only the CEP serving the cooling loads and another model with the CEP and a new chiller plant on the west side of campus serving the cooling loads. The following is a discussion of the development of the models.

Initially, the future loads through Year 2015 were connected to the existing chilled water mains and all of the pumping was provided by pumps located in the CEP, sized for the future flow. This model is illustrated in Drawing III-C-2-1a of Appendix III-C. The pump head was input to match the existing loads to verify if the existing pump head was adequate to reach the far west end of campus with the additional loads and branch piping through Year 2015. The results indicated that the head provided currently should be adequate to serve the system through Year 2015. The head rating on the existing pumps is slightly less than what the model indicated would be needed, however our estimates for pressure drop at each building is conservative. The model results also indicated the pipe diameter of the chilled water mains would be adequate for the flow. Chilled water pipes are typically sized to not exceed 10 feet per second (fps) and the model indicated the velocity in some of the pipe mains did not even reach 8 fps. The complete pipe data results are provided in Figure III-C-2-1b in Appendix III-C.

The next model was developed to show the results of continuing to serve the future chilled water loads through Year 2030 from the CEP with the existing distribution piping and pumps. The model is illustrated in Drawing III-C-2-1c of Appendix III-C. The results indicated the existing distribution piping and pumps are not sufficient. The velocity in some of the piping mains is in excess of 11.5 fps. The pump head required is in excess of 200 ft while the existing CEP pumps are only rated for 160 ft. The complete pipe data results are provided in Figure III-C-2-1d in Appendix III-C.

Another model, which is illustrated in Drawing III-C-2-1e of Appendix III-C, was developed to add a new chilled water plant on the west side of campus to supplement the plant at the CEP for the loads added from year 2015 to year 2030. It consisted of 1,600 tons of cooling and associated pumps capable of producing the same head as the pumps at the CEP. This model indicated the pump head selected for the new plant would be adequate and this plant would allow the velocity in the existing chilled water to be maintained at 10 fps or less. The new plant would make it possible to continue operating the existing pumps at the CEP. The complete pipe data results are provided in Figure III-C-2-1f in Appendix III-C.

The following conclusions were made regarding the future expansion of the existing chilled water distribution system to accommodate future loads.

The flow model indicated the existing piping did not have any limitations with the existing loads and would accommodate additional building loads. The distribution piping and pump head also should be adequate for the additional loads through year 2015. However, after year 2015, expansion of the current chilled water system will be necessary. One option would be to add all the extra chiller capacity to the CEP, replace the pumps at the CEP, and replace chilled water piping mains or install parallel mains to boost capacity. A second option would be to construct a new 1,600 ton chilled water plant on the west side of campus to serve the loads on that side of the campus and only add the remainder of the needed chiller

capacity to the CEP to continue using pumps with the same rated head as provided now.

This would reduce the flow and velocity in the existing pipes. This solution would require adding some distribution piping to the existing system which is outlined in Drawing III-C-2-2 in Appendix III-C. The chilled water production would also continue at the CEP to serve the loads on the east side of the main campus. Table III-C-8 is also provided to illustrate cost for the expansion of the distribution system through 2030 in current dollars.

3. Summary

The CEP chilled water system is currently below recommended firm capacity. The plant can however accommodate campus loads in full if all equipment is operating and in part if any portion of the system fails. Plant full load capacity appears to exceed projected growth around year 2015 when the plant overall capacity is exceeded. Considerations will need to be evaluated around this timeframe to add capacity through additional equipment and or reduce capacity through revised operations. Preliminary evaluations are included within Section IV, Part D.

The existing chilled water distribution system accommodates the current loads, and can accommodate additional loads in the future. The system does reach a point where its limits are exceeded during the 20 year growth period which would require replacement of existing infrastructure and potentially equipment that was installed new in year 2008. The options evaluated in Section IV, Part D address capacity and distribution deficiencies.

The recommended options along with projected growth utility corridor locations are shown on Drawing III-C-2-2 of Appendix III-C.

Estimates for each utility corridor installation are provided in Table III-C-8 as present value dollars. Each option and estimate is preliminary and values are recommended to be evaluated in detail at the time of installation.

Table III-C-8

Table III-C-8 Chilled Water Distribution System Expansion Estimate									
Description of Items	Quantity	Unit	Ductile Iron Unit Cost	Ductile Iron Total Cost	HDPE Unit Cost	HDPE Total Cost	SCH. 80 PVC Unit Cost	SCH. 80 PVC Total Cost	
System Sizes and Configuration									
Construction Period 2010-2015									
Chilled Water - Ductile Iron									
Direct Buried w/ 10" CHW Piping, Pipe Wrap, Bedding & Backfill (Underneath Lewis Street to Development Area A)	1515	If	\$550	\$833,250	\$520	\$787,800	\$700	\$1,060,500	
Direct Buried w/ 8" CHW Piping, Pipe Wrap, Bedding & Backfill (Extension of Piping, North of Information Technology)	80	If	\$525	\$42,000	\$500	\$40,000	\$610	\$48,800	
Direct Buried w/ 6" CHW Piping, Pipe Wrap, Bedding & Backfill (Branch Connection to Crane Hill Hall)	300	If	\$500	\$150,000	\$485	\$145,500	\$555	\$166,500	
Direct Buried w/ 6" CHW Piping, Pipe Wrap, Bedding & Backfill (Branch Connection from Centennial Complex to Visual Arts)	410	If	\$500	\$205,000	\$485	\$198,850	\$555	\$227,550	
System Allowances									
1% Connect to Existing Systems Allowance	4	Is	\$12,300	\$49,200	\$11,700	\$46,800	\$15,000	\$60,000	
7% Fitting Allowance	1	Is	\$86,100	\$86,100	\$82,100	\$82,100	\$105,200	\$105,200	
Total 2010-2015									
						\$2,082,691	\$1,984,323		
System Sizes and Configuration									
Construction Period 2015-2020									
Chilled Water - Ductile Iron									
700	\$1,085,000	Direct Buried w/ 10" CHW Piping, Pipe Wrap, Bedding & Backfill (From Lewis Street Alcove, North to Development Area A)	1550	If	\$550	\$852,500	\$520	\$806,000	\$
610	\$158,600	Direct Buried w/ 8" CHW Piping, Pipe Wrap, Bedding & Backfill (Extension of Utility Tunnel, South of Wyoming Technology Business Center)	280	If	\$525	\$136,500	\$500	\$130,000	\$
555	\$244,200	Direct Buried w/ 6" CHW Piping, Pipe Wrap, Bedding & Backfill (From CEP to Development Area C)	440	If	\$500	\$220,000	\$485	\$213,400	\$
490	\$183,750	Direct Buried w/ 4" CHW Piping, Pipe Wrap, Bedding & Backfill (From new Utility Tunnel, South of Wyoming Technology Business Center, to Development Area F)	375	If	\$465	\$174,375	\$450	\$168,750	\$
System Allowances									
700	\$66,800	1% Connect to Existing Systems Allowance	4	Is	\$13,800	\$55,200	\$13,200	\$52,800	\$16,
000	\$117,000	7% Fitting Allowance	1	Is	\$96,800	\$96,800	\$92,300	\$92,300	\$117,
100	\$50,100	3% Valve Allowance	1	Is	\$41,500	\$41,500	\$39,500	\$39,500	\$50,
Total 2015-2020									
						\$2,341,630	\$2,341,630		

D. Compressed Air System

1. Current and Annual Load Growth and Consumption Profiles

The UW does not currently incorporate individual building metering to determine compressed air consumption and peaks. The existing building loads were developed by comparison to a database of similar building types and their historic peak and diversified load values. The diversified loads were then adjusted to reflect the peak compressed air output generated by the compressors located at the Engineering Building and the CEP.

The peak loads were developed from existing building gross sq ft (GSF) numbers provided by the UW which were then applied to load density values per building function (classroom, residence hall, research lab, etc.). The loads were next diversified according to building function. For example, based on how the buildings operate, research labs are not heavily diversified (diversity of $\pm 90\%$) while libraries and museums are on the other end of the spectrum (diversity of 60% to 70%). These diversity factors were then applied across the campus facilities to develop the total compressed air output at the Engineering Building. Table III-D-1 indicates the load densities and diversities selected for use on the campus based on building function. These values were then applied to each campus building to develop the values illustrated in Table III-D-2 and III-D-3.

The future projected and potential loads were developed using the same methodology and are shown in Table III-D-4 and III-D-5.

A summary of the load totals is illustrated in Table III-D-6. To further represent the existing load in combination with the projected loads the values defined above were then included graphically in Figure III-D-1. The figure also shows the development in relation to the firm and overall compressed air capacity of the campus for non adjusted and adjusted projections. The adjusted of the compressed air utilized on campus due to Control upgrades and reductions of pneumatics on campus.

Table III-D-2 through DB-6 identifies a column number that are in relation to the information below and where this information was generated from.

1. Building Numbers: Provided by the UW.
2. Building Name: Provided by the UW.
3. Year Built: Provide by the UW.
4. Building Gross Square Foot: Provided by the UW.
5. Building Type: Assumed per Building Type and per UW input.
6. Building Peak Loads: Based on building type in comparison to Table III-D-1 historic load data.
7. Building Diversified Loads: Based on building type in comparison to Table III-D-1 historic load data and adjusted to approximate peak campus capacity.

Table III-D-1

LOAD AND DIVERSITY FACTORS BY BUILDING TYPE (LARGE PLANTS)				
Building Type	Building Gross SCFM/SF	Air Use Diversity	Compressed Air Density Building	
			Diversified SCFM/GSF	Future Building
Agricultural/Greenhouse	0.00014	0.60	0.000084	0
Greenhouse/Laboratory (Light)	0.00013	0.75	0.000098	0
Animal / Veterinary	0.00005	0.70	0.000035	0.00000875
Art Studio	0.00009	0.78	0.000066	0
Auditorium	0.00006	0.25	0.000015	0
Classroom	0.00005	0.65	0.000033	0
Classroom/Library	0.00006	0.65	0.000036	0
Clinic	0.00007	0.68	0.000044	0.0000132
Data Center	0.00012	0.90	0.000108	0
Food Service	0.00014	0.70	0.000098	0
Greek Residence Housing	0.00014	0.70	0.000098	0
Gymnasium	0.00003	0.70	0.000021	0
Gymnasium w/ Spectators	0.00006	0.70	0.000042	0
Gymnasium/Pool	0.00009	0.80	0.000068	0.000034
Hotel	0.00014	0.70	0.000098	0
Laboratory (Light)	0.00012	0.90	0.000108	0.000027
Laboratory (Medium)	0.00014	0.90	0.000126	0.0000378
Laboratory (Heavy)	0.00014	0.90	0.000126	0.0000441
Library	0.00006	0.65	0.000039	0
Museum	0.00006	0.60	0.000036	0
Museum/Office	0.00007	0.65	0.000046	0
Office	0.00008	0.70	0.000056	0
Office/Classroom	0.00007	0.68	0.000044	0
Office/Classroom/Auditorium	0.00006	0.53	0.000034	0
Office/Classroom/Clinic	0.00007	0.68	0.000044	0
Office/Classroom/Gymnasium/Pool	0.00008	0.74	0.000055	0
Office/Classroom/Laboratory (Light)	0.00008	0.75	0.000063	0.0000156
Office/Classroom/Laboratory (Medium)	0.00009	0.75	0.000068	0.0000203
Office/Classroom/Library	0.00006	0.67	0.000042	0
Office/Clinical	0.00006	0.73	0.000044	0
Office/Data Center	0.00010	0.80	0.000080	0
Office/Food Service	0.00011	0.70	0.000077	0
Office/Laboratory (Light)	0.00010	0.80	0.000080	0.0000200
Office/Library	0.00007	0.68	0.000047	0
Office/Sports Training	0.00007	0.70	0.000046	0
Pool	0.00014	0.90	0.000126	0.000063
Residence Hall	0.00014	0.70	0.000098	0
Service/Grounds Facility	0.00003	0.70	0.000021	0
Sports Training	0.00005	0.70	0.000035	0
Sports Arena	0.00006	0.25	0.000015	0
Sports Arena - Outdoor	0.00005	0.25	0.000013	0
Student Center/Union	0.00014	0.70	0.000098	0

