



COLORADO

Transportation
Investment Office

DYNAMIC PRICING POLICY WORKSHOP

CTIO Board Retreat

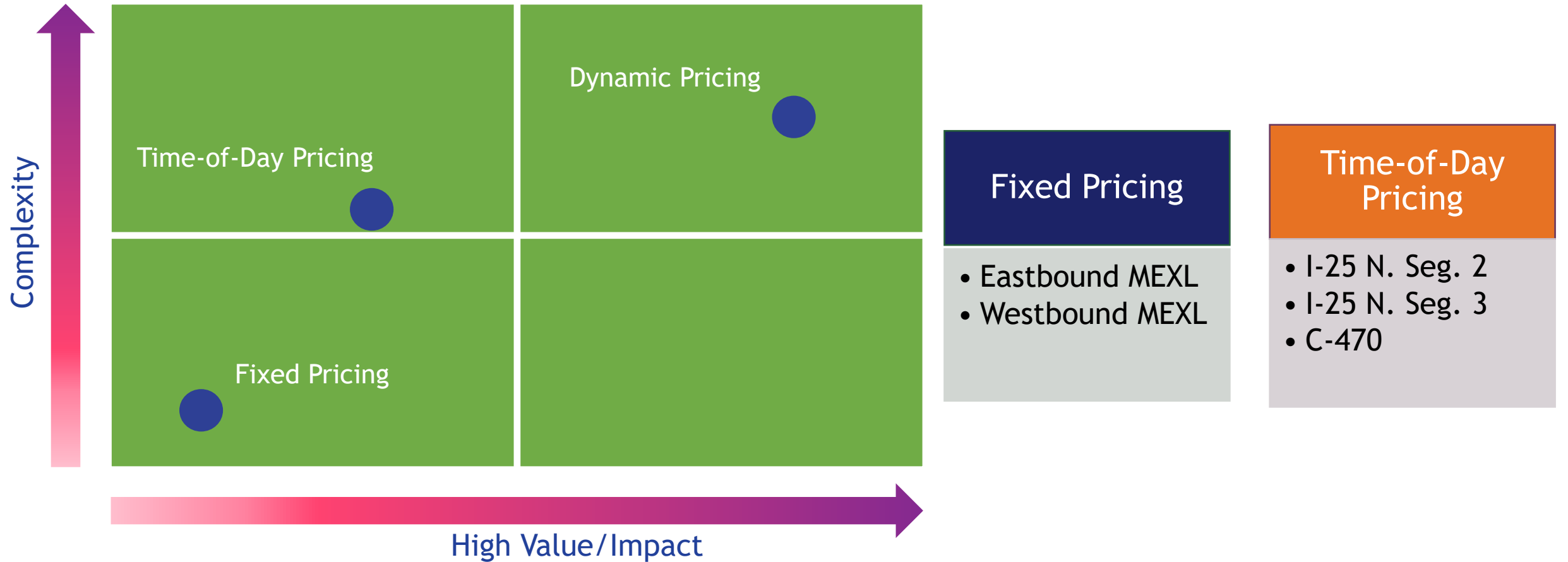
April 18, 2023

Introduction

- Overview
- Dynamic Pricing Data Collection Locations
- Key Criteria for Algorithm
- Dynamic Pricing Policy Decisions
- Timeline
- Questions

Overview

Pricing Strategies



What is Dynamic Pricing?

What is Dynamic Pricing?

- Dynamic pricing is a traffic demand management strategy that promotes travel time reliability in Express Lanes.

Benefit of Dynamic Pricing Over Time-of-Day Pricing

- Time-of-Day Pricing is based on historical traffic trends; it does not manage traffic demand efficiently during varying conditions.

