Northwest Power and Conservation Council

February 7, 2006

MEMORANDUM

TO: Power Committee Members

FROM: Terry Morlan

SUBJECT: Presentation on Transmission System Effects of 2005 Summer Spill

Michael Viles of the Bonneville Transmission Business Line will present an analysis of the effects of 2005 summer spill requirements on the Bonneville transmission system. Beyond providing information on how the summer spill requirements affected Bonneville's transmission system operations, the presentation should be very educational about how the transmission system operates and where some of the current constraints on the system exist.

This is an informational briefing and does not require any Council action.

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851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

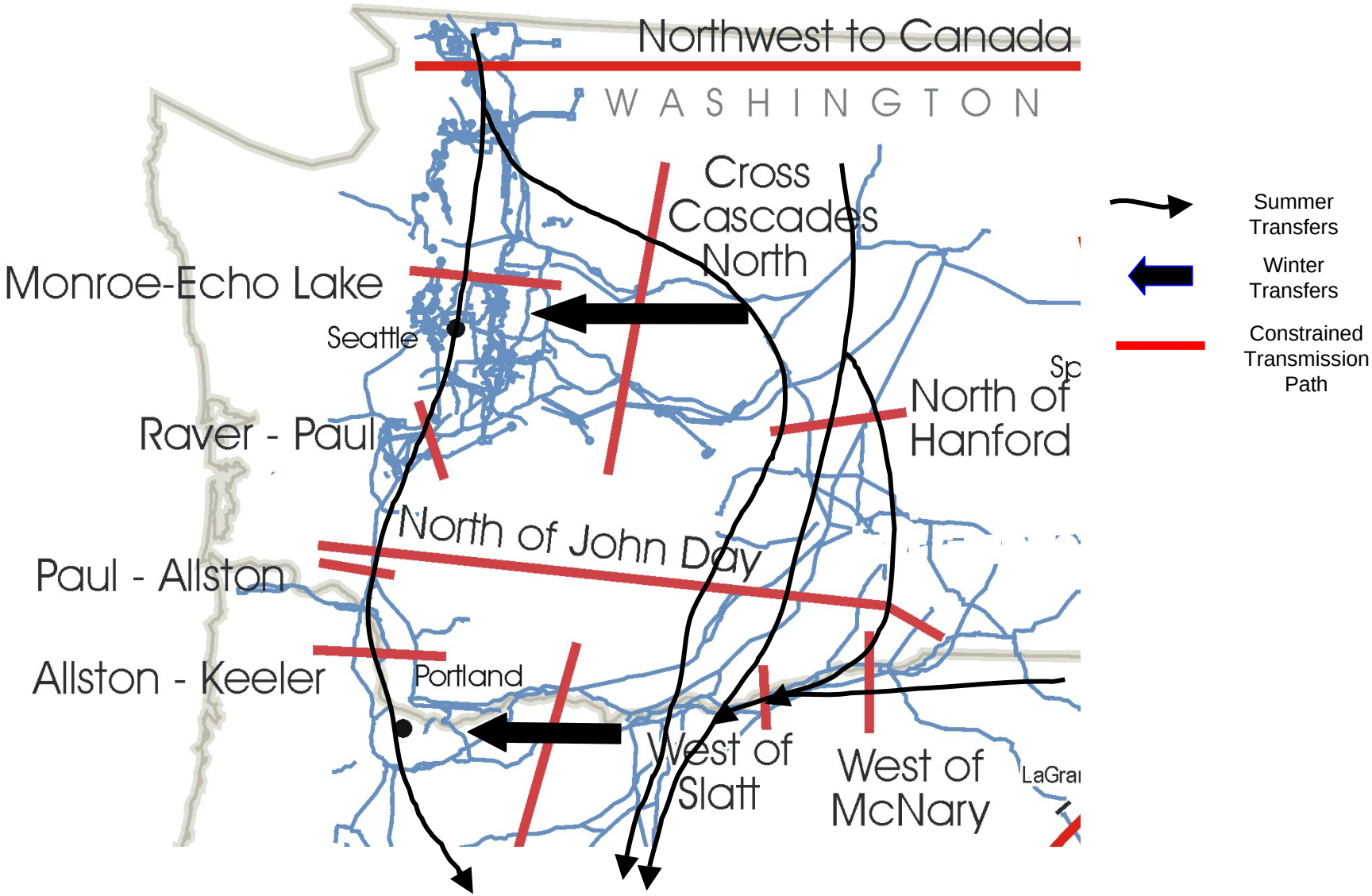
NW Transmission System Bottlenecks and Impacts of 2005 Summer Operation