Table III-D-2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Existing Core Campus Building Compressed Air Load Estimate							
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Peak Load (SCFM)	Building Diversified Load (SCFM)	Future Loading
Northwest Campus							
1	Engineering (Old)	1927	80,010	Office/Classroom/Laboratory (Light)	6.7	5.0	1.3
1	Engineering (Petro/Aero)	1959	65,834	Office/Classroom/Laboratory (Light)	5.5	4.1	1.0
1	Engineering (Addition)	1983	185,136	Office/Classroom/Laboratory (Light)	15.4	11.6	2.9
2	Ag C (Old)	1949	107,053	Classroom	5.4	3.5	0.0
2	Ag C (Addition)	1982	114,726	Office/Classroom/Laboratory (Light)	9.6	7.2	1.8
3	Ag A	1949	29,291	Classroom/Library	1.6	1.0	0.0
4 & 5	Ag B & D	1949	8,980	Office/Laboratory (Light)	0.0	0.0	0.2
6	Vocational Education	1966	27,840	Office/Classroom	0.0	0.0	0.0
14	Education	1950	123,674	Classroom/Library	6.8	4.4	0.0
19	McWhinnie Hall	1928	26,625	Office	2.1	1.5	0.0
22	Half Acre Gymnasium	1925	112,906	Gymnasium/Pool	9.6	7.7	3.8
22	Half Acre (Raquetball Courts)	1980	6,400	Gymnasium	0.2	0.1	0.0
25	Anthropology	2007	52,499	Office/Classroom	0.0	0.0	0.0
36	Service Building (Old)	1954	9,211	Service/Grounds Facility	0.0	0.0	0.0
36	Service Building (Auto)	1960	57,592	Service/Grounds Facility	0.0	0.0	0.0
36	Service Building (Shops)	1956	14,465	Service/Grounds Facility	0.0	0.0	0.0
38	Wyoming Hall	1950	69,579	Office	5.6	3.9	0.0
91	Earth Sciences	1985	65,000	Office/Classroom/Laboratory (Light)	5.4	4.1	1.0
93	Bureau of Mines	1950	62,628	Office/Laboratory (Light)	6.3	5.0	1.3
2013&2014	Bee Lab	1956	2,480	Office/Laboratory (Light)	0.0	0.0	0.0
Subtotal			1,221,929		80	59	13
North & Northeast Campus							
80	Animal Science/Molecular Biology	1985	93,631	Office/Classroom/Laboratory (Light)	7.8	5.9	1.5
90	Central Energy Plant	1982	57,803	Service/Grounds Facility	0.0	0.0	0.0
111	Regulated Materials Management Center	1993	19,000	Office	0.0	0.0	0.0
125	Centennial Complex	1983	126,200	Museum/Office	8.8	5.7	0.0
150	WY Tech Business Center	2007	31,000	Office/Data Center	0.0	0.0	0.0
Subtotal			327,634		17	12	1
West & Southwest Campus							
7	Arts & Sciences	1934	66,186	Office/Classroom/Auditorium	4.2	2.2	0.0
9	Biological Sciences	1969	205,350	Office/Classroom/Laboratory (Light)	17.1	12.8	3.2
11	Health Sciences (Old Biochemistry)	1914	42,951	Office/Classroom/Laboratory (Light)	3.6	2.7	0.7
12	Classroom	1968	78,836	Classroom	3.9	2.8	0.0
12	Classroom (Addition)	2007	17,225	Classroom	0.9	0.6	0.0
13	College of Business	1960	62,000	Office/Classroom	4.0	2.7	0.0
18	Geology (Old)	1902	20,280	Office/Classroom	1.3	0.9	0.0
18	Geology (Addition)	1956	37,491	Office/Classroom/Library	2.4	1.8	0.0
23	Student Health	1960	30,513	Office/Classroom/Clinic	2.0	1.3	0.0
23	Student Health (Addition)	2008	1,500	Office/Classroom	0.1	0.1	0.0
24	Hoyt Hall	1916	29,939	Office/Classroom	1.9	1.3	0.0
26	Coe Library (Am Studies)	1958	119,390	Library	7.2	4.7	0.0
26	Coe Library (Addition)	1978	85,676	Library	5.1	3.3	0.0
27	Merica Hall	1908	17,651	Office	1.4	1.0	0.0
30	Aven Nelson	1924	32,832	Office/Classroom	2.1	1.4	0.0
31	Old Main	1887	34,089	Office	2.7	1.9	0.0
32	Pharmacy	1969	52,397	Office/Classroom/Laboratory (Light)	4.4	3.3	0.8
32	Health Sciences (Biochem & Pharm Add.)	2005	29,000	Office/Classroom/Laboratory (Light)	2.4	1.8	0.5
33	Physical Sciences	1968	179,777	Office/Classroom/Laboratory (Medium)	16.2	12.1	3.6
39	Wyoming Union (Old+79 addn)	1939	137,418	Student Center/Union	19.2	13.5	0.0
39	Wyoming Union (Addition)	2001	25,000	Student Center/Union	3.5	2.5	0.0
44	Knight Hall (Old)	1941	65,704	Office	5.3	3.7	0.0
44	Knight Hall (Food Service)	1950	12,723	Office	1.0	0.7	0.0
44	Knight Hall (Addition)	1946	3,244	Office	0.3	0.2	0.0
50	Ross Hall	1960	90,665	Office/Food Service	10.0	7.0	0.0
82	Williams Conservatory	1994	8,633	Greenhouse/Laboratory (Light)	0.0	0.0	0.0
84	Iverson Hospital	1939	46,902	Office/Data Center	4.7	3.8	0.0
920	Geo Survey Building	1975	23,171	Office	0.0	0.0	0.0
Subtotal			1,556,543		127	90	9
SHEET SUBTOTAL EXISTING			3,106,106		224	160	24

Table III-D-3

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Existing Core Campus Building Compressed Air Load Estimate							
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Peak Load (SCFM)	Building Diversified Load (SCFM)	Future Loading
East Campus							
21	Campus Greenhouse	1961	5,737	Agricultural/Greenhouse	0.0	0.0	0.0
84	Information Technology	2008	84,241	Office/Data Center	0.0	0.0	0.0
77	Law School	1977	48,463	Office/Classroom	3.2	2.1	0.0
77	Law Library (Addition)	1983	17,000	Classroom	0.9	0.6	0.0
78	Fine Arts	1972	175,598	Office/Classroom/Auditorium	11.1	5.9	0.0
78	Fine Arts (Addition)	1999	5,000	Art Studio	0.4	0.3	0.0
79	Corbett Physical Education	1975	83,646	Office/Classroom/Gymnasium/Pool	6.3	4.6	0.0
123 & 124	Wainwright/Willett Bungalows	1950	3,500	Art studio	0.3	0.2	0.0
Subtotal			423,185		22	14	0
King Row							
40	Crane Hall	1962	88,935	Residence Hall	12.5	8.7	0.0
41	Crane Hill Cafeteria	1962	49,622	Food Service	6.9	4.9	0.0
42	Downey Hall	1965	85,361	Residence Hall	12.0	8.4	0.0
43	Hill Hall	1962	88,935	Residence Hall	12.5	8.7	0.0
46	McIntyre Hall	1966	132,226	Residence Hall	18.5	13.0	0.0
48	Orr Hall	1966	85,361	Residence Hall	12.0	8.4	0.0
51	Washakie Center (Old)	1966	70,937	Food Service	9.9	7.0	0.0
51	Washakie Center (Addition)	2004	10,579	Food Service	1.5	1.0	0.0
52	White Hall	1967	132,054	Residence Hall	18.5	12.9	0.0
Subtotal			744,010		104	73	0
Sorority Row							
58	Sigma Phi Epsilon House	1952	16,634	Residence Hall	0.0	0.0	0.0
908	Pi Kappa Alpha	1983	16,750	Greek Residence Housing	0.0	0.0	0.0
909	Delta Delta Delta	1941	13,552	Greek Residence Housing	0.0	0.0	0.0
910	Chi Omega	1954	8,454	Greek Residence Housing	0.0	0.0	0.0
911	Kappa Kappa Gamma	1941	20,082	Greek Residence Housing	0.0	0.0	0.0
912	Pi Beta Phi (Old)	1949	12,395	Greek Residence Housing	0.0	0.0	0.0
912	Pi Beta Phi (Addition)	1994	3,363	Greek Residence Housing	0.0	0.0	0.0
Subtotal			91,230		0	0	0
Fraternity Row							
55	Honors House	1939	9,031	Residence Hall	0.0	0.0	0.0
61	Beta House	1966	12,567	Office/Classroom	0.8	0.6	0.0
902	Alpha Tau Omega	1957	9,154	Greek Residence Housing	0.0	0.0	0.0
904	HSL	1957	5,247	Residence Hall	0.0	0.0	0.0
905	Sigma Alpha Epsilon	1956	10,557	Greek Residence Housing	0.0	0.0	0.0
906	Sigma Chi	1957	10,881	Greek Residence Housing	0.0	0.0	0.0
907	Sigma Nu	1960	10,226	Greek Residence Housing	0.0	0.0	0.0
Subtotal			67,663		1	1	0
Athletics Campus							
16	Fieldhouse	1951	195,855	Gymnasium w/ Spectators	11.8	8.2	0.0
17	Fieldhouse North Addition	1984	71,694	Office	0.0	0.0	0.0
73	Rochele Athletics Center	2001	47,450	Office/Sports Training	3.1	2.2	0.0
74	Indoor Practice Facility	2007	83,759	Sports Training	0.0	0.0	0.0
89	Arena Auditorium	1982	260,990	Sports Arena	15.7	3.9	0.0
Subtotal			659,748		30	14	0
Current Additions							
26	Information Library & Learning Center (ILLC)	2009	85,913	Office/Library	0.0	0.0	0.0
Subtotal			85,913		0	0	0
SHEET SUBTOTAL EXISTING			2,071,749		158	102	0
TOTALS EXISTING			5,177,855		381	262	24

Table III-D-4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)
Projected Core Campus Building Compressed Air Load Estimate							
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	Building Peak Load (SCFM)	Building Diversified Load (SCFM)	Building Diversified Load (SCFM)
Immediate Future Additions							
13	College of Business Addition	2010	103,000	Office/Classroom	6.7	4.5	0.0
77	Law - Moot Court Addition	2010	24,000	Classroom	1.2	0.8	0.0
Subtotal			127,000		8	5	0
North of Lewis							
A	School of Energy Resources	2011-2015	40,000	Office/Classroom/Laboratory (Light)	3.3	2.5	0.6
A	Science Teaching Lab Facility	2011-2015	100,000	Office/Classroom/Laboratory (Medium)	9.0	6.8	2.0
A	Long Term Development	2015-2020	315,000	Office/Classroom	20.5	13.8	0.0
A	Long Term Development	2020-2025	100,000	Office/Classroom	6.5	4.4	0.0
Subtotal			555,000		39	27	3
South of Ivinson							
B	Foundation House	2011-2015	10,000	Office/Classroom	0.7	0.4	0.0
B	Long Term Development	2020-2025	130,000	Office/Classroom	8.5	5.7	0.0
Subtotal			140,000		9	6	0
Service & Maintenance							
C	Service and Maintenance	2015-2020	151,997	Service/Grounds Facility	4.6	3.2	0.0
Subtotal			151,997		5	3	0
West Willett							
D	Surface Parking	2010-2030	0	Office/Classroom/Auditorium	0.0	0.0	0.0
Subtotal			0		0	0	0
Crane-Hill							
E	Crane Hill Demo and Rebuild of 250 Beds	2011-2015	227,492	Residence Hall	31.8	22.3	0.0
Subtotal			0		32	22	0
Research/Business							
F	Business Incubator	2015-2020	30,000	Office/Classroom/Laboratory (Light)	2.5	1.9	0.5
Subtotal			30,000		3	2	0
East Campus Academic							
G	Animal Science	2020-2025	200,000	Office/Classroom/Laboratory (Light)	16.7	12.5	3.1
G	Addition to CC	2015-2020	30,000	Museum/Office	2.1	1.4	0.0
G	Visual Arts East of CCC	2011-2015	80,000	Office/Classroom/Auditorium	5.1	2.7	0.0
G	Long Term Development	2025-2030	90,000	Office/Classroom	5.9	3.9	0.0
Subtotal			400,000		30	21	3
Stadium Parking Lot							
H	Stadium Suites	2011-2012	20,000	Office	1.6	1.1	0.0
Subtotal			20,000		2	1	0
Grand Avenue Commercial							
I	Office Space, Classroom	2025-2030	85,000	Office/Library	6.0	4.0	0.0
Subtotal			85,000		6	4	0
Rocky Mountain							
J	Office Space, Classroom	2025-2030	26,327	Office/Library	1.8	1.2	0.0
Subtotal			26,327		2	1	0
West Summit View							
K	250 Beds for Housing	2025-2030	185,822	Office/Library	13.0	8.8	0.0
Subtotal			185,822		13	9	0
East Summit View							
L	250 Beds for Housing	2025-2030	119,739	Residence Hall	16.8	11.7	0.0
Subtotal			119,739		17	12	0
Armory							
M	Service and Maintenance	POST 2030	0	Service/Grounds Facility	0.0	0.0	0.0
Subtotal			0		0	0	0
SHEET SUBTOTAL PROJECTED			1,840,885		164	114	6