Dynamic Pricing Data Collection Locations

Data Collection Location WB MEXL

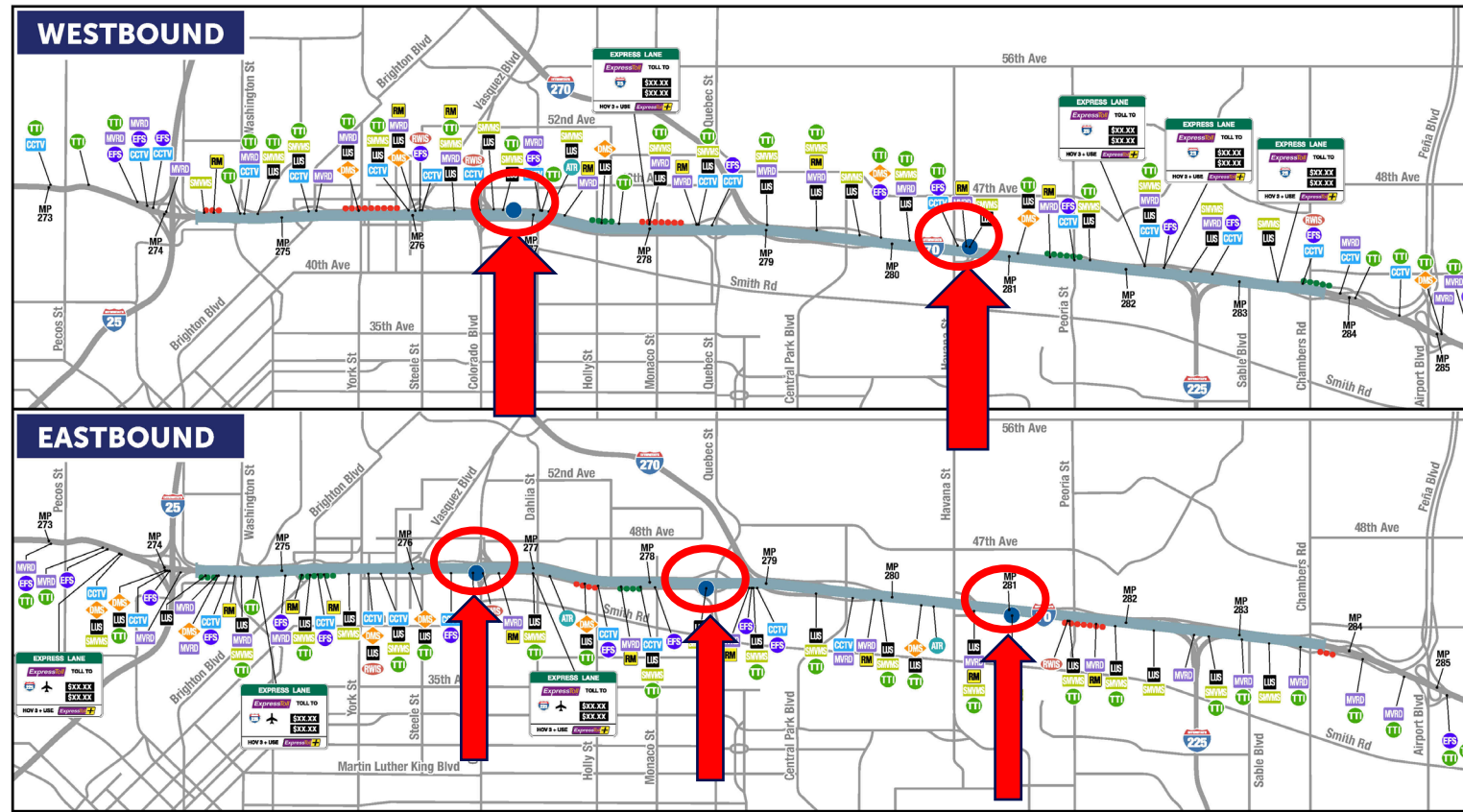


Data Collection Location Central 70

CENTRAL 70 EXPRESS LANES CORRIDOR



COLORADO
Department of Transportation



Key Criteria for Algorithm

Algorithm Goals

- **Maintain Speeds & Level of Service in Express Lanes**
- **Adhere to CTIO Tolling Policy**
 - **Fiscally responsible toll rates that balance needs such as:**
 - ✓ **Traffic speeds**
 - ✓ **Reliable travel times**
 - ✓ **Debt coverage**
 - ✓ **Operations and maintenance costs**
 - ✓ **Financing future corridor improvements**
- **Toll rates based on express lanes corridor-specific objectives**