BPA Transmission Business Line
Mike Viles
System Engineer, Technical Operations
February 2006

Transmission Loading Characteristics

- NW load peaks in Winter
  - Heaviest power flows are east to west
- Spring run-off
  - Heavy NW to Canada power flows
- California peaks in Summer
  - Heaviest power flows are north to south

Figure 1: NW Paths & Seasonal Direction of Powerflow



Summer 2005 Problem Areas

- North of Hanford Path
  - Monitors flow of power on two 500-kV lines on eastside of Cascade Mountains.
- Paul-Allston Path
  - Monitors flow of power on two 500-kV lines between Olympia and Longview.
- Allston-Keeler Path
  - Monitors flow of power on one 500-kV line between Longview and Portland

Problems

- Exceeding the Operational Transfer Capability (OTC) of these paths
  - Operating above an OTC creates risk of unreliable system response to critical contingences
  - WECC requires that the actual power flow on these paths get below the OTC within 20 (stability limited) or 30 minutes (thermally limited)
  - Amount of OTC excursions and time above OTC was significantly higher in Summer 2005 than Summer 2004 and Summer 2003

Transmission Impacts of Increased Spill on Lower Snake and Lower Columbia Projects

- Reducing generation on the Lower Snake and Lower Columbia plants:
  - Increases North to South power flow across problem paths (see next 2 slides)
  - Reduces transfer capability from NW to California

