GDC

BIG WORLD, SMALL TEAM
DESIGNING A SCALABLE AMBIENCE SYSTEM FOR GHOST OF TSUSHIMA

Apoorva Bansal

Rev. Dr. Bradley D Meyer

IT TOOK A VILLAGE

SOUND DESIGN	MUSIC	VO
Rev. Dr. Bradley D Meyer	Andrew Buresh	Kyle Richards
Josh Lord	Pete Scaturro	Bianca Salinas
Michelle Hebert	Keith Leary	Heather Plunkard
Michael Pitaniello	Nicholas Mastroianni	Leilani Ramirez
Tye Hastings	Adam Kallibjian	Kevin McClelland
Adam Lidbetter	Sonia Coronado	**QA**
Mike Niederquell	Monty Mudd	Morgan Fryer-McCulloch
Erik Buensuceso	Scott Shoemaker	Jeric Chapman
Safar Bake	Dan Ramos	**PROGRAMMING**
Rob Castro		Apoorva Bansal
Andres Herrera		

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PROLOGUE