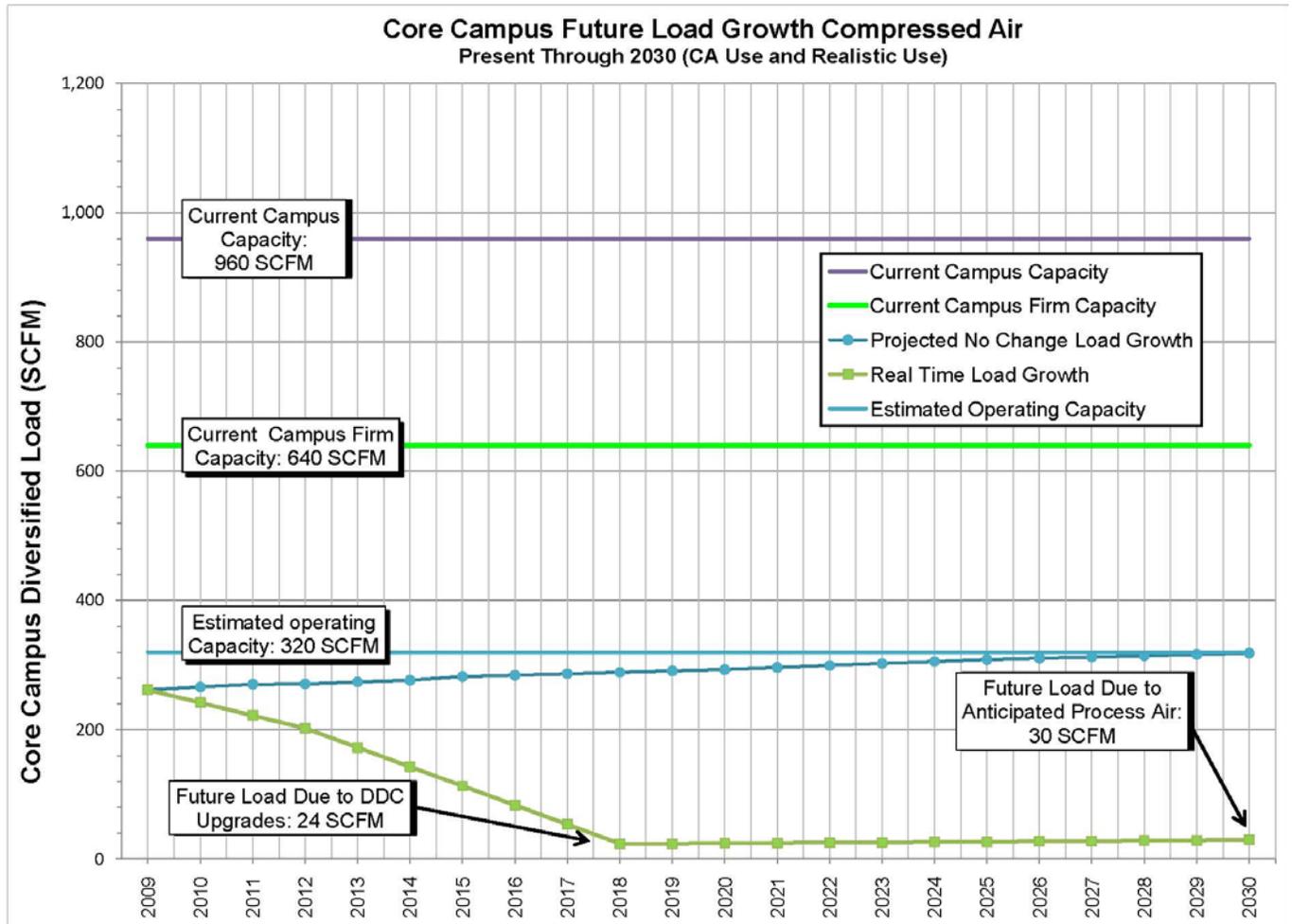
Table III-D-5

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)
Projected Core Campus Building Compressed Air Load Estimate							
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	Building Peak Load (SCFM)	Building Diversified Load (SCFM)	Building Diversified Load (SCFM)
0	<u>Undefined</u>						
Reserve 1	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0	0.0	0.0
	Subtotal		FUTURE		0	0	0
	<u>Undefined</u>						
Reserve 2	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0	0.0	0.0
	Subtotal		FUTURE		0	0	0
	<u>Undefined</u>						
Reserve 3	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0	0.0	0.0
	Subtotal		FUTURE		0	0	0
	<u>Campus North West</u>						
Berry Building	Berry, Office Space, Academics	2011-2012	40,000	Office/Classroom	2.6	1.8	0.0
	Subtotal		40,000		3	2	0
	<u>Campus South West</u>						
Half Acre Addition	Half Acre Gymnasium	2012-2015	30,000	Gymnasium	0.9	0.6	0.0
	Subtotal		30,000		1	1	0
	<u>Campus East</u>						
Child Care	Office Space	2020-2025	10,000	Office	0.8	0.6	0.0
	Subtotal		10,000		1	1	0
SHEET SUBTOTAL PROJECTED			80,000		4	3	0
TOTALS PROJECTED			2,032,259		168	117	6

Table III-D-6

(1)	(4)	(6)	(7)	(7)
Core Campus Compressed Air Load Estimate Summary				
	Building Gross SF	Campus Peak Load (SCFM)	Campus Diversified Load (SCFM)	Campus Diversified Load (SCFM)
TOTAL EXISTING	5,177,855	381	262	24
TOTAL PROJECTED	2,032,259	168	117	6
TOTAL EXISTING AND PROJECTED	7,210,114	550	378	30

Figure III-D-1



2. Distribution Evaluation

The compressed air system was evaluated based on its physical condition and flow capacity limitations. The physical condition was evaluated by conducting a field survey of the UW utility tunnels and the flow capacity limitations were evaluated by using flow modeling software. The results of the physical condition and flow modeling are also located in Section II, Existing Conditions.

3. Summary

The flow model results with respect to current and future loads, indicate the existing compressed air utility is adequate to sustain the load growth of the campus as compressed air is typically comprised of pneumatic control use which is rapidly declining with the installation of new DDC control systems as well as renovation and revision of existing building pneumatics to DDC. Existing control air is assumed to be approximately 60-100% of each buildings control air pending the building use and potential process loads within the building.

Where compressed air is required for process use, utility corridors at the projects discretion will need to be evaluated to determine if appropriate towards the project economics.

E. Electrical System

1. Current and Annual Load Growth and Consumption Profiles

The UW does not currently incorporate extensive building metering to determine individual building electrical consumption and peaks. While some of the buildings on campus are equipped with electric revenue metering, the current building loads were developed using a database of load data from similar sized campuses for buildings of similar age and function.

The peak loads were developed from existing building gross sq ft (GSF) numbers provided by the UW which were then applied to load density values per building function (classroom, residence hall, research lab, etc.). The loads were next diversified according to building function. For example, based on how the buildings operate, research labs are not heavily diversified (diversity of $\pm 90\%$) while libraries and museums are on the other end of the spectrum (diversity of 60% to 70%). These diversity factors were then applied across the campus facilities to develop the total electric KW use. Table III-E-1 indicates the load densities and diversities selected for use on the campus based on building function. These values were applied to each campus building to develop the values illustrated in Table III-E-2 and III-E-3. These demands are estimated peak building demands which are not diversified from a campus perspective. Thus the estimated building and campus consumption values when are typically higher than that actually experienced on campus

The future projected and potential loads were developed using the same methodology and are shown in Table III-E-4, III-E-5. A summary of the load totals is illustrated in Table III-E-6.

Table III-E-2 through E-6 identifies a column number that are in relation to the information below and where this information was generated from.

1. Building Numbers: Provided by the UW.
2. Building Name: Provided by the UW.
3. Campus Feed: Provided by the UW
4. Year Built: Provide by the UW.
5. Building Gross Square Foot: Provided by the UW.
6. Building Type: Assumed per Building Type and per UW input.
7. Building Peak Loads: Based on building type in comparison to Table III-E-1 historic load data.
8. Building Diversified Loads: Based on building type in comparison to Table III-E-1 historic load data and adjusted to approximate peak campus capacity.

Table III-E-1

LOAD AND DIVERSITY FACTORS BY BUILDING TYPE			
Building Type	Building Gross W/SF	Electrical Usage	
		Electric Use Diversity	Building Diversified W/GSF
Agricultural/Greenhouse	3.0	0.60	1.8
Greenhouse/Laboratory (Light)	8.2	0.75	6.2
Animal / Veterinary	4.1	0.70	2.9
Art Studio	3.1	0.78	2.4
Auditorium	3.6	0.25	0.9
Classroom	2.8	0.65	1.8
Classroom/Library	4.3	0.65	2.8
Clinic	6.2	0.68	4.2
Data Center	9.5	0.90	8.6
Food Service	2.2	0.70	1.5
Greek Residence Housing	3.8	0.70	2.7
Gymnasium	3.5	0.70	2.5
Gymnasium w/ Spectators	5.0	0.70	3.5
Gymnasium/Pool	4.9	0.80	3.9
Hotel	2.4	0.70	1.7
Laboratory (Light)	4.6	0.90	4.1
Laboratory (Medium)	6.2	0.90	5.6
Laboratory (Heavy)	12.0	0.90	10.8
Library	2.0	0.65	1.3
Museum	3.0	0.60	1.8
Museum/Office	4.0	0.65	2.6
Office	5.0	0.70	3.5
Office/Classroom	4.3	0.68	2.9
Office/Classroom/Auditorium	4.3	0.53	2.3
Office/Classroom/Clinic	3.9	0.68	2.6
Office/Classroom/Gymnasium/Pool	4.4	0.74	3.2
Office/Classroom/Laboratory (Light)	4.9	0.75	3.7
Office/Classroom/Laboratory (Medium)	3.5	0.75	2.7
Office/Classroom/Library	4.6	0.67	3.1
Office/Clinical	4.1	0.73	3.0
Office/Data Center	5.6	0.80	4.5
Office/Food Service	5.6	0.70	3.9
Office/Laboratory (Light)	4.8	0.80	3.8
Office/Library	3.5	0.68	2.4
Office/Sports Training	4.8	0.70	3.4
Pool	6.2	0.90	5.6
Residence Hall	2.2	0.70	1.5
Service/Grounds Facility	3.5	0.70	2.5
Sports Training	4.6	0.70	3.2
Sports Arena	3.0	0.25	0.8
Sports Arena - Outdoor	20.0	0.25	5.0
Student Center/Union	5.5	0.70	3.9

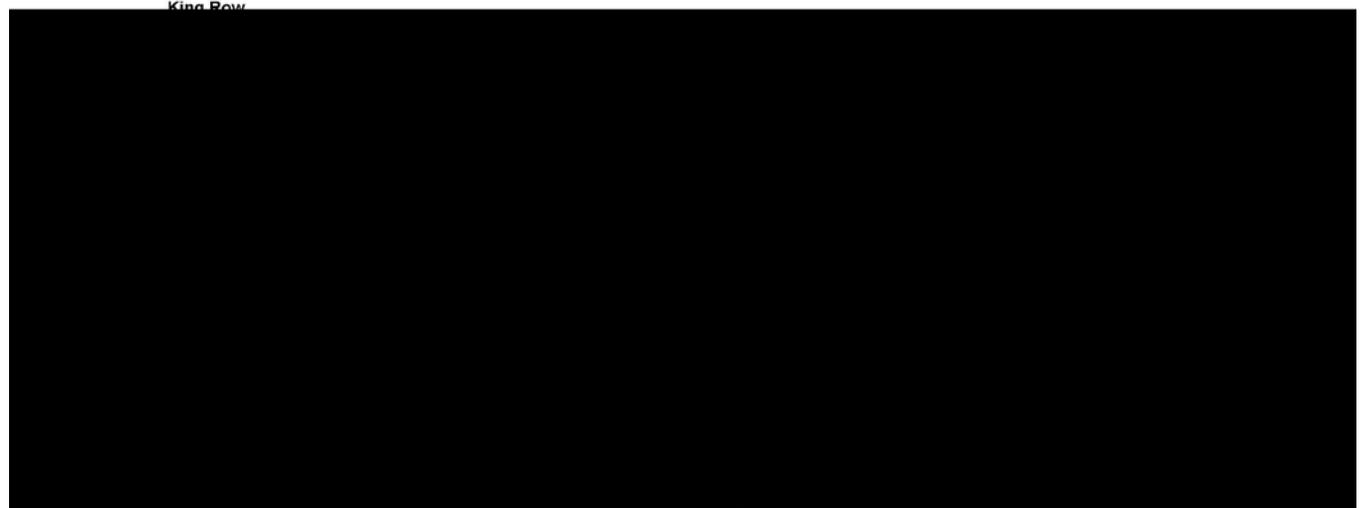
Table III-E-2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Existing Core Campus Building Electrical Load Estimate							
Bldg #	Building Name	Fed Bldg	Year Built	Building Gross SF	Building Type	Building Peak Load (kW)	Building Diversified Load (kW)
Northwest Campus							
1	Engineering (Old)	WCDS	1927	80,010	Office/Classroom/Laboratory (Light)	395	296
1	Engineering (Petro/Aero)	WCDS	1959	65,834	Office/Classroom/Laboratory (Light)	325	244
1	Engineering (Addition)	WCDS	1983	185,136	Office/Classroom/Laboratory (Light)	913	685
2	Ag C (Old)	WCDS	1949	107,053	Classroom	300	195
2	Ag C (Addition)	WCDS	1982	114,726	Office/Classroom/Laboratory (Light)	566	424
3	Ag A	WCDS	1949	29,291	Classroom/Library	126	82
4 & 5	Ag B & D	WCDS	1949	8,980	Office/Laboratory (Light)	43	34
6	Vocational Education	WCDS	1966	27,840	Office/Classroom	120	81
14	Education	WCDS	1950	123,674	Classroom/Library	532	346
19	McWhinnie Hall	WCDS	1928	26,625	Office	133	93
22	Half Acre Gymnasium	WCDS	1925	112,906	Gymnasium/Pool	548	438
22	Half Acre (Raquetball Courts)	WCDS	1980	6,400	Gymnasium	22	16
25	Anthropology	WCDS	2007	52,499	Office/Classroom	226	152
Service/Buildings							
	Service/Buildings Facility	32	23	36	Service Building (Old)	WCDS 1954	9,211
	Service/Buildings Facility	202	141	36	Service Building (Auto)	WCDS 1960	57,592
	Service/Buildings Facility	51	35	36	Service Building (Shops)	WCDS 1956	14,465
	Office	348	244	38	Wyoming Hall	WCDS 1950	69,579
	Office/Classroom/Laboratory (Light)	321	241	91	Earth Sciences	WCDS 1995	65,000
	Office/Laboratory (Light)	301	240	93	Bureau of Mines	WCDS 1950	62,628
	Office/Laboratory (Light)	12	10	2013&2014	Bee Lab	WCDS 1956	2,480
	5514	4019			Subtotal		1,221,929
WCDS = West Campus Distribution System							
North & Northeast Campus							
	Office/Classroom/Laboratory (Light)	462	346	80	Animal Science/Molecular Biology	ECDS 1985	93,631
	Service/Buildings Facility	202	142	90	Central Energy Plant	ECDS 1982	57,803
	Office	95	67	111	Regulated Materials Management Center	ECDS 1993	19,000
	Museum/Office	505	328	125	Centennial Complex	ECDS 1993	126,200
	Office/Data Center	174	139	150	WY Tech Business Center	ECDS 2007	31,000
	1438	1022			Subtotal		327,634
ECDS = East Campus Distribution System							
West & Southwest Campus							
	Office/Classroom/Auditorium	285	152	7	Arts & Sciences	WCDS 1934	66,186
	Office/Classroom/Laboratory (Light)	1013	760	9	Biological Sciences	WCDS 1969	205,350
	Office/Classroom/Laboratory (Light)	212	159	11	Health Sciences (Old Biochemistry)	WCDS 1914	42,951
	Classroom	221	143	12	Classroom	WCDS 1968	78,836
	Classroom	48	31	12	Classroom (Addition)	WCDS 2007	17,225
	Office/Classroom	267	180	13	College of Business	WCDS 1960	62,000
	Office/Classroom	87	59	18	Geology (Old)	WCDS 1902	20,280
	Office/Classroom/Library	172	114	18	Geology (Addition)	WCDS 1956	37,491
	Office/Classroom/Clinic	119	80	23	Student Health	WCDS 1960	30,513
	Office/Classroom	6	4	23	Student Health (Addition)	WCDS 2008	1,500