Sample Algorithm Calculation

Parameter	Denote	Value	Unit
Speed_Optimal	s0	75	mph
Time_Optimal	t0	20	second
los_weight	los_weight	1	
toll_increment	deltaP	0.01	\$
delta_los_optima	deltaLosO	10	

Time_Optimal	t0	0.0056	hour
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Parameter	Denote	Value	Unit
positive_L	L+	10	
negative_L	L-	10	
positive_C	C+	1	
negative_C	C-	1	
positive_K	k+	7.5	
negative_K	k-	7.5	
positive_sigmoid	l+	0.15	
negative_sigmoid	l-	0.15	

Other config	Denote	Value	Unit
calculation interval	deltaT	300	second
traffic time window		600	second

LOS	A	B	C	D
minLOS	200	0	-200	-1000000
maxLOS	1000000	200	0	-200
minRate	0.25	0.5	0.75	1
maxRate	0.5	1	1.5	2

Hour	sML	vML	sGP	vGP	tML (second)	tGP (second)	tML (hour)	tGP (hour)	losML	losGP	los	Derivative	Exponent	Multiplier	Increment	CalculatedRate	Final Rate	minRate	maxRate
13:40	78.180832	26	67.693	99	23.07692308	6.060606061	0.006410256	0.001683502	39.52398498	-276.7212346	39.523985	-0.506687	4.9251515	1	0.01	0.51	0.51	0.5	1
13:45	77.452087	9	68.075	81	66.66666667	7.407407407	0.018518519	0.002057613	334.7019676	-218.6404319	334.70197	0.983927	-6.25445	-9	-0.09	0.42	0.42	0.25	0.5
13:50	77.535416	16	68.392	88	37.5	6.818181818	0.010416667	0.001893939	151.172051	-242.6993101	151.17205	-0.611766	5.7132479	1	0.01	0.43	0.5	0.5	1
13:55	76.811935	20	67.856	90	30	6.666666667	0.008333333	0.001851852	92.50885224	-247.9508176	92.508852	-0.195544	2.59158	0	0	0.5	0.5	0.5	1
14:0	76.07917	15	67.654	100	40	6	0.011111111	0.001666667	157.8730941	-279.8174245	157.87309	0.217881	-0.509106	-5	-0.05	0.45	0.5	0.5	1
14:5	77.166664	21	69.748	105	28.57142857	5.714285714	0.007936508	0.001587302	83.09998468	-303.0734529	83.099985	-0.249244	2.9943277	1	0.01	0.51	0.51	0.5	1
14:10	77.077499	20	69.134	94	30	6.382978723	0.008333333	0.00177305	93.83967227	-264.6118697	93.839672	0.035799	0.8565078	-2	-0.02	0.49	0.5	0.5	1
14:15	76.53125	17	66.944	110	35.29411765	5.454545455	0.009803922	0.001515152	129.3837124	-309.1515834	129.38371	0.11848	0.236399	-3	-0.03	0.47	0.5	0.5	1
14:20	75.4636	25	66.634	99	24	6.060606061	0.006666667	0.001683502	38.37227924	-273.4515266	38.372279	-0.303371	3.4002858	1	0.01	0.51	0.51	0.5	1
14:25	76.469299	31	66.837	118	19.35483871	5.084745763	0.005376344	0.001412429	-2.932325174	-333.7368668	-2.932325	-0.137682	0.0923849	4	0.04	0.55	0.75	0.75	1.5
14:30	76.409927	34	68.02	93	17.64705882	6.451612903	0.004901961	0.001792115	-22.28298917	-258.2047124	-22.28299	-0.064502	0.6412334	2	0.02	0.77	0.77	0.75	1.5
14:35	77.031677	38	66.252	105	15.78947368	5.714285714	0.004385965	0.001587302	-44.79115734	-291.0410678	-44.79116	-0.075027	0.5622958	3	0.03	0.8	0.8	0.75	1.5
14:40	76.908455	39	66.634	124	15.38461538	4.838709677	0.004273504	0.001344086	-50.56131455	-351.4687295	-50.56131	-0.019234	0.9807461	2	0.02	0.82	0.82	0.75	1.5