Figure 2: North of Hanford Flow

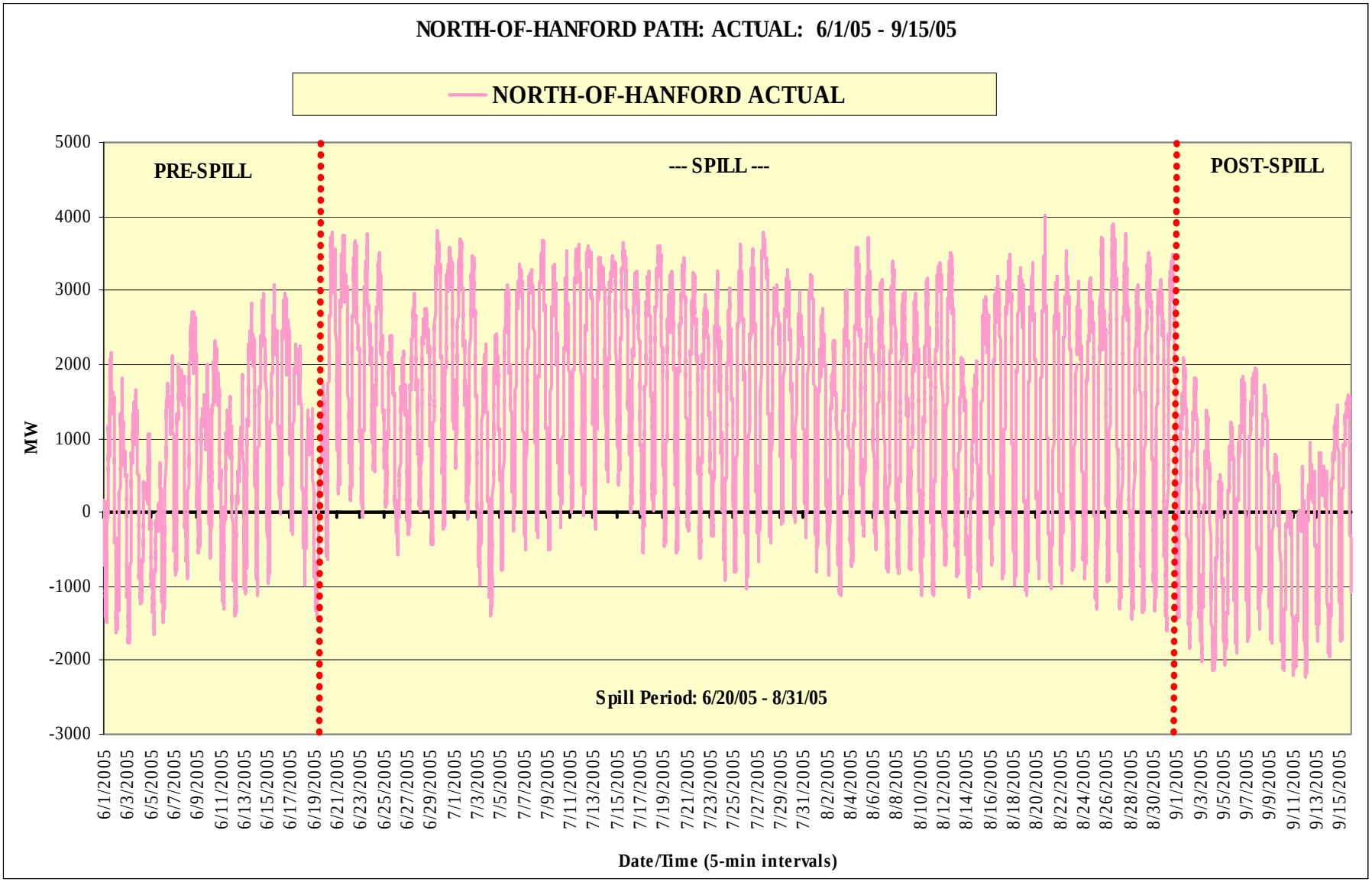