Table III-E-3

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Existing Core Campus Building Electrical Load Estimate							
Bldg #	Building Name	Fed By	Year Built	Building Gross SF	Building Type	Building Peak Load (kW)	Building Diversified Load (kW)
East Campus							
21	Campus Greenhouse	ECDS	1961	5,737	Agricultural/Greenhouse	17	10
64	Information Technology	ECDS	2008	84,241	Office/Data Center	472	377
77	Law School	ECDS	1977	48,463	Office/Classroom	208	141
77	Law Library (Addition)	ECDS	1993	17,000	Classroom	48	31
78	Fine Arts	ECDS	1972	175,598	Office/Classroom/Auditorium	755	403
78	Fine Arts (Addition)	ECDS	1999	5,000	Art Studio	16	12
79	Corbett Physical Education	ECDS	1975	83,646	Office/Classroom/Gymnasium/Pool	368	271
123 & 124	Wainwright/Willett Bungalows	ECDS	1950	3,500	Art studio	11	8
Subtotal				423,185		1894	1254

ECDS = East Campus Distribution System



King Row								
Bldg #	Building Name	Fed By	Year Built	Building Gross SF	Building Type	Building Peak Load (kW)	Building Diversified Load (kW)	
	Residence Hall		196	137	40	Crane Hall	ECDS 1962	88,935
	Food Service		109	76	41	Crane Hill Cafeteria	ECDS 1962	49,622
	Residence Hall		188	131	42	Downey Hall	ECDS 1965	85,361
	Residence Hall		196	137	43	Hill Hall	ECDS 1962	88,935
	Residence Hall		291	204	46	McIntyre Hall	ECDS 1966	132,226
	Residence Hall		188	131	48	Orr Hall	ECDS 1966	85,361
	Food Service		156	109	51	Washakie Center (Old)	ECDS 1966	70,937
	Food Service		23	16	51	Washakie Center (Addition)	ECDS 2004	10,579
	Residence Hall		291	203	52	White Hall	ECDS 1967	132,054
Subtotal				1637	1146	Subtotal		744,010

ECDS = East Campus Distribution System

Sorority Row								
Bldg #	Building Name	Fed By	Year Built	Building Gross SF	Building Type	Building Peak Load (kW)	Building Diversified Load (kW)	
	Residence Hall		37	26	56	Sigma Phi Epsilon House	ECDS 1952	16,634
	Greek Residence Housing		64	45	908	Pi Kappa Alpha	ECDS 1963	16,750
	Greek Residence Housing		51	36	909	Delta Delta Delta	ECDS 1941	13,552
	Greek Residence Housing		32	22	910	Chi Omega	ECDS 1954	8,454
	Greek Residence Housing		76	53	911	Kappa Kappa Gamma	ECDS 1941	20,082
	Greek Residence Housing		47	33	912	Pi Beta Phi (Old)	ECDS 1949	12,395
	Greek Residence Housing		13	9	912	Pi Beta Phi (Addition)	ECDS 1994	3,363
Subtotal				320	224	Subtotal		91,230

ECDS = East Campus Distribution System

Fraternity Row								
Bldg #	Building Name	Fed By	Year Built	Building Gross SF	Building Type	Building Peak Load (kW)	Building Diversified Load (kW)	
	Residence Hall		20	14	55	Honors House	ECDS 1939	9,031

Table III-E-4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Projected Core Campus Building Electrical Load Estimate							
Bldg #	Building Name	Fed By	Outlook Year Built	Building Gross SF	Building Type	Building Peak Load (kW)	Building Diversified Load (kW)
Immediate Future Additions							
13	College of Business Addition	WCDS	2010	103,000	Office/Classroom	443	299
77	Law - Moot Court Addition	ECDS	2010	24,000	Classroom	67	44
Subtotal				127,000		510	343
ECDS = East Campus Distribution System, WCDS = West Campus Distribution System							
North of Lewis							
A	School of Energy Resources	WCDS	2011-2015	40,000	Office/Classroom/Laboratory (Light)	197	148
A	Science Teaching Lab Facility	WCDS	2011-2015	100,000	Office/Classroom/Laboratory (Medium)	353	265
A	Long Term Development	WCDS	2015-2020	315,000	Office/Classroom	1355	914
A	Long Term Development	WCDS	2020-2025	100,000	Office/Classroom	430	290
Subtotal				555,000		2335	1618
WCDS = West Campus Distribution System							
South of Ivinson							
B	Foundation House	SF	2011-2015	10,000	Office/Classroom	43	29
B	Long Term Development	WCDS	2020-2025	130,000	Office/Classroom	559	377
Subtotal				140,000		602	406
WCDS = West Campus Distribution System, SF = Separately Fed							
Service & Maintenance							
	Service and Maintenance	WCDS	2015-2020	151,997	Service/Grounds Facility	532	372
Subtotal				151,997		532	372
WCDS = West Campus Distribution System							
West Willett							
	Surface Parking	NA	2010-2030	0	Office/Classroom/Auditorium	0	0
Subtotal				0		0	0
NA = Not Applicable							
Crane-Hill							
	Crane Hill Demo and Rebuild of 250 Beds	ECDS	2011-2015	227,492	Residence Hall	500	350
Subtotal				0		500	350
ECDS = East Campus Distribution System							
Research/Business							
	Business Incubator	ECDS	2015-2020	30,000	Office/Classroom/Laboratory (Light)	148	111
Subtotal				30,000		148	111
ECDS = East Campus Distribution System							
East Campus Academic							
	Animal Science	ECDS	2020-2025	200,000	Office/Classroom/Laboratory (Light)	987	740
	Addition to CC	ECDS	2015-2020	30,000	Museum/Office	120	78
	Visual Arts East of CCC	ECDS	2011-2015	80,000	Office/Classroom/Auditorium	344	183
	Long Term Development	ECDS	2025-2030	90,000	Office/Classroom	387	261
Subtotal				400,000		1838	1263
ECDS = East Campus Distribution System							
Stadium Parking Lot							
	Stadium Suites	ECDS	2011-2012	20,000	Office	100	70
Subtotal				20,000		100	70
ECDS = East Campus Distribution System							
Grand Avenue Commercial							

Table III-E-5

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Projected Core Campus Building Electrical Load Estimate							

Table III-E-6

--	--	--	--	--	--	--	--

2. General Overview

The loads served by the campus underground primary distribution system will continue to grow with the addition of facilities as the UW campus expands. The increase in load can be generalized as a linear relationship

consistent with previous load growth and building expansion. Growth rates can be considered in this manner due to the offset between increased electrical requirements and application of energy conserving technologies. Increases in load density in new buildings can be attributed to expansion of technical systems and increased HVAC loads to meet current building code requirements. For this reason, new buildings that replace existing facilities one-for-one need not be considered in providing for load growth in the distribution systems.

Using load densities (expressed in watts per sq ft values) and applying sq ft expansion values to programmed space expansion requirements, impact of load increase to the distribution systems can be predicted. While energy-saving practices and equipment help to reduce demand and usage for the newer and modified older facilities, the code-driven changes in building environmental systems (such building exhaust or air handling equipment) have resulted in a net increase in building load densities. It should be noted that different load density values should be applied to housing space as compared to academic and administrative facilities.

3. Load Analysis

After review of the "Building Electrical Load Estimate" for existing facilities, loads have been analyzed for specific loop feeds and services (East and West) by application information reflected on the respective Campus One-Line Diagrams prepared by ESC as part of the modeling study in 2004. The values stated and summarized by feeder in the "Building Diversified Peak Load" column reasonably compare to the demand loads shown on the One-Line Diagrams for the East and West service points. Using this data, it can be stated that utilization of both major systems leave some amount of room for additional loads, but only with careful application of only those loads in the development plan that will be completed in the next three to four years. The West service is more closely loaded to optimum capacity than is the East service.

The two main systems will both require additional interconnected service points to accommodate new or increased loads. This approach can allow for new feeder geometry to reduce existing feeder loads and provide new feeder paths to serve new projects. It is suggested that the practice of inclusion of the new distribution equipment with feeder loops tying to the existing service systems be continued into future phases.

In order to direct and control load growth to the primary distribution system, application of accurate load data is critical. Variations in load densities will vary greatly for the type of facility being considered. A laboratory space requires a substantially higher load density than does a dedicated classroom facility. The individual load densities start with higher values at the facility and decreases as consideration is given throughout the distribution system due to diversity between the various occupancies on a typical college campus application.

The UW might be well-served in considering a modification to their distribution equipment involving more effective metering to provide more accurate load data. Installing a power meter on each distribution feeder would permit the acquisition of more effective load data. Meters with

communications capability would allow a centralized system residing on a computer to collect load data, as well as consumption data on a regular basis and store such data for a predetermined period of time. The stored historical data could be recalled in the form of a trend chart for load profile analysis or tabular data for reporting review. Such historical data could be utilized for more accurate system planning and determination of required system improvements based on actual system performance and loads. This is especially helpful in reviewing aggregate load versus non-coincidental load. In addition, power quality (PQ) grade meters could be used to provide additional data such as harmonics, voltage sag/swell, or other sub-cycle events or disturbances.

4. Summary

Application of data collected with regard to loading of feeders and equipment indicates a margin of expansion that may be expected to occur without major modification. New services to areas within the boundaries of the existing West and East service areas can serve to expand capacity and meet the requirements for added building expansion. Drawing III-E-4-1 within the Appendix indicates Development Opportunity Sites, coupled with programmed Diversified Peak Loads, demonstrates the movement of campus expansion efforts from the west side to the east side. Some programmed loads in the immediate future can be served from existing infrastructure if carefully developed and designed to minimize any chance for system over load.

As development continues to the east and north, expansion into additional distribution regions may dictate added electrical service points in those areas. By integrating all of the distribution grids through interconnection tie feeders and devices, the reliability and load characteristics can be tailored to meet campus development. Application of the load flow model, following changes since the initial report of 2004, will serve to supply more accurate design data in expansion of the primary service infrastructure.

Estimates for each utility corridor installation can be determined by applying approximately \$46.50 per linear ft for 15 KV ductbank which includes two 4" PVC conduits, one circuit with #4/0 three-phase conductors, concrete encased, and with excavation. This is an estimate for installed cost without overhead or inflation. Each option and estimate is preliminary and values are recommended to be evaluated in detail at the time of installation.

F. Domestic Water System

1. Current and Annual Load Growth and Consumption Profiles

The UW does not currently incorporate building metering in all UW campus buildings. Determination of individual building domestic water consumption is therefore not possible for some buildings. The current building loads were developed using a database of water demand data from similar sized campuses for buildings of similar age and function.

The peak estimated demand values were developed from existing building gross sq ft (GSF) numbers provided by UW, which were then applied to load density values based on building functions (classroom, residence hall, research lab, etc.). Demands were next diversified according to building function. For example, based on how the buildings operate, research labs are not heavily diversified (diversity of $\pm 90\%$) while libraries and museums are on the other end of the spectrum (diversity of 60% to 70%). These diversity factors were applied across the campus facilities to develop estimated total peak diversified campus domestic water demand.

Table III-F-1 indicates the demand densities and diversities selected for use on the campus based on building function. These values were applied to each campus building to develop the values illustrated in Table III-F-2 and III-F-3. The future projected and potential demands were developed using the same methodology and are shown in Table III-F-4, III-F-5. A summary of the demand totals is illustrated in Table III-F-6. These demands are estimated peak building demands which are not diversified from a campus perspective. Thus the estimated building and campus consumption values when applied to hours of use are typically higher than that actually experienced on campus.

Table III-F-2 through F-6 identifies a column number that are in relation to the information below and where this information was generated from.

1. Building Numbers: Provided by the UW.
2. Building Name: Provided by the UW.
3. Year Built: Provide by the UW.
4. Building Gross Square Foot: Provided by the UW.
5. Building Type: Assumed per Building Type and per UW input.
6. Building Diversified Peak Loads: Based on building type in comparison to Table III-F-1 historic load data.