14:45	76.274475	29	66.588	104	20.68965517	5.769230769	0.005747126	0.001602564	10.38326965	-289.0540437	10.38327	0.203149	-0.398615	-5	-0.05	0.77	0.77	0.5	1
14:50	76.415268	31	68.618	103	19.35483871	5.825242718	0.005376344	0.001618123	-3.064429655	-292.6564125	-3.06443	-0.044826	0.7888075	2	0.02	0.79	0.79	0.75	1.5
14:55	77.728043	29	67.013	111	20.68965517	5.405405405	0.005747126	0.001501502	14.4218529	-312.5483348	14.421853	0.058288	0.6878429	-2	-0.02	0.77	0.77	0.5	1
15:0	75.732796	38	67.827	92	15.78947368	6.52173913	0.004385965	0.001811594	-46.65028082	-254.4137293	-46.65028	-0.203574	-0.401803	5	0.05	0.82	0.82	0.75	1.5
15:5	74.713539	41	69.964	95	14.63414634	6.315789474	0.004065041	0.001754386	-63.8134332	-270.3386447	-63.81343	-0.057211	0.6959212	2	0.02	0.84	0.84	0.75	1.5
15:10	75.933273	29	68.307	108	20.68965517	5.555555556	0.005747126	0.00154321	9.424722708	-307.7760668	9.4247227	0.244127	-0.705954	-6	-0.06	0.78	0.78	0.5	1
15:15	76.296455	37	66.706	124	16.21621622	4.838709677	0.004504505	0.001344086	-40.20329696	-351.7892032	-40.2033	-0.165427	-0.1157	4	0.04	0.82	0.82	0.75	1.5
15:20	77.081688	41	67.029	107	14.63414634	5.607476636	0.004065041	0.001557632	-61.25133522	-300.0180008	-61.25134	-0.07016	0.598799	3	0.03	0.85	0.85	0.75	1.5
15:25	76.666443	35	66.817	116	17.14285714	5.172413793	0.004761905	0.001436782	-27.87250387	-327.4274069	-27.8725	0.111263	1.9594708	0	0	0.85	0.85	0.75	1.5
15:30	76.006218	47	67.229	123	12.76595745	4.87804878	0.003546099	0.001355014	-92.38102679	-351.0008068	-92.38103	-0.215028	-0.487713	5	0.05	0.9	0.9	0.75	1.5
15:35	77.477951	55	69.281	117	10.90909091	5.128205128	0.003030303	0.001424501	-129.4962912	-340.6473952	-129.4963	-0.123718	0.1971184	4	0.04	0.94	0.94	0.75	1.5
15:40	74.24102	55	70.013	107	10.90909091	5.607476636	0.003030303	0.001557632	-128.5941938	-310.639266	-128.5942	0.003007	1.1475524	1	0.01	0.95	0.95	0.75	1.5
15:45	74.716263	77	70.379	125	7.792207792	4.8	0.002164502	0.001333333	-217.1773636	-371.5281022	-217.1774	-0.295277	-1.089579	6	0.06	1.01	1.01	1	2
15:50	76.321487	46	70.716	124	13.04347826	4.838709677	0.003623188	0.001344086	-87.39018787	-369.758282	-87.39019	0.432624	4.3696794	-1	-0.01	1	1	0.75	1.5

Algorithm Parameters

Parameter	Denote	Value	Unit
Speed_Optimal	s0	75	mph
Time_Optimal	t0	20	second
los_weight	los_weight	1	
toll_increment	deltaP	0.01	\$
delta_los_optima	deltaLosO	10	



Controls calculation of Level of Service and whether general purpose data is considered

Time_Optimal	t0	0.0056	hour
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Parameter	Denote	Value	Unit
positive_L	L+	10	
negativie_L	L-	10	
positive_C	C+	1	
negative_C	C-	1	
positive_K	k+	7.5	
negative_K	k-	7.5	
positive_sigmoid	l+	0.15	
negative_sigmoid	l-	0.15	