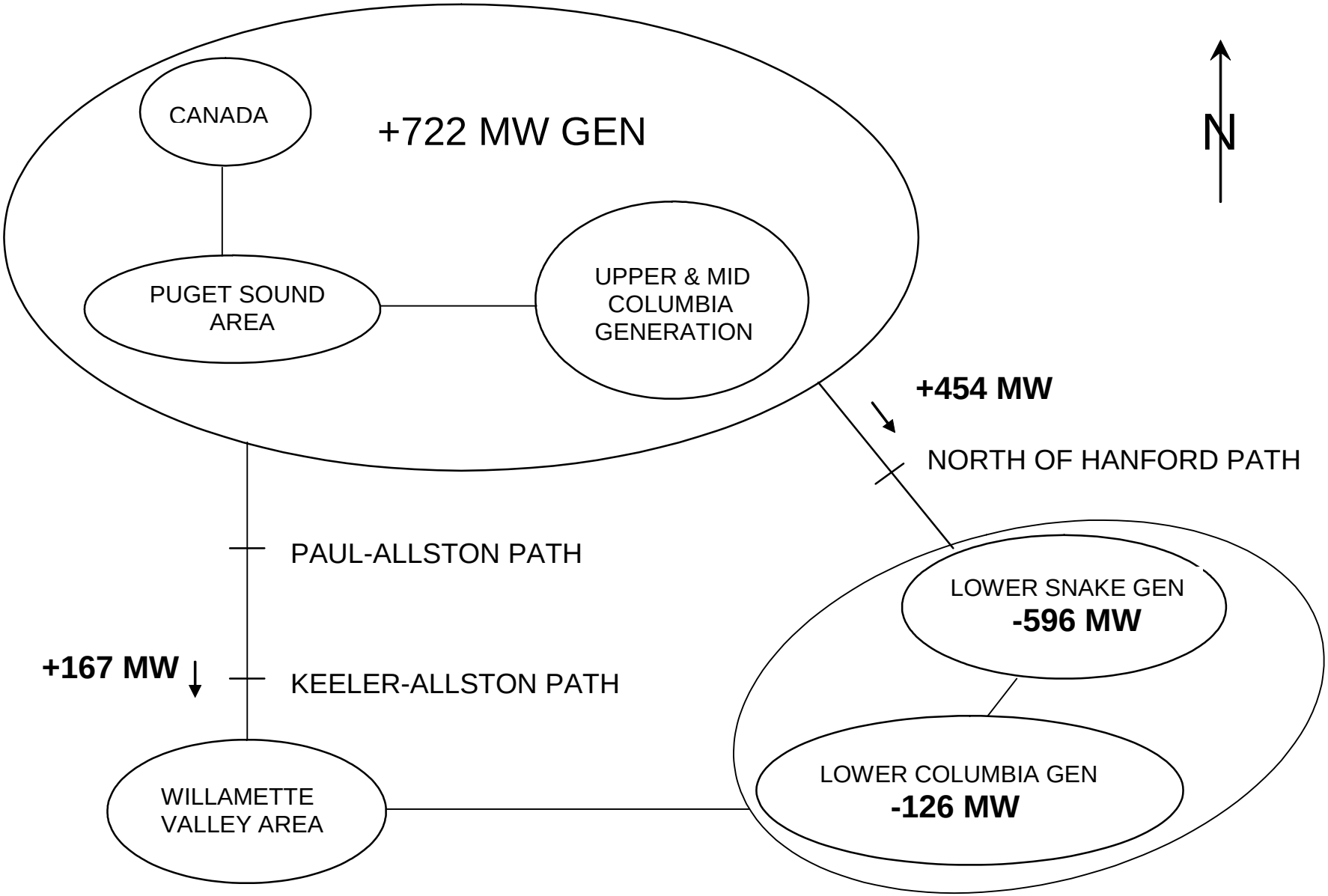