Table III-F-1

LOAD AND DIVERSITY FACTORS BY BUILDING TYPE	
DIVERSIFIED PEAK LOAD	
Building Type	Domestic Cold Water GPM/GSF
Agricultural/Greenhouse	0.0023
Greenhouse/Laboratory (Light)	0.0015
Animal / Veterinary	0.0012
Art Studio	0.0009
Auditorium	0.0009
Classroom	0.0006
Classroom/Library	0.0006
Clinic	0.0006
Data Center	0.0004
Food Service	0.0015
Greek Residence Housing	0.0015
Gymnasium	0.0012
Gymnasium w/ Spectators	0.0015
Gymnasium/Pool	0.0012
Hotel	0.0012
Laboratory (Light)	0.0012
Laboratory (Medium)	0.0015
Laboratory (Heavy)	0.0023
Library	0.0004
Museum	0.0006
Museum/Office	0.0009
Office	0.0009
Office/Classroom	0.0009
Office/Classroom/Auditorium	0.0009
Office/Classroom/Clinic	0.0009
Office/Classroom/Gymnasium/Pool	0.0012
Office/Classroom/Laboratory (Light)	0.0012
Office/Classroom/Laboratory (Medium)	0.0015
Office/Classroom/Library	0.0009
Office/Clinical	0.0009
Office/Data Center	0.0006
Office/Food Service	0.0015
Office/Laboratory (Light)	0.0012
Office/Library	0.0009
Office/Sports Training	0.0009
Pool	0.0012
Residence Hall	0.0015
Service/Grounds Facility	0.0009
Sports Training	0.0009
Sports Arena	0.0015
Sports Arena - Outdoor	0.0015
Student Center/Union	0.0012

Table III-F-2

(1)	(2)	(3)	(4)	(5)	(6)
Existing Core Campus Building Domestic Cold Water Load Estimate					
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Diversified Peak Load (GPM)
Northwest Campus					
1	Engineering (Old)	1927	80,010	Office/Classroom/Laboratory (Light)	96.0
1	Engineering (Petro/Aero)	1959	65,834	Office/Classroom/Laboratory (Light)	79.0
1	Engineering (Addition)	1983	185,136	Office/Classroom/Laboratory (Light)	222.2
2	Ag C (Old)	1949	107,053	Classroom	64.2
2	Ag C (Addition)	1982	114,726	Office/Classroom/Laboratory (Light)	137.7
3	Ag A	1949	29,291	Classroom/Library	17.6
4 & 5	Ag B & D	1949	8,980	Office/Laboratory (Light)	10.8
6	Vocational Education	1966	27,840	Office/Classroom	25.1
14	Education	1950	123,674	Classroom/Library	74.2
19	McWhinnie Hall	1928	26,625	Office	24.0
22	Half Acre Gymnasium	1925	112,906	Gymnasium/Pool	135.5
22	Half Acre (Raquetball Courts)	1980	6,400	Gymnasium	7.7
25	Anthropology	2007	52,499	Office/Classroom	47.2
36	Service Building (Old)	1954	9,211	Service/Grounds Facility	8.3
36	Service Building (Auto)	1960	57,592	Service/Grounds Facility	51.8
36	Service Building (Shops)	1956	14,465	Service/Grounds Facility	13.0
38	Wyoming Hall	1950	69,579	Office	62.6
91	Earth Sciences	1995	65,000	Office/Classroom/Laboratory (Light)	78.0
93	Bureau of Mines	1950	62,628	Office/Laboratory (Light)	75.2
2013&2014	Bee Lab	1956	2,480	Office/Laboratory (Light)	3.0
Subtotal			1,221,929		1,233
North & Northeast Campus					
80	Animal Science/Molecular Biology	1985	93,631	Office/Classroom/Laboratory (Light)	112.4
90	Central Energy Plant	1982	57,803	Service/Grounds Facility	52.0
111	Regulated Materials Management Center	1993	19,000	Office	17.1
125	Centennial Complex	1993	126,200	Museum/Office	113.6
150	WY Tech Business Center	2007	31,000	Office/Data Center	18.6
Subtotal			327,634		314
West & Southwest Campus					
7	Arts & Sciences	1934	66,186	Office/Classroom/Auditorium	59.6
9	Biological Sciences	1969	205,350	Office/Classroom/Laboratory (Light)	246.4
11	Health Sciences (Old Biochemistry)	1914	42,951	Office/Classroom/Laboratory (Light)	51.5
12	Classroom	1968	78,836	Classroom	47.3
12	Classroom (Addition)	2007	17,225	Classroom	10.3
13	College of Business	1960	62,000	Office/Classroom	55.8
18	Geology (Old)	1902	20,280	Office/Classroom	18.3
18	Geology (Addition)	1956	37,491	Office/Classroom/Library	33.7
23	Student Health	1960	30,513	Office/Classroom/Clinic	27.5
23	Student Health (Addition)	2008	1,500	Office/Classroom	1.4
24	Hoyt Hall	1916	29,939	Office/Classroom	26.9
26	Coe Library (Am Studies)	1958	119,390	Library	47.8
26	Coe Library (Addition)	1978	85,676	Library	34.3
27	Merica Hall	1908	17,651	Office	15.9
30	Aven Nelson	1924	32,832	Office/Classroom	29.5
31	Old Main	1887	34,089	Office	30.7
32	Pharmacy	1969	52,397	Office/Classroom/Laboratory (Light)	62.9
32	Health Sciences (Biochem & Pharm Add.)	2005	29,000	Office/Classroom/Laboratory (Light)	34.8
33	Physical Sciences	1968	179,777	Office/Classroom/Laboratory (Medium)	269.7
39	Wyoming Union (Old+79 addn)	1939	137,418	Student Center/Union	164.9
39	Wyoming Union (Addition)	2001	25,000	Student Center/Union	30.0
44	Knight Hall (Old)	1941	65,704	Office	59.1
44	Knight Hall (Food Service)	1950	12,723	Office	11.5
44	Knight Hall (Addition)	1946	3,244	Office	2.9
50	Ross Hall	1960	90,665	Office/Food Service	136.0
82	Williams Conservatory	1994	8,633	Greenhouse/Laboratory (Light)	12.9
84	Iverson Hospital	1939	46,902	Office/Data Center	28.1
920	Geo Survey Building	1975	23,171	Office	20.9
Subtotal			1,556,543		1,571
SHEET SUBTOTAL EXISTING			3,106,106		3,117

Table III-F-3

(1)	(2)	(3)	(4)	(5)	(6)
Existing Core Campus Building Domestic Cold Water Load Estimate					
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Diversified Peak Load (GPM)
East Campus					
21	Campus Greenhouse	1961	5,737	Agricultural/Greenhouse	13.2
64	Information Technology	2008	84,241	Office/Data Center	50.5
77	Law School	1977	48,463	Office/Classroom	43.6
77	Law Library (Addition)	1993	17,000	Classroom	10.2
78	Fine Arts	1972	175,598	Office/Classroom/Auditorium	158.0
78	Fine Arts (Addition)	1999	5,000	Art Studio	4.5
79	Corbett Physical Education	1975	83,646	Office/Classroom/Gymnasium/Pool	100.4
123 & 124	Wainwright/Willett Bungalows	1950	3,500	Art studio	3.2
Subtotal			423,185		384
King Row					
40	Crane Hall	1962	88,935	Residence Hall	133.4
41	Crane Hill Cafeteria	1962	49,622	Food Service	74.4
42	Downey Hall	1965	85,361	Residence Hall	128.0
43	Hill Hall	1962	88,935	Residence Hall	133.4
46	McIntyre Hall	1966	132,226	Residence Hall	198.3
48	Orr Hall	1966	85,361	Residence Hall	128.0
51	Washakie Center (Old)	1966	70,937	Food Service	106.4
51	Washakie Center (Addition)	2004	10,579	Food Service	15.9
52	White Hall	1967	132,054	Residence Hall	198.1
Subtotal			744,010		1,116
Sorority Row					
56	Sigma Phi Epsilon House	1952	16,634	Residence Hall	25.0
908	Pi Kappa Alpha	1963	16,750	Greek Residence Housing	25.1
909	Delta Delta Delta	1941	13,552	Greek Residence Housing	20.3
910	Chi Omega	1954	8,454	Greek Residence Housing	12.7
911	Kappa Kappa Gamma	1941	20,082	Greek Residence Housing	30.1
912	Pi Beta Phi (Old)	1949	12,395	Greek Residence Housing	18.6
912	Pi Beta Phi (Addition)	1994	3,363	Greek Residence Housing	5.0
Subtotal			91,230		137
Fraternity Row					
55	Honors House	1939	9,031	Residence Hall	13.5
61	Beta House	1966	12,567	Office/Classroom	11.3
902	Alpha Tau Omega	1957	9,154	Greek Residence Housing	13.7
904	HSL	1957	5,247	Residence Hall	7.9
905	Sigma Alpha Epsilon	1956	10,557	Greek Residence Housing	15.8
906	Sigma Chi	1957	10,881	Greek Residence Housing	16.3
907	Sigma Nu	1960	10,226	Greek Residence Housing	15.3
Subtotal			67,663		94
Athletics Campus					
16	Fieldhouse	1951	195,855	Gymnasium w/ Spectators	293.8
17	Fieldhouse North Addition	1984	71,694	Office	64.5
73	Rochele Athletics Center	2001	47,450	Office/Sports Training	42.7
74	Indoor Practice Facility	2007	83,759	Sports Training	75.4
89	Arena Auditorium	1982	260,990	Sports Arena	391.5
Subtotal			659,748		868
Current Additions					
26	Information Library & Learning Center (ILLC)	2009	85,913	Office/Library	77.3
Subtotal			85,913		77
SHEET SUBTOTAL EXISTING			2,071,749		2,676
TOTALS EXISTING			5,177,855		5,793

Table III-F-4

(1)	(2)	(3)	(4)	(5)	Building Diversified Peak Load (GPM)
Projected Core Campus Building Domestic Cold Water Load Estimate					
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	
<u>Immediate Future Additions</u>					
13	College of Business Addition	2010	103,000	Office/Classroom	92.7
77	Law - Moot Court Addition	2010	24,000	Classroom	14.4
Subtotal			127,000		107
<u>North of Lewis</u>					
A	School of Energy Resources	2011-2015	40,000	Office/Classroom/Laboratory (Light)	48.0
A	Science Teaching Lab Facility	2011-2015	100,000	Office/Classroom/Laboratory (Medium)	150.0
A	Long Term Development	2015-2020	315,000	Office/Classroom	283.5
A	Long Term Development	2020-2025	100,000	Office/Classroom	90.0
Subtotal			555,000		572
<u>South of Ivinson</u>					
B	Foundation House	2011-2015	10,000	Office/Classroom	9.0
B	Long Term Development	2020-2025	130,000	Office/Classroom	117.0
Subtotal			140,000		126
<u>Service & Maintenance</u>					
C	Service and Maintenance	2015-2020	151,997	Service/Grounds Facility	136.8
Subtotal			151,997		137
<u>West Willett</u>					
D	Surface Parking	2010-2030	0	Office/Classroom/Auditorium	0.0
Subtotal			0		0
<u>Crane-Hill</u>					
E	Crane Hill Demo and Rebuild of 250 Beds	2011-2015	227,492	Residence Hall	341.2
Subtotal			0		341
<u>Research/Business</u>					
F	Business Incubator	2015-2020	30,000	Office/Classroom/Laboratory (Light)	36.0
Subtotal			30,000		36
<u>East Campus Academic</u>					
G	Animal Science	2020-2025	200,000	Office/Classroom/Laboratory (Light)	240.0
G	Addition to CC	2015-2020	30,000	Museum/Office	27.0
G	Visual Arts East of CCC	2011-2015	80,000	Office/Classroom/Auditorium	72.0
G	Long Term Development	2025-2030	90,000	Office/Classroom	81.0
Subtotal			400,000		420
<u>Stadium Parking Lot</u>					
H	Stadium Suites	2011-2012	20,000	Office	18.0
Subtotal			20,000		18
<u>Grand Avenue Commercial</u>					
I	Office Space, Classroom	2025-2030	85,000	Office/Library	76.5
Subtotal			85,000		77
<u>Rocky Mountain</u>					
J	Office Space, Classroom	2025-2030	26,327	Office/Library	23.7
Subtotal			26,327		24
<u>West Summit View</u>					
K	250 Beds for Housing	2025-2030	185,822	Office/Library	167.2
Subtotal			185,822		167
<u>East Summit View</u>					
L	250 Beds for Housing	2025-2030	119,739	Residence Hall	179.6
Subtotal			119,739		180
<u>Armory</u>					
M	Service and Maintenance	POST 2030	0	Service/Grounds Facility	0.0
Subtotal			0		0
SHEET SUBTOTAL PROJECTED			1,840,885		2,204

Table III-F-5

(1)	(2)	(3)	(4)	(5)	Building Diversified Peak Load (GPM)
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	
0	<u>Undefined</u>				
Reserve 1	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0
	Subtotal		FUTURE		0
Reserve 2	<u>Undefined</u>				
	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0
	Subtotal		FUTURE		0
Reserve 3	<u>Undefined</u>				
	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0
	Subtotal		FUTURE		0
	<u>Campus North West</u>				
Berry Building	Berry, Office Space, Academics	2011-2012	40,000	Office/Classroom	36.0
	Subtotal		40,000		36
	<u>Campus South West</u>				
Half Acre Addition	Half Acre Gymnasium	2012-2015	30,000	Gymnasium	36.0
	Subtotal		30,000		36
	<u>Campus East</u>				
Child Care	Office Space	2020-2025	10,000	Office	9.0
	Subtotal		10,000		9
SHEET SUBTOTAL PROJECTED			80,000		81
TOTALS PROJECTED			2,032,259		2,285

Table III-F-6

(1)	(4)	(6)
	Building Gross SF	Campus Diversified Peak Load (GPM)
TOTAL EXISTING	5,177,855	5,793
TOTAL PROJECTED	2,032,259	2,285
TOTAL EXISTING AND PROJECTED	7,210,114	8,077

2. Distribution Evaluation

The UW campus lies within the boundary of City of Laramie potable water distribution system Pressure Zone 2. As a result, potable water on campus is provided by gravity from the Zone 2 above-ground water tanks located on a ridge immediately east of campus. A boundary between city Pressure Zone 1 and Pressure Zone 2 is located along a portion of the west and north campus boundary. Future campus development may therefore take place in areas that are currently within City Pressure Zone 1. Current City policy typically requires that development within an

existing pressure zone must utilize the available water supply and water pressure in that pressure zone. Since Pressure Zone 1 provides lower water pressure than does Pressure Zone 2, UW may consider approaching the City regarding future campus expansion into current Pressure Zone 1. Supplying potable water to all future UW campus expansion from Pressure Zone 2 would be preferable to supplying potable water to any future expansion from Pressure Zone 1. A map showing City of Laramie potable water distribution system pressure zones is included in Appendix II-F-3.