Controls how fast toll rates go up or down

Other config	Denote	Value	Unit
calculation interval	deltaT	300	second
traffic time window		600	second



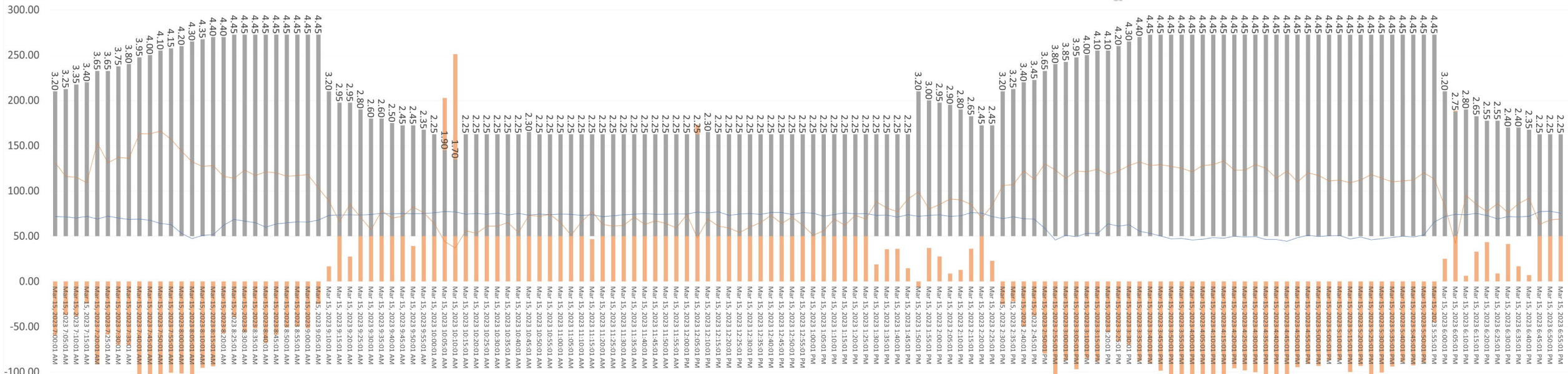
Controls how often new rates calculated

LOS	A	B	C	D
minLOS	200	0	-200	-1000000
maxLOS	1000000	200	0	-200
minRate	0.25	0.5	0.75	1
maxRate	0.5	1	1.5	2



Controls minimum and maximum toll rates (bands)

Dynamic Pricing Shadow Testing on C70



Rate Parameter

Param name	Param value	Dynamic los
Toll_Increment	0.05	
Max_Rate	5.00	LOS_D
Max_Rate	3.20	LOS_B
Max_Rate	2.25	LOS_A
Max_Rate	4.45	LOS_C
Min_Rate	2.25	LOS_B
Min_Rate	3.20	LOS_C
Min_Rate	4.45	LOS_D
Min_Rate	1.50	LOS_A
Time_Optimal	3.0	
Speed_Optimal	75.0	
LOS_Weight	1.0	
Positive_K	7.5	
Negative_K	7.5	

Role of Toll Engineer Related to Dynamic Pricing



Dynamic Pricing Policy Decisions

Dynamic Pricing Algorithm Parameters (Criteria) Policy Considerations

Capped or not capped maximum rates (Policy)

- Recommend capping maximum toll rates

Rate Change interval (Corridor-based)