Figure 3: Peak Generation Changes between 6/17/05 & 6/21/05



SUMMER 2005 INCREASED SPILL OPERATIONS RESULTED IN GREATLY INCREASED POWER FLOW FROM NORTH TO SOUTH OVER KEY CONSTRAINED TRANSMISSION PATHS

FIGURE 4: PATH FLOWS OVER OTC (JUN-AUG)

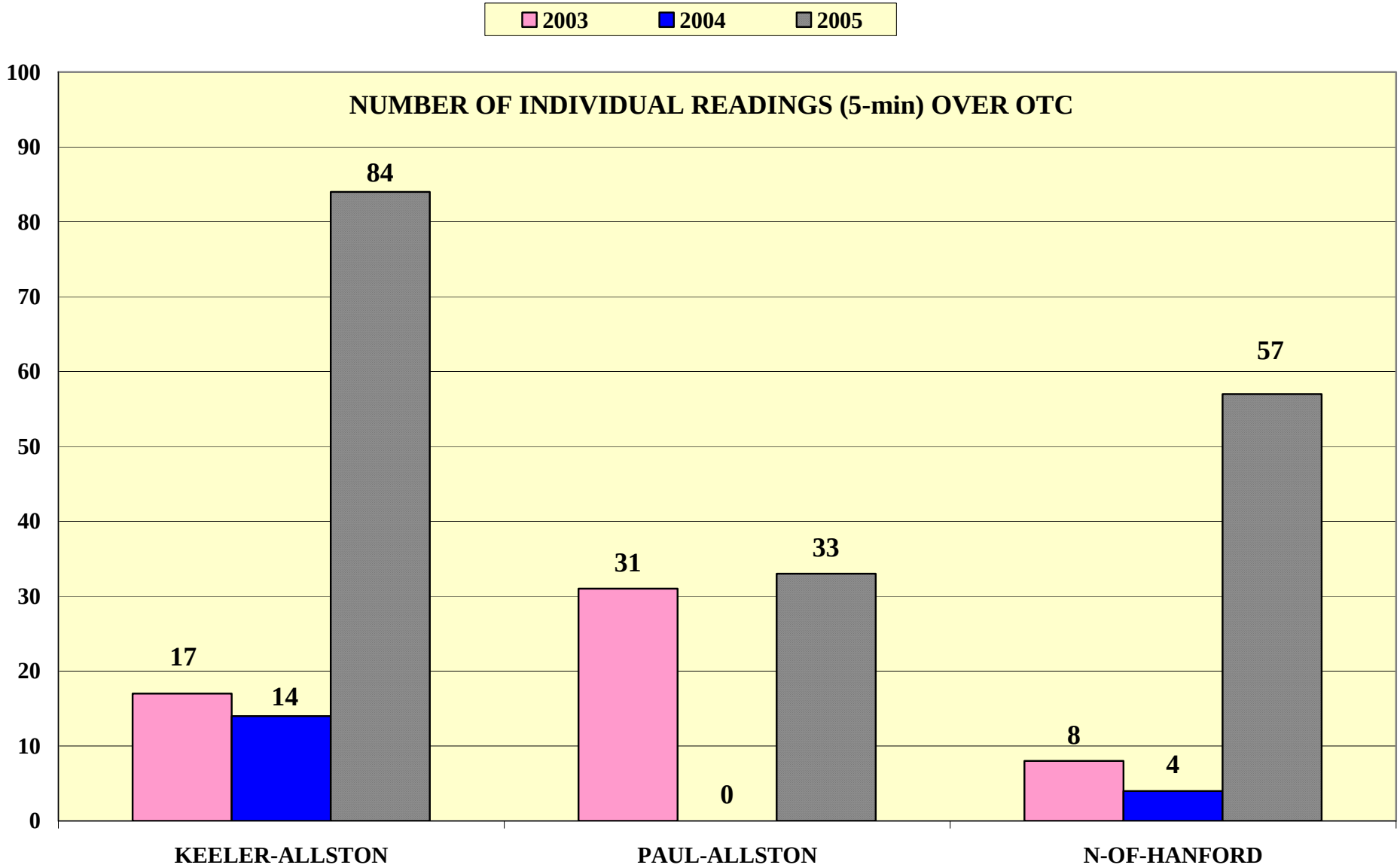
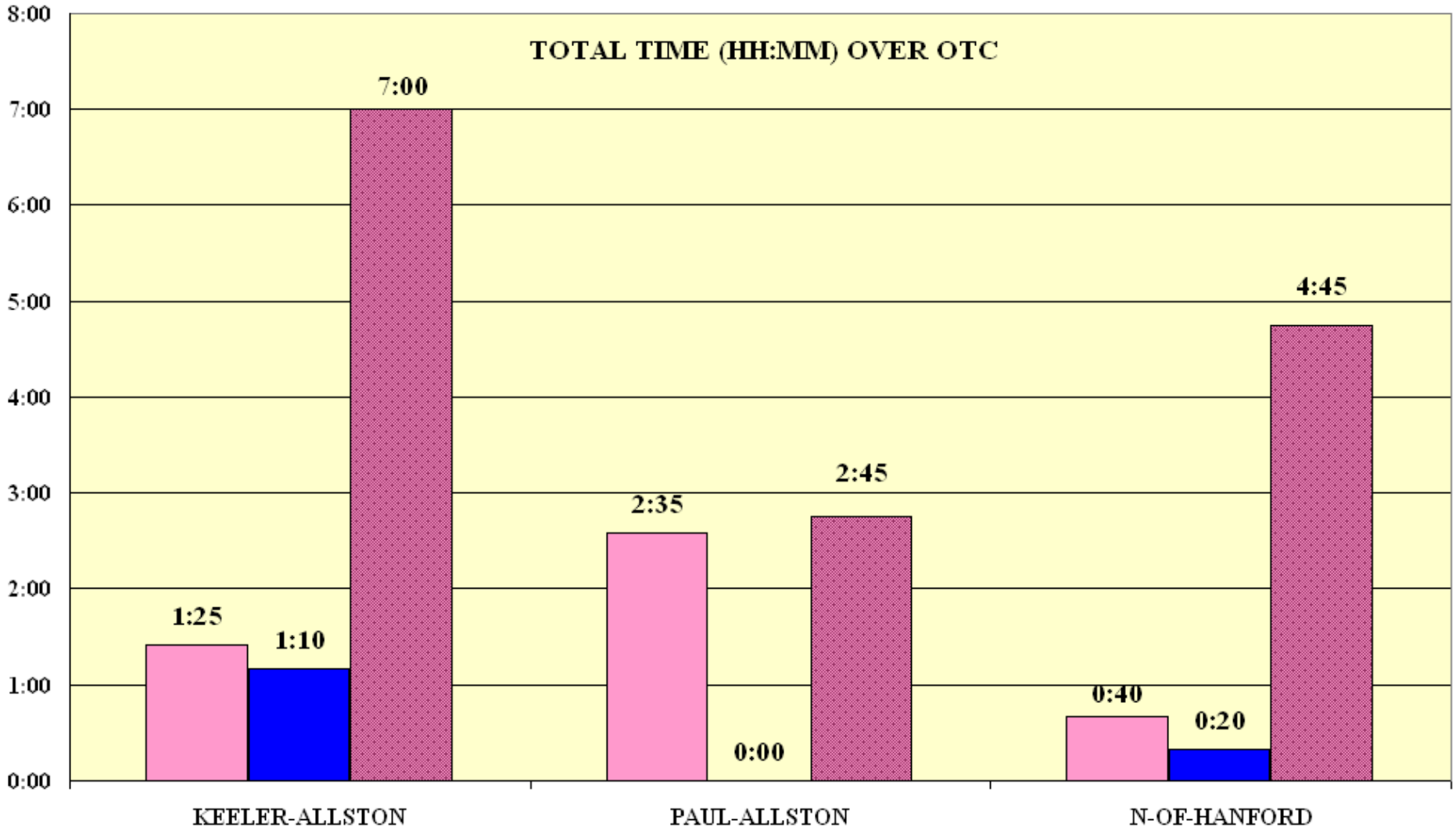