Maintenance and expansion of the existing campus master water metering system will be important during future campus expansion. This metering system provides information regarding campus water consumption and a basis for UW payment to the City of Laramie for water that is used on campus. Since master meters simplify the City meter reading and billing process but do not provide water demand data for individual buildings, and since individual building water meters are not expensive, installation of a water meter on each future or remodeled building is advisable.

In order to assess potential future campus growth and accompanying potable water distribution system expansion, theoretical new water line loops were schematically added to the campus WaterCAD® model in the following areas:

- Flint St. from 9th St. to 15th St.;
- Gibbons St. extension from 15th St. to 19th St.;
- 22nd St. from Grand Ave to Willett Drive;
- 22nd St. from Willet Drive to 19th St.; and
- Ivinson Ave from 9th St. to 15th St.

Fire-flow demand nodes were placed every 400 ft along these anticipated future water line loops based on typical 400 ft fire hydrant spacing, and a minimum required fire-flow of 2,000 gpm was again assessed at each future fire flow node during each modeling scenario. Future additional average and peak campus daily increases in demand were not included in future conditions modeling since these demand rates are typically insignificant in relation to fire flow demand.

The WaterCAD® V8i campus potable water distribution system model was used to assess both quantities and locations of potential future campus water demand. Future condition WaterCAD® model output, including a tabulated scenario summary, a system map, and a tabulated system fire flow report, is included in Appendix III-F-1. On WaterCAD® mapping, pipes are color coded by diameter. Fire flow was assessed at selected nodes in the expanded future water distribution system. Green nodes on these maps indicate locations at which the model shows that the expanded future distribution system is capable of delivering adequate fire flow and pressure. Red nodes on the maps indicate locations where the model shows that the expanded future distribution system will not be

capable of delivering adequate fire flow. The future conditions analysis was completed on the basis of six modeling scenarios, including:

- *Scenario DF-1* – This scenario considered current average estimated daily campus demand of 500 gpm plus fire flow demand in existing and anticipated future expansion areas.
- *Scenario DF-2* – This scenario reviewed current peak estimated daily campus demand calculated on the basis of a 2.72 peaking factor plus fire flow demand in existing and anticipated future expansion areas.
- *Scenario DF-3* – This scenario included current peak estimated daily demand with the addition of a 1,000 gpm demand in the east portion of campus plus fire flow demand in existing and anticipated future expansion areas.
- *Scenario DF-4* – This scenario assessed current peak estimated daily campus demand plus irrigation demand plus fire flow demand in existing and anticipated future expansion areas, with all existing 6" diameter campus water lines changed to hypothetical eight 8" diameter water lines.
- *Scenario DF-5* – This scenario reviewed current peak estimated daily campus demand plus irrigation demand plus fire flow demand in existing and anticipated future expansion areas and with all existing 6 " diameter water lines changed to hypothetical 10" diameter water lines.

As was the case with existing condition WaterCAD® model runs, fire flow demand was developed and evaluated concurrently with average and peak daily campus water demand. In several locations, fire flow demand was applied to a node that is located in close proximity to an actual hydrant location due to the inability to include more than a specified number of nodes in the model.

WaterCAD® modeling of campus water demand under future conditions indicated that:

- Future 10" diameter water mains should provide adequate fire flows and pressures in areas of anticipated future expansion under average daily, peak daily, and peak daily plus irrigation flow analyses;
- Theoretical replacement of existing 6" diameter campus water lines with 8" diameter water lines eliminated six out of 17 of the fire flow demand nodes that were shown under existing condition modeling to be incapable of meeting fire flow requirements; and
- Theoretical replacement of existing 6" diameter campus water lines with 10" diameter water lines eliminated all 17 of the fire demand nodes that were shown under existing condition modeling to be incapable of meeting fire flow requirements.

3. Summary

Future expansion of the UW campus will likely result in increased demand from an existing potable water distribution system that currently fails to meet theoretical fire flow demand criteria on much of the campus. Future water demand could result in increased flow rates and inadequate pressures in areas of campus that are currently served by undersized water mains, such as the east campus student housing area, as well as areas where existing water service lines do not exist. Enlargement of existing campus water mains and design and construction of new water lines will be should meet campus requirements and conform to City of Laramie requirements and specifications. The WaterCAD® modeling analyses that are described above could serve as a basis for future water line routing and sizing.

G. Irrigation Water System

1. Current and Annual Load Growth and Consumption Profile

The current and future load growth of the campus was evaluated through existing campus data and UW staff input based on irrigation zone nozzle flow densities and known flow rates of each campus well that supplies water to each zone. These values were utilized within the flow models described below.

2. Distribution Evaluation

The existing core campus irrigation water distribution system consists of approximately 44,450 lineal ft of pipe of varying diameters and materials that receive water primarily from one campus water well. The distribution system is complex, contains a variety of types of components, is operated largely on the basis of past experience, and is not fully documented or understood by UW staff. As noted previously, the current campus irrigation system source of supply consists of a single campus water well. This well produces from 400 gpm to 500 gpm, which is distributed by campus staff to a number of irrigation zone during various time increments. Lack of at least one additional, comparable, and redundant source of supply for the irrigation water system presents a major risk in that, should the existing water supply well fail or become inoperable for a significant period of time, campus irrigation operations would be significantly impacted. Lack of redundancy in the campus irrigation water supply system is a serious issue. Without at least one additional reliable irrigation water source of supply, it is likely only a matter of time before a crisis occurs in campus irrigation operations due to lack of an adequate quantity of irrigation water.

Evaluation of future irrigation system expansion focused on addition of new or rehabilitated UW-owned water well sources of supply and expansion of the irrigation water distribution system into areas of potential future campus growth. Future condition analysis was completed by modifying and running the existing condition campus irrigation system WaterCAD® V8i model. Output from each future conditions modeling

scenario included a WaterCAD®-generated tabulated modeling scenario summary, a color-coded modeling map, and a tabulated system pipe and node summary. On these WaterCAD® maps, red nodes indicate locations at which the model shows that 60 psig design water pressure was determined by the model to be unavailable. Dark blue lines on these maps indicate existing irrigation water mains, and light blue lines represent future irrigation water mains. These future condition output documents are included in Appendix III-G-1. The six future condition WaterCAD® irrigation system modeling scenarios included:

- *Scenario IF-1* – This scenario assessed current peak hour core campus irrigation water demand plus estimated future west campus irrigation demand of 10 gpm at each future demand node with the existing Fine Arts Building water well, the rehabilitated west campus water well, and one new east campus water well as the sources of supply.
- *Scenario IF-2* – This scenario included current peak hour core campus irrigation water demand plus estimated future west campus irrigation demand of 20 gpm at each future demand node with the existing Fine Arts Building water well, the rehabilitated west campus water well, and one new east campus water well as the sources of supply.
- *Scenario IF-3* – This scenario considered current peak hour core campus irrigation water demand plus estimated future west campus irrigation demand of 30 gpm at each future demand node with the existing Fine Arts Building water well, the rehabilitated west campus water well, and one new east campus water well as the sources of supply.
- *Scenario IF-4* – This scenario was based on current peak hour core campus irrigation water demand plus estimated future east campus demand of 5 gpm at each future demand node with one new east campus water well as the source of supply.
- *Scenario IF-5* – This scenario assessed current peak hour core campus irrigation water demand plus estimated future east campus demand of 10 gpm at each future demand node with one new east campus water well as the source of supply.
- *Scenario IF-6* – This scenario reviewed current peak hour core campus irrigation water demand plus estimated future east campus demand of 15 gpm at each future demand node with one new east campus water well as the source of supply.

As was the case during existing condition irrigation modeling, future condition modeling scenarios as described above were intended to quantify the available discharge rates at future demand nodes. Minimum acceptable discharge pressure at each discharge node was 60 psig. These future condition models included estimated current peak day campus irrigation water demand and considered the future campus on the basis of two major zones. The western zone received water from the existing Fine Arts well, the existing west campus well, the existing well

located near the engineering building, and a new east well. The eastern zone received water from a new east well only. The new east well was modeled to produce required discharge rates at an 80 psig discharge pressure as does the existing Fine Arts well. Preliminary expanded system pipe sizing and future condition modeling described above indicated that:

- The first of three west campus analyses, Scenario IF-1, assessing demand of 10 gpm at each of 13 future demand nodes indicated that the existing Fine Arts water well and the rehabilitated west well should discharge at 364 gpm and 194 gpm, respectively, the existing water well that is located near the engineering building will not discharge, and that each of the 13 future demand nodes should be capable of discharging at varying rates of flow and at a minimum 60 psig pressure;
- The second of three west campus analyses, Scenario IF-2, assessing demand of 20 gpm at each of 13 future demand nodes indicated that the existing Fine Arts water well and the rehabilitated central well should discharge at 394 gpm and 250 gpm, respectively, the existing water well that is located near the engineering building will not discharge, and that each of the 13 future demand nodes should be capable of discharging at a minimum 60 psig pressure;
- The third of three west campus analyses, Scenario IF-3, assessing demand of 30 gpm at each of 13 future demand nodes indicated that the existing Fine Arts water well and the rehabilitated west campus well should discharge at 418 gpm and 277 gpm, respectively, with an additional 32 gpm discharge from the existing well that is located near the engineering building, and that each of the 13 future demand nodes should be capable of discharging at a minimum 60 psig pressure;
- The first of three east campus analyses, Scenario IF-4 assessing demand of 5 gpm at each of 23 future demand nodes, indicated that required future east water well discharge will be 413 gpm and that each of the 23 future demand nodes should be capable of discharging at a minimum 60 psig pressure;
- The second of three east campus analyses, Scenario IF-5 assessing demand of 10 gpm at each of 23 future demand nodes, indicated that required future east water well will discharge at a rate of 448 gpm and that each of the 23 future demand nodes should be capable of discharging at a minimum 60 psig pressure; and
- The third of three east campus analyses, Scenario IF-6, assessing demand of 15 gpm at each of 23 future demand nodes, indicated that required future east water well discharge will be 563 gpm, and that six of the 23 future demand nodes, which are located at the northeast end of campus where current irrigation utilizes City water, will not be capable of discharging at a minimum 60 psig pressure.

The apparent successful operation of the future condition campus irrigation system will likely depend upon adequate and redundant source

water production as well as proper design of extended irrigation water mains.

3. Summary

The existing UW campus irrigation system will presumably be expanded concurrently with future campus facility expansion. Future condition modeling completed during this project indicated that, with proper pipe sizing and the construction and/or rehabilitation of additional irrigation water wells, expanded areas of the campus can be irrigated efficiently and without reliance on use of potable City of Laramie water. Continuation of current irrigation system operating procedures, including operation of three separate campus irrigation systems by three separate groups of UW staff and lack of accurate understanding of or standard operating procedures for the campus irrigation system, will not be resolved by expansion of the irrigation distribution water well and pipeline system.

H. Sanitary Sewer System

1. Current and Annual Load Growth and Consumption Profiles

UW does not currently own or operate sanitary sewer flow metering systems to quantify individual building sanitary sewer discharges. Current estimated building sanitary sewer discharges were developed using a database of load data from similar sized campuses and for buildings of similar age and function.

The peak discharges were developed from existing building gross sq ft (GSF) numbers provided by UW, which were then applied to discharge density values based on building function (classroom, residence hall, research lab, etc.). Discharges were next diversified according to building function. For example, based on how the buildings operate, research labs are not heavily diversified (diversity of $\pm 90\%$) while libraries and museums are on the other end of the spectrum (diversity of 60% to 70%). These diversity factors were then applied across the campus facilities to develop the total peak diversified campus sanitary sewer discharge rates.

Table III-H-1 indicates the discharge densities and diversities selected for use on the campus based on building function. These values were applied to each campus building to develop the values illustrated in Table III-H-2 and III-H-3. The future projected and potential loads were developed using the same methodology and are shown in Table III-H-4, III-H-5. A summary of the estimated total discharges is illustrated in Table III-H-6. These flows are peak building discharges which are not diversified from a campus perspective. Thus the building and campus discharge values when applied to calculated hourly discharge values are typically higher than those actually experienced on campus.

Table III-H-2 through H-6 identifies a column number that are in relation to the information below and where this information was generated from.

1. Building Numbers: Provided by the UW.
2. Building Name: Provided by the UW.
3. Year Built: Provide by the UW.
4. Building Gross Square Foot: Provided by the UW.
5. Building Type: Assumed Per Building Type and per UW input.
6. Building Diversified Peak Loads: Based on building type in comparison to Table III-H-1 historic load data.