- Most common are 5, 10, and 15 minutes
- Recommend 5 minutes

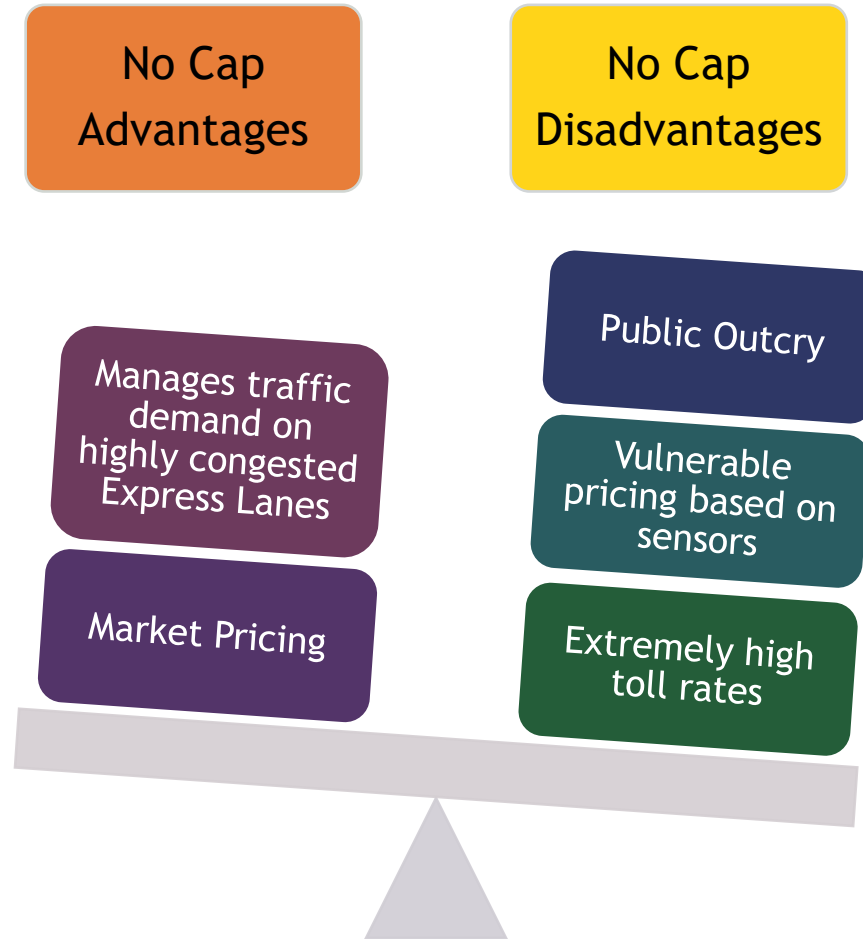
Maximum Increment or Decrement (Corridor-based)

- Most common, 5 cents, 10 cents, and 25 cents
- Recommend corridor-specific amounts

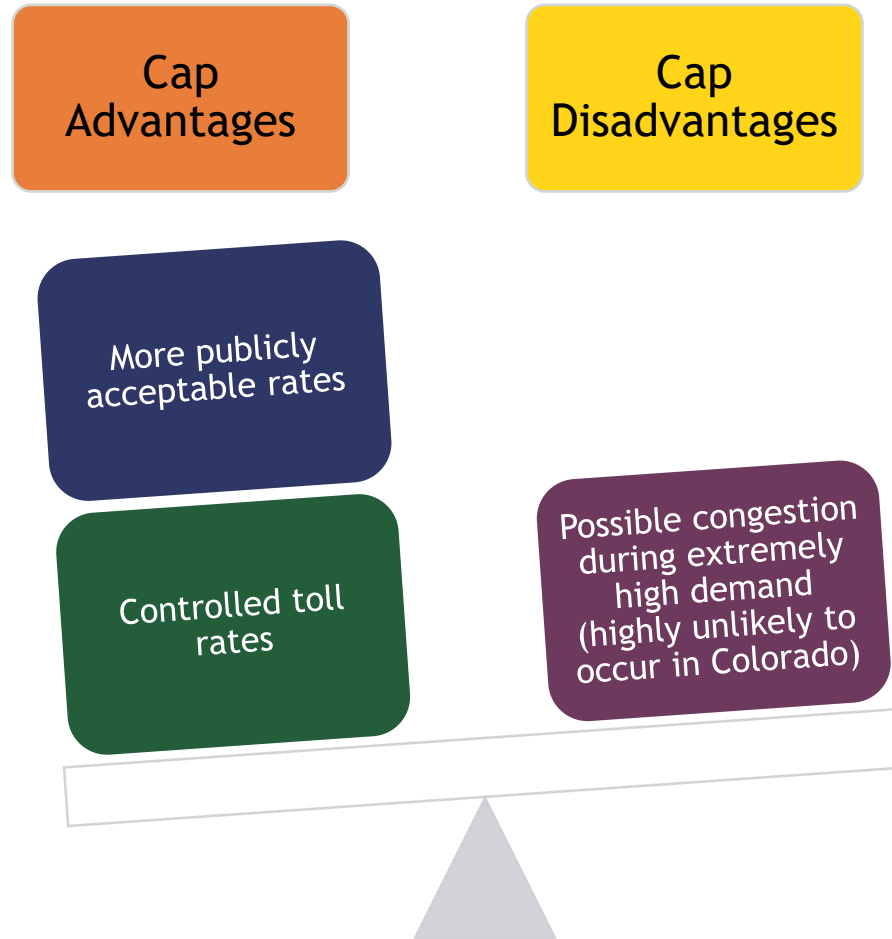
Procedure to Reconsider Board-Approved Algorithm