FIGURE 5: PATH FLOWS OVER OTC (JUN-AUG)



OTC Excursions in August 2005

- In August 2005 there were 29 periods when the OTC of one of these paths was exceeded for at least 5 minutes (Table 1) using 10 second SCADA data. Figure 4 and 5 used minute SCADA data.
  - 10 second data for BPA monitored paths started being collected on August 1, 2005.

OTC Excursions in August 2005

- Comparison of 10 second data vs. 5 minute data for August 2005 below shows that the 10 second data has slightly more time over the OTC and a higher maximum excursion

10 SECOND DATA VS. 5 MINUTE SCADA DATA ANALYSIS FOR AUGUST 2005

	KEELER-ALLSTON		PAUL-ALLSTON		NORTH OF HANFORD	
	10 SECOND	5 MINUTE	10 SECOND	5 MINUTE	10 SECOND	5 MINUTE
TIME OVER OTC (hh:mm:ss)	4:11:00	4:10:00	3:14:50	2:45:00	2:45:30	2:40:00
MAXIMUM AMOUNT OVER OTC (MW)	228	222	122	110	359	322
AVERAGE AMOUNT OVER OTC	7	20	17	25	22	69

TABLE 1: OTC EXCURSIONS IN AUGUST 2005

EVENT	PATH	START EXCURSION	EXCURSION DURATION (mm:ss)	EXCURSION MAX MW OVER OTC
1	Paul-Allston	04-Aug-05 10:57:00	05:00	14.2
2	Paul-Allston	04-Aug-05 11:04:50	12:50	75.6
3	Paul-Allston	04-Aug-05 11:53:00	06:10	57.3
4	Keeler-Allston	04-Aug-05 13:55:50	06:00	43.2
5	Keeler-Allston	04-Aug-05 16:46:40	08:20	12.8
6	Keeler-Allston	04-Aug-05 17:13:10	06:40	17.0
7	Paul-Allston	05-Aug-05 09:50:10	30:00	122.1
8	Keeler-Allston	05-Aug-05 13:09:20	20:40	36.4
9	Keeler-Allston	06-Aug-05 16:22:30	**05:50**	**227.9**
10	Paul-Allston	09-Aug-05 11:57:30	08:30	51.7
11	Paul-Allston	12-Aug-05 10:16:30	28:40	55.1
12	Paul-Allston	12-Aug-05 10:59:00	05:10	23.6
13	Paul-Allston	12-Aug-05 11:06:50	25:10	46.8
14	Paul-Allston	17-Aug-05 10:06:30	07:20	46.3
15	North-of-Hanford	20-Aug-05 17:54:40	**07:30**	**359.0**
16	Keeler-Allston	25-Aug-05 14:04:00	16:00	30.9
17	Keeler-Allston	25-Aug-05 15:10:10	12:40	38.3
18	Paul-Allston	26-Aug-05 09:55:50	17:50	73.8
19	Keeler-Allston	26-Aug-05 12:42:20	15:00	55.9
20	North-of-Hanford	26-Aug-05 12:54:50	28:30	220.6
21	Keeler-Allston	26-Aug-05 13:03:00	20:10	61.3
22	Keeler-Allston	26-Aug-05 13:27:10	17:50	72.7
23	North-of-Hanford	26-Aug-05 13:27:50	18:50	147.7
24	North-of-Hanford	26-Aug-05 14:00:00	20:20	146.4
25	Keeler-Allston	26-Aug-05 14:02:20	10:30	36.0
26	North-of-Hanford	26-Aug-05 14:27:10	18:00	109.0
27	North-of-Hanford	26-Aug-05 15:11:30	24:10	73.3
28	North-of-Hanford	27-Aug-05 16:26:00	09:40	73.3
29	Keeler-Allston	27-Aug-05 16:28:10	06:50	20.2

Shaded times indicate simultaneous problems on multiple paths

BOLD Indicates excursion caused by line outage

Unplanned Transmission Outages

- The two largest OTC excursions (events 9 and 15) were caused by temporary unplanned transmission line outages.
  - The excursion goes away when the line is put back in service
  - Large dispatcher response would have been needed if the line could not be returned to service

Planned Transmission Outages

- 16 of the 29 OTC excursions were aggravated by reduced OTC caused by planned system outages.
  - All 10 OTC excursions on Paul-Allston path were aggravated by planned outages to replace wood poles
    - Work was planned for 16 days from 5 AM to Noon to avoid the afternoon high load periods
    - There were OTC excursions on 6 days
    - The OTC excursions on this path would not have occurred with the normal path OTC

Planned Transmission Outages

- The six OTC excursions on the Keeler-Allston path on August 25 and 26 were aggravated by a planned maintenance outage of a 230/115 kV transformer
  - The reduction in OTC was only 10 MW so all the OTC excursions would have happened even if the transformer had been in service.
  - The duration and magnitude of the OTC excursions increased as a result of the outage, placing the system in a “riskier” operating position.

Simultaneous Problems

- On August 26 and 27, BPA dispatchers had to fight simultaneous problems on the Keeler-Allston and North of Hanford paths.

Response to OTC Excursions

- 20 of these OTC excursions required dispatcher action to reduce the flow on the path (Table 2)
- In some cases, the dispatcher action is significant