Table III-H-1

LOAD AND DIVERSITY FACTORS BY BUILDING TYPE	
Building Type	DIVERSIFIED PEAK LOAD Sanitary GPM/GSF
Agricultural/Greenhouse	0.0015
Greenhouse/Laboratory (Light)	0.0012
Animal / Veterinary	0.0009
Art Studio	0.0006
Auditorium	0.0009
Classroom	0.0004
Classroom/Library	0.0004
Clinic	0.0006
Data Center	0.0004
Food Service	0.0012
Greek Residence Housing	0.0012
Gymnasium	0.0009
Gymnasium w/ Spectators	0.0012
Gymnasium/Pool	0.0009
Hotel	0.0009
Laboratory (Light)	0.0009
Laboratory (Medium)	0.0012
Laboratory (Heavy)	0.0020
Library	0.0004
Museum	0.0006
Museum/Office	0.0006
Office	0.0006
Office/Classroom	0.0006
Office/Classroom/Auditorium	0.0006
Office/Classroom/Clinic	0.0006
Office/Classroom/Gymnasium/Pool	0.0009
Office/Classroom/Laboratory (Light)	0.0009
Office/Classroom/Laboratory (Medium)	0.0012
Office/Classroom/Library	0.0006
Office/Clinical	0.0006
Office/Data Center	0.0006
Office/Food Service	0.0012
Office/Laboratory (Light)	0.0009
Office/Library	0.0006
Office/Sports Training	0.0006
Pool	0.0009
Residence Hall	0.0012
Service/Grounds Facility	0.0006
Sports Training	0.0006
Sports Arena	0.0015
Sports Arena - Outdoor	0.0015
Student Center/Union	0.0009

Table III-H-2

(1)	(2)	(3)	(4)	(5)	(6)
Existing Core Campus Building Sanitary Sewer Load Estimate					
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Diversified Peak Load (GPM)
Northwest Campus					
1	Engineering (Old)	1927	80,010	Office/Classroom/Laboratory (Light)	72.0
1	Engineering (Petro/Aero)	1959	65,834	Office/Classroom/Laboratory (Light)	59.3
1	Engineering (Addition)	1983	185,136	Office/Classroom/Laboratory (Light)	166.6
2	Ag C (Old)	1949	107,053	Classroom	42.8
2	Ag C (Addition)	1982	114,726	Office/Classroom/Laboratory (Light)	103.3
3	Ag A	1949	29,291	Classroom/Library	11.7
4 & 5	Ag B & D	1949	8,980	Office/Laboratory (Light)	8.1
6	Vocational Education	1966	27,840	Office/Classroom	16.7
14	Education	1950	123,674	Classroom/Library	49.5
19	McWhinnie Hall	1928	26,625	Office	16.0
22	Half Acre Gymnasium	1925	112,906	Gymnasium/Pool	101.6
22	Half Acre (Raquetball Courts)	1980	6,400	Gymnasium	5.8
25	Anthropology	2007	52,499	Office/Classroom	31.5
36	Service Building (Old)	1954	9,211	Service/Grounds Facility	5.5
36	Service Building (Auto)	1960	57,592	Service/Grounds Facility	34.6
36	Service Building (Shops)	1956	14,465	Service/Grounds Facility	8.7
38	Wyoming Hall	1950	69,579	Office	41.7
91	Earth Sciences	1995	65,000	Office/Classroom/Laboratory (Light)	58.5
93	Bureau of Mines	1950	62,628	Office/Laboratory (Light)	56.4
2013&2014	Bee Lab	1956	2,480	Office/Laboratory (Light)	2.2
Subtotal			1,221,929		892
North & Northeast Campus					
80	Animal Science/Molecular Biology	1985	93,631	Office/Classroom/Laboratory (Light)	84.3
90	Central Energy Plant	1982	57,803	Service/Grounds Facility	34.7
111	Regulated Materials Management Center	1993	19,000	Office	11.4
125	Centennial Complex	1993	126,200	Museum/Office	75.7
150	WY Tech Business Center	2007	31,000	Office/Data Center	18.6
Subtotal			327,634		225
West & Southwest Campus					
7	Arts & Sciences	1934	66,186	Office/Classroom/Auditorium	39.7
9	Biological Sciences	1969	205,350	Office/Classroom/Laboratory (Light)	184.8
11	Health Sciences (Old Biochemistry)	1914	42,951	Office/Classroom/Laboratory (Light)	38.7
12	Classroom	1968	78,836	Classroom	31.5
12	Classroom (Addition)	2007	17,225	Classroom	6.9
13	College of Business	1960	62,000	Office/Classroom	37.2
18	Geology (Old)	1902	20,280	Office/Classroom	12.2
18	Geology (Addition)	1956	37,491	Office/Classroom/Library	22.5
23	Student Health	1960	30,513	Office/Classroom/Clinic	18.3
23	Student Health (Addition)	2008	1,500	Office/Classroom	0.9
24	Hoyt Hall	1916	29,939	Office/Classroom	18.0
26	Coe Library (Am Studies)	1958	119,390	Library	47.8
26	Coe Library (Addition)	1978	85,676	Library	34.3
27	Merica Hall	1908	17,651	Office	10.6
30	Aven Nelson	1924	32,832	Office/Classroom	19.7
31	Old Main	1887	34,089	Office	20.5
32	Pharmacy	1969	52,397	Office/Classroom/Laboratory (Light)	47.2
32	Health Sciences (Biochem & Pharm Add.)	2005	29,000	Office/Classroom/Laboratory (Light)	26.1
33	Physical Sciences	1968	179,777	Office/Classroom/Laboratory (Medium)	215.7
39	Wyoming Union (Old+79 addn)	1939	137,418	Student Center/Union	123.7
39	Wyoming Union (Addition)	2001	25,000	Student Center/Union	22.5
44	Knight Hall (Old)	1941	65,704	Office	39.4
44	Knight Hall (Food Service)	1950	12,723	Office	7.6
44	Knight Hall (Addition)	1946	3,244	Office	1.9
50	Ross Hall	1960	90,665	Office/Food Service	108.8
82	Williams Conservatory	1994	8,633	Greenhouse/Laboratory (Light)	10.4
84	Iverson Hospital	1939	46,902	Office/Data Center	28.1
920	Geo Survey Building	1975	23,171	Office	13.9
Subtotal			1,556,543		1,189
SHEET SUBTOTAL EXISTING			3,106,106		2,306

Table III-H-3

(1)	(2)	(3)	(4)	(5)	(6)
Existing Core Campus Building Sanitary Sewer Load Estimate					
Bldg #	Building Name	Year Built	Building Gross SF	Building Type	Building Diversified Peak Load (GPM)
East Campus					
21	Campus Greenhouse	1961	5,737	Agricultural/Greenhouse	8.6
64	Information Technology	2008	84,241	Office/Data Center	50.5
77	Law School	1977	48,463	Office/Classroom	29.1
77	Law Library (Addition)	1993	17,000	Classroom	6.8
78	Fine Arts	1972	175,598	Office/Classroom/Auditorium	105.4
78	Fine Arts (Addition)	1999	5,000	Art Studio	3.0
79	Corbett Physical Education	1975	83,646	Office/Classroom/Gymnasium/Pool	75.3
123 & 124	Wainwright/Willett Bungalows	1950	3,500	Art studio	2.1
Subtotal			423,185		281
King Row					
40	Crane Hall	1962	88,935	Residence Hall	106.7
41	Crane Hill Cafeteria	1962	49,622	Food Service	59.5
42	Downey Hall	1965	85,361	Residence Hall	102.4
43	Hill Hall	1962	88,935	Residence Hall	106.7
46	McIntyre Hall	1966	132,226	Residence Hall	158.7
48	Orr Hall	1966	85,361	Residence Hall	102.4
51	Washakie Center (Old)	1966	70,937	Food Service	85.1
51	Washakie Center (Addition)	2004	10,579	Food Service	12.7
52	White Hall	1967	132,054	Residence Hall	158.5
Subtotal			744,010		893
Sorority Row					
56	Sigma Phi Epsilon House	1952	16,634	Residence Hall	20.0
908	Pi Kappa Alpha	1963	16,750	Greek Residence Housing	20.1
909	Delta Delta Delta	1941	13,552	Greek Residence Housing	16.3
910	Chi Omega	1954	8,454	Greek Residence Housing	10.1
911	Kappa Kappa Gamma	1941	20,082	Greek Residence Housing	24.1
912	Pi Beta Phi (Old)	1949	12,395	Greek Residence Housing	14.9
912	Pi Beta Phi (Addition)	1994	3,363	Greek Residence Housing	4.0
Subtotal			91,230		109
Fraternity Row					
55	Honors House	1939	9,031	Residence Hall	10.8
61	Beta House	1966	12,567	Office/Classroom	7.5
902	Alpha Tau Omega	1957	9,154	Greek Residence Housing	11.0
904	HSL	1957	5,247	Residence Hall	6.3
905	Sigma Alpha Epsilon	1956	10,557	Greek Residence Housing	12.7
906	Sigma Chi	1957	10,881	Greek Residence Housing	13.1
907	Sigma Nu	1960	10,226	Greek Residence Housing	12.3
Subtotal			67,663		74
Athletics Campus					
16	Fieldhouse	1951	195,855	Gymnasium w/ Spectators	235.0
17	Fieldhouse North Addition	1984	71,694	Office	43.0
73	Rochele Athletics Center	2001	47,450	Office/Sports Training	28.5
74	Indoor Practice Facility	2007	83,759	Sports Training	50.3
89	Arena Auditorium	1982	260,990	Sports Arena	391.5
Subtotal			659,748		748
Current Additions					
26	Information Library & Learning Center (ILLC)	2009	85,913	Office/Library	51.5
Subtotal			85,913		52
SHEET SUBTOTAL EXISTING			2,071,749		2,157
TOTALS EXISTING			5,177,855		4,462

Table III-H-4

(1)	(2)	(3)	(4)	(5)	(6)
Projected Core Campus Building Sanitary Sewer Load Estimate					
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	Building Diversified Peak Load (GPM)
Immediate Future Additions					
13	College of Business Addition	2010	103,000	Office/Classroom	61.8
77	Law - Moot Court Addition	2010	24,000	Classroom	9.6
Subtotal			127,000		71
North of Lewis					
A	School of Energy Resources	2011-2015	40,000	Office/Classroom/Laboratory (Light)	36.0
A	Science Teaching Lab Facility	2011-2015	100,000	Office/Classroom/Laboratory (Medium)	120.0
A	Long Term Development	2015-2020	315,000	Office/Classroom	189.0
A	Long Term Development	2020-2025	100,000	Office/Classroom	60.0
Subtotal			555,000		405
South of Ivinson					
B	Foundation House	2011-2015	10,000	Office/Classroom	6.0
B	Long Term Development	2020-2025	130,000	Office/Classroom	78.0
Subtotal			140,000		84
Service & Maintenance					
C	Service and Maintenance	2015-2020	151,997	Service/Grounds Facility	91.2
Subtotal			151,997		91
West Willett					
D	Surface Parking	2010-2030	0	Office/Classroom/Auditorium	0.0
Subtotal			0		0
Crane-Hill					
E	Crane Hill Demo and Rebuild of 250 Beds	2011-2015	227,492	Residence Hall	273.0
Subtotal			0		273
Research/Business					
F	Business Incubator	2015-2020	30,000	Office/Classroom/Laboratory (Light)	27.0
Subtotal			30,000		27
East Campus Academic					
G	Animal Science	2020-2025	200,000	Office/Classroom/Laboratory (Light)	180.0
G	Addition to CC	2015-2020	30,000	Museum/Office	18.0
G	Visual Arts East of CCC	2011-2015	80,000	Office/Classroom/Auditorium	48.0
G	Long Term Development	2025-2030	90,000	Office/Classroom	54.0
Subtotal			400,000		300
Stadium Parking Lot					
H	Stadium Suites	2011-2012	20,000	Office	12.0
Subtotal			20,000		12
Grand Avenue Commercial					
I	Office Space, Classroom	2025-2030	85,000	Office/Library	51.0
Subtotal			85,000		51
Rocky Mountain					
J	Office Space, Classroom	2025-2030	26,327	Office/Library	15.8
Subtotal			26,327		16
West Summit View					
K	250 Beds for Housing	2025-2030	185,822	Office/Library	111.5
Subtotal			185,822		111
East Summit View					
L	250 Beds for Housing	2025-2030	119,739	Residence Hall	143.7
Subtotal			119,739		144
Armory					
M	Service and Maintenance	POST 2030	0	Service/Grounds Facility	0.0
Subtotal			0		0

Table III-H-5

(1)	(2)	(3)	(4)	(5)	(6)
Projected Core Campus Building Sanitary Sewer Load Estimate					
Bldg #	Building Name	Outlook Year Built	Building Gross SF	Building Type	Building Diversified Peak Load (GPM)
0	<u>Undefined</u>				
Reserve 1	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0
	Subtotal		FUTURE		0
	<u>Undefined</u>				
Reserve 2	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0
	Subtotal		FUTURE		0
	<u>Undefined</u>				
Reserve 3	Office Space, Classroom	POST 2030	0	Office/Classroom/Laboratory (Light)	0.0
	Subtotal		FUTURE		0
	<u>Campus North West</u>				
Berry Building	Berry, Office Space, Academics	2011-2012	40,000	Office/Classroom	24.0
	Subtotal		40,000		24
	<u>Campus South West</u>				
Half Acre Addition	Half Acre Gymnasium	2012-2015	30,000	Gymnasium	27.0
	Subtotal		30,000		27
	<u>Campus East</u>				
Child Care	Office Space	2020-2025	10,000	Office	6.0
	Subtotal		10,000		6
SHEET SUBTOTAL PROJECTED			80,000		57
TOTALS PROJECTED			2,032,259		1,643

Table III-H-6

(1)	(4)	(6)
Core Campus Sanitary Sewer Load Estimate Summary		
	Building Gross SF	Building Diversified Peak Load (GPM)
TOTAL EXISTING	5,177,855	4,462
TOTAL PROJECTED	2,032,259	1,643
TOTAL EXISTING AND PROJECTED	7,210,114	6,105

2. Distribution Evaluation

The existing UW campus sanitary sewer collection system comprises a portion of the City of Laramie sanitary sewer collection system. The campus sanitary sewer collection system discharges by gravity into the City collection system at several points. Future campus expansion is anticipated to occur adjacent to or near existing areas of the campus and within the corporate limits of the City of Laramie. Existing or expanded

sanitary sewer collection system facilities will therefore serve future campus expansion.