- Algorithm goals of adhering to Tolling Policy objective(s) are not being met

Advantages and Disadvantages Related to “No Cap”

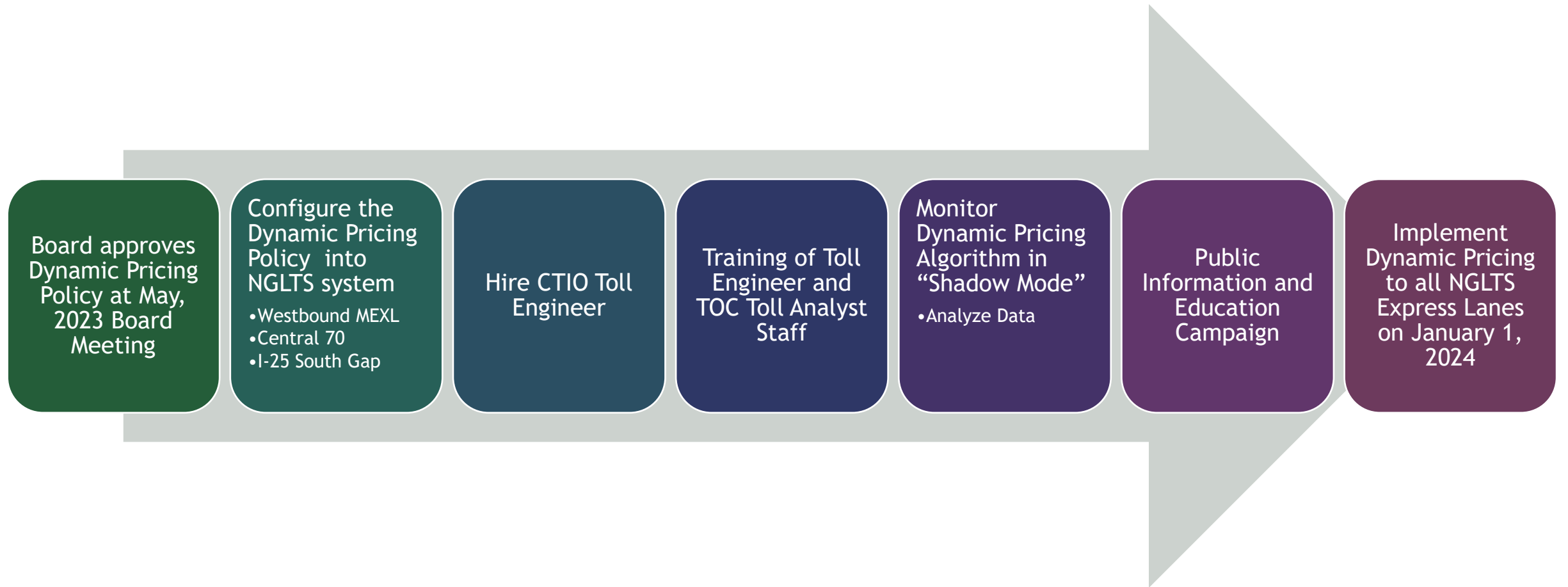


Advantages and Disadvantages Related to a “Cap”



Timeline

Next Steps Timeline



Questions and Comments