TABLE 2: DISPATCHER ACTIONS

EVENT	PATH	START EXCURSION	EXCURSION DURATION (mm:ss)	EXCURSION MAX MW OVER OTC	BPA DISPATCHER ACTIONS			
					A. BYPASS SERIES CAPACITORS (# bypassed)	B. REQUEST PHASE SHIFTER OPERATION	C. PBL GENERATION REDISPATCH	D. CURTAIL SCHEDULES
2	Paul-Allston	04-Aug-05 11:04:50	12:50	75.6	Yes (4)		140 MW UC to LC	106 MW
4	Keeler-Allston	04-Aug-05 13:55:50	06:00	43.2	Yes (4)			
6	Keeler-Allston	04-Aug-05 17:13:10	06:40	17.0			200 MW UC to LC	
7	Paul-Allston	05-Aug-05 09:50:10	30:00	122.1	Yes (4)		300 MW UC to LC	191 MW
8	Keeler-Allston	05-Aug-05 13:09:20	20:40	36.4	Yes (4)		140 MW UC to LC	182 MW
10	Paul-Allston	09-Aug-05 11:57:30	08:30	51.7	Yes (4)	100 MW W to E		
11	Paul-Allston	12-Aug-05 10:16:30	28:40	55.1	Yes (4)	50 MW W to E	200 MW UC to LC	345 MW
13	Paul-Allston	12-Aug-05 11:06:50	25:10	46.8		100 MW W to E		110 MW
14	Paul-Allston	17-Aug-05 10:06:30	07:20	46.3	Yes (4)	Yes	200 MW UC to LC	400 MW
16	Keeler-Allston	25-Aug-05 14:04:00	16:00	30.9			200 MW UC to LC	222 MW
17	Keeler-Allston	25-Aug-05 15:10:10	12:40	38.3			100 MW UC to LC	72 MW
18	Paul-Allston	26-Aug-05 09:55:50	17:50	73.8	Yes (4)	50 MW W to E	200 MW UC to LC	356 MW
19	Keeler-Allston	26-Aug-05 12:42:20	15:00	55.9	Yes (4) / No (4)	100 MW W to E	Not Available	286 MW
20	North-of-Hanford	26-Aug-05 12:54:50	28:30	220.6	No (4)			
21	Keeler-Allston	26-Aug-05 13:03:00	20:10	61.3				450 MW
22	Keeler-Allston	26-Aug-05 13:27:10	17:50	72.7				300 MW
25	Keeler-Allston	26-Aug-05 14:02:20	10:30	36.0				
26	North-of-Hanford	26-Aug-05 14:27:10	18:00	109.0				300 MW
27	North-of-Hanford	26-Aug-05 15:11:30	24:10	73.3			Not Available	
28	North-of-Hanford	27-Aug-05 16:26:00	09:40	73.3			200 MW	

Shaded times indicate simultaneous problems on multiple paths

Definitions: UC = Upper Columbia, LC = Lower Columbia

Tools in the Toolbox

- Existing tools are reactive instead of pro-active
- Bypass series capacitors in east to west transmission to force more power flow north to south on the east side of the Cascades
  - Helps relieve west side problem but may shift problem to east side (see events 19 and 20)

Tools in the Toolbox

- Use Nelway phase shifter to move power to the east side of the Cascades
- PBL redispatch from Upper Columbia to Lower Columbia plants
  - Dependent on water constraints
  - May not be very effective at relieving some paths (i.e., 5 MW redispatch unloads path 1 MW)
- Curtail Schedules
  - May not be very effective at relieving some paths

Summary

- Increased spill changed generation patterns and increased north to south flow on the NW transmission system
- The transmission system was operated “closer to the edge” in summer 2005 than summer 2004 and summer 2003 (i.e., significantly more OTC excursions)
- Planned and unplanned transmission outages impact OTCs
- OTC excursions can result in significant dispatcher action to control

Outlook for Summer 2006

- Expecting more water for generation on Lower Snake and Lower Columbia due to better water conditions and less spill in the summer
  - Reduced North to South power flow on internal paths
- Addition of the Schultz-Wautoma 500kV transmission line
  - Increases North of Hanford path capacity
  - Reduces loading on Keeler-Allston path

Problems in the Future

- The following will increase loading on the transmission system and aggravate existing problems and cause new problems
  - Load growth
  - New generation
  - Changes in generation patterns
    - Spill impacts
    - Outages of aging thermal units

Problems in the Future

- Our aging transmission will require more maintenance related outages
  - BPA has an ongoing spacer damper and wood pole replacement program
- To prevent an escalation of OTC excursions, tools are needed to manage schedules across the internal constrained paths.
  - This would allow curtailments in the pre-schedule timeframe and minimize real-time curtailments

The End