Specific future anticipated campus expansion areas have been defined by AEI and are summarized in Table II-H-1 in Appendix III-H-1. Table II-H-1 also includes AEI-generated estimated future domestic sanitary sewerage discharges from each area of anticipated campus expansion. Evaluation of the impacts of this estimated future campus expansion was completed using the open channel flow analysis tool in the “Look Up” tab of the sanitary and storm sewer facility spreadsheet that is printed in Appendix II-H-2. A map showing the locations of modeled sanitary sewer lines in relation to anticipated future development areas is also included in Appendix III-H-1.

Open channel flow analysis using the campus sanitary sewer system spreadsheet model was completed for one critical reach of existing sanitary sewer line that is located immediately downstream of each of the areas within which future additional estimated sanitary sewerage discharges have been estimated. The portion of calculated full-flow pipe conveyance capacity that each additional estimated future discharge represents was then calculated. If the ratio of estimated future discharge to full-flow pipe capacity was low - say, less than 0.10 or 10% of full-flow pipe capacity - it was assumed that the existing sanitary sewer collection system will suffice during future development with no changes. If the ratio of estimated future discharge to full-flow pipe capacity exceeded 0.10 or 10%, it was assumed that future development may require expansion or other modification of the existing sanitary sewer collection system. The higher the ratio of estimated future discharge to full-flow pipe capacity, the higher the level of risk regarding the adequacy of the existing sanitary sewer collection system was assumed to be.

As shown in Table II-H-1, the following future development may significantly impact existing sanitary sewer conveyance facilities:

- For long term development in future development Area A, the area immediately north of Lewis St., the ratio of future discharge to full-pipe flow capacity is 0.60 in the existing 8” sanitary sewer that is located north of campus under 11th St.;
- For service and maintenance future development in Area C, the ratio of future discharge to full-pipe flow capacity is 0.14 in the existing north-flowing 8” sanitary sewer that is located just north of 15th St.; and
- Based on combined estimated discharges in future development Area G, the East Campus academic area, the ratio of future discharges to full-pipe flow capacities is 0.58 in the existing southeast-flowing 8” sanitary sewer line that is located near this area

Modeled reaches of sanitary sewer line are shown on Map 1 in Appendix III-H-1. Future sanitary sewer collection system improvements should be determined based on specific new or remodeled building designs and could consist of replacing and enlarging selected existing sanitary sewer lines or constructing new lines. In all cases, reliance on gravity flow and

avoidance of pumping sanitary sewage should be primary design and analysis criteria.

3. Summary

The campus sanitary sewer collection system is a component of the City of Laramie sanitary sewer collection system. Project analysis of the potential impacts of estimated future campus development on the existing sanitary sewer collection system indicates that these impacts should be relatively few in number. Future enlargement or expansion of the existing sanitary sewage collection system should be based upon specific building designs combined with actual campus sanitary sewage flow data.

I. Storm Sewer System

1. Current and Annual Load Growth and Consumption Profiles

Current and Annual load growth was performed through evaluating existing data from UW staff and projected building growth defined by a separate consulting firm performing a long range development plan (LRDP) for UW. The existing data consisted of current UW maps that included information on existing buildings and both impermeable and permeable surfaces. Projected growth areas were supplied by the LRDP on a map that included projected growth areas, including approximate building areas and impermeable and permeable surfaces. Discussions with the UW Physical Plant Staff have also provided insight regarding problem areas on campus.

2. Distribution Evaluation

Storm water hydrologic analyses and related hydraulic calculations were completed for selected basins within and near campus to assess potential impacts of future campus development on storm water runoff. Modeled basins were those specified by UW staff as the likely locations of near-term campus expansion and development. Campus drainage basins that are currently developed and are not anticipated to be the sites of future development or expansion were not modeled under future conditions. Map SW9 in Appendix II-I-1 shows the locations of these basins, which are listed and discussed below and which include:

- i. The area between Bradley St. and Flint St. and between 9th St. and 15th St.;
- ii. The area between Ivinson Avenue and Grand Avenue and between 9th St. and 15th St.;
- iii. The old student housing area at the east end of the campus;
- iv. Basin B21, the power plant – west basin;
- v. Basin B22, the Harney St. – east basin;
- vi. Basin B24, the Animal Sciences – north basin;
- vii. Basin B27, the Animal Sciences – southwest basin;
- viii. Basin 32, the Art Museum – east basin; and

ix. Basin B42, the 15th St./22nd St. – northwest basin.

i. Bradley St./Flint St. area

The Bradley St./Flint St. area is shown on Map SW9 in Appendix II-I-1. This area is currently full developed either with UW buildings or residential houses. It is reasonable to assume that, when this area is owned and fully developed by UW in the future, the impermeable portion of the area will not be significantly different than is currently the case. The average impermeable portion of campus drainage basins that were assessed under current conditions and that are summarized in Table II-I-1 is about 55%. During this and other analyses of future campus development, the percent impermeable following full development was assumed to be 55%. This adjustment typically resulted in post-development runoff CN values that were higher than pre-development values and post-development times of concentration that were lower than pre-development values. As a result, modeled peak post-development discharge rates for the basins under consideration were higher than modeled pre-development discharge rates.

The City of Laramie requires that storm water management during development results in calculation of a post-development peak storm water runoff rate during the 100 year storm that is equal to or less than the pre-development peak storm water runoff rate during the same storm. Since the Bradley St./Flint St. area is currently developed, the 14.9 cfs current calculated peak runoff rate at the drainage outlet of this area during the 100 year, 6 hour storm should not change significantly as a result of future campus development. This fact could be used as the basis for requesting City of Laramie waiver of required new detention pond design and construction in this area.

A C3D-generated runoff hydrograph for the 100 year, 6 hour storm over this area is included in Appendix III-I-1. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

ii. Ivinson Avenue/Grand Avenue area

This area is also shown on Map SW9 in Appendix II-I-1. The Ivinson Avenue/Grand Avenue area is currently full developed with UW buildings, other buildings, and houses. Like the Bradley St./Flint St. assessment described above, analysis of this area was based on the assumption that, when this area is owned and fully developed by UW, the impermeable portion of the area should not be significantly different from current conditions and should cover about 55% of the area. The calculated Ivinson Avenue/Grand Avenue peak discharge of 7.0 cfs should not change significantly as a result of future campus development in this area. As with the Bradley/Flint area, this fact could be used as the basis for requesting City of Laramie waiver of required new detention pond design and construction in this area during and as a result of future campus development.

A C3D-generated runoff hydrograph for this area and the 100 year, 6 hour storm is included in Appendix III-I-1. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

iii. Old student housing area

The old student housing area covers approximately 29 acres in the eastern portion of the campus as shown on Map SW9 in Appendix II-I-1. This area is currently fully developed with student residential structures, which will be demolished and replaced with other UW facilities in the future. Like the two analyses described above, analysis of this area was based on the assumption that the impermeable portion of the area does and will continue to cover about 55% of the area. The calculated current old student housing peak discharge rate of 9.8 cfs should not change significantly as a result of future campus development in this area. Again, this fact may reduce required future detention pond design and construction in this area.

A C3D-generated runoff hydrograph for this area and the 100 year, 6 hour storm is included in Appendix III-I-1. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

iv., iv., v., and vi. Basins B21, 22, and 24

As shown on Map SW9 in Appendix II-I-1, Basin B21, the power plant – west basin, discharges into an existing detention pond that is located at the intersection of 15th St. and Harney St. As is also shown on this map, nearby basins B20, B20A, B22, and B24 discharge into basin B21 and into the detention pond. These five basins were therefore assessed together under both existing conditions and projected post-development conditions during the 100 year, 6 hour storm. During this assessment, flow times were calculated through existing storm sewer pipes discharging from upstream basins B20A, B22, and B24 into downstream basins B20 and B21. Since calculated pipe flow times were short – typically less than two minutes – the five individual basin hydrographs were combined directly without routing between hydrographs. The combined hydrograph for each design storm was then routed through existing Pond B21.

Based on available information and site topography, the pre-development analysis indicated that Pond B21 should attenuate about 9.0 cfs of combined pond inflow from the 100 year, 6 hour storm to a peak pond discharge rate of 7.4 cfs with a maximum water depth of about 1.4 ft. The estimated depth of this pond based on one foot contours is approximately 2.0 ft. This post-development analysis also indicated that current pond storage capacity is inadequate to route the 100 year, 6 hour storm through the pond without the pond overtopping. A site survey of the detention pond area, from which a topographic map having a 0.2 ft or 0.5 ft contour interval could be prepared, would allow refinement of both the pre-development and the post-development pond routing models. Based on this analysis, the pond should be capable of routing inflow from the pre-development 100 year, 6 hour storm, but the

calculated amount of peak flow rate attenuation that is provided by the pond is not significant.

C3D-generated pre-development and post-development runoff hydrographs for each basin under consideration and combined pre- and post-development hydrographs for the 100 year, 6 hour storm are included in Appendix III-I-1. This appendix also contains pond routing output data. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

v. Basin 27

Pre-development and post-development hydrologic analysis of Basin 27, the Animal Sciences – southeast basin, during the 100 year, 6 hour storm indicated that 1.1 cfs pre-development peak storm water runoff discharge could increase to about 2.7 cfs post-development peak discharge. During future development of this basin, storm water management facilities will likely be required to attenuate the peak post-development discharge rate to a level equal to or less than the pre-development peak discharge rate.

A pre-development and a post-development C3D-generated runoff hydrograph for Basin 27 during the 100 year, 6 hour storm are included in Appendix III-I-1. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

vi. Basin 32

Pre-development and post-development hydrologic analysis of Basin 32, the Art Museum – east basin, during the 100 year, 6 hour storm indicated that 1.4 cfs pre-development peak storm water runoff discharge could increase to about 4.5 cfs post-development peak discharge. Storm water management facilities will likely be required during development of this basin to attenuate the peak post-development discharge rate to a level equal to or less than the pre-development peak discharge rate.

Pre-development and a post-development C3D-generated runoff hydrographs for Basin 32 during the 100 year, 6 hour storm are included in Appendix III-I-1. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

vii. Basin 42

Pre-development and post-development hydrologic analysis of Basin 42, the Animal Sciences – southeast basin, during the 100 year, 6 hour storm indicated that 0.7 cfs pre-development peak storm water runoff discharge could increase to about 3.3 cfs post-development peak discharge. As with Basin 27, the Cemetery/Willett St. basin, and Basin 32, the Art Museum – east basin, storm water management facilities will likely be required during development of this basin to attenuate the

peak post-development discharge rate to a level equal to or less than the pre-development peak discharge rate.

Pre-development and a post-development C3D-generated runoff hydrographs for Basin 42 during the 100 year, 6 hour storm are included in Appendix III-I-1. Calculations are shown in the Appendix II-I-2 work spreadsheet. Hydrologic data and C3D output data are summarized in Table III-I-1 below.

Table III-I-1

<u>Item no.</u>	<u>Basin no. and name</u>	<u>Area (ac)</u>	<u>CN</u>	<u>Time of concentration (min)</u>	<u>Qpk, 100 yr, 6 hr storm, pre-development</u>	<u>Qpk, 100 yr, 6 hr storm, post-development</u>
1	Bradley St/Flint St	34.78	82.2	40.9	14.9	14.9
2	Iverson/Grand Ave	18.30	84.1	67.9	7.0	7.0
3	Old student housing	28.83	81.3	54.8	9.8	9.8
4	Basin B20 - existing	3.70	82.7	90.2	1.1	na
5	Basin B20A - existing	5.00	77.8	63.1	1.2	na
6	Basin B21 – existing	16.00	76.7	46.1	3.9	na
7	Basin B22 – existing	7.45	79.2	115.9	1.5	na
8	Basin B24 - existing	13.42	74.6	64.1	2.3	na
9	Combined	45.57	na	na	9.0	na
10	Basin B20 – future	3.70	85.1	89.8	na	1.3
11	Basin B20A – future	5.00	85.7	63.1	na	2.3
12	Basin B21 – future	16.00	86.2	44.5	na	9.0
13	Basin B22 – future	7.45	87.2	115.5	na	2.6
14	Basin B24 - future	13.42	87.2	62.7	na	6.9
15	Combined	45.57	na	na	na	20.2
16	Basin 27	3.69	76.7	31.0	1.1	na
			87.2	31.0	na	2.7
17	Basin 32	8.83	71.9	39.0	1.4	na
			83.9	38.6	na	4.5
18	Basin 42	9.26	66.8	52.1	0.7	na
			81.4	51.2	na	3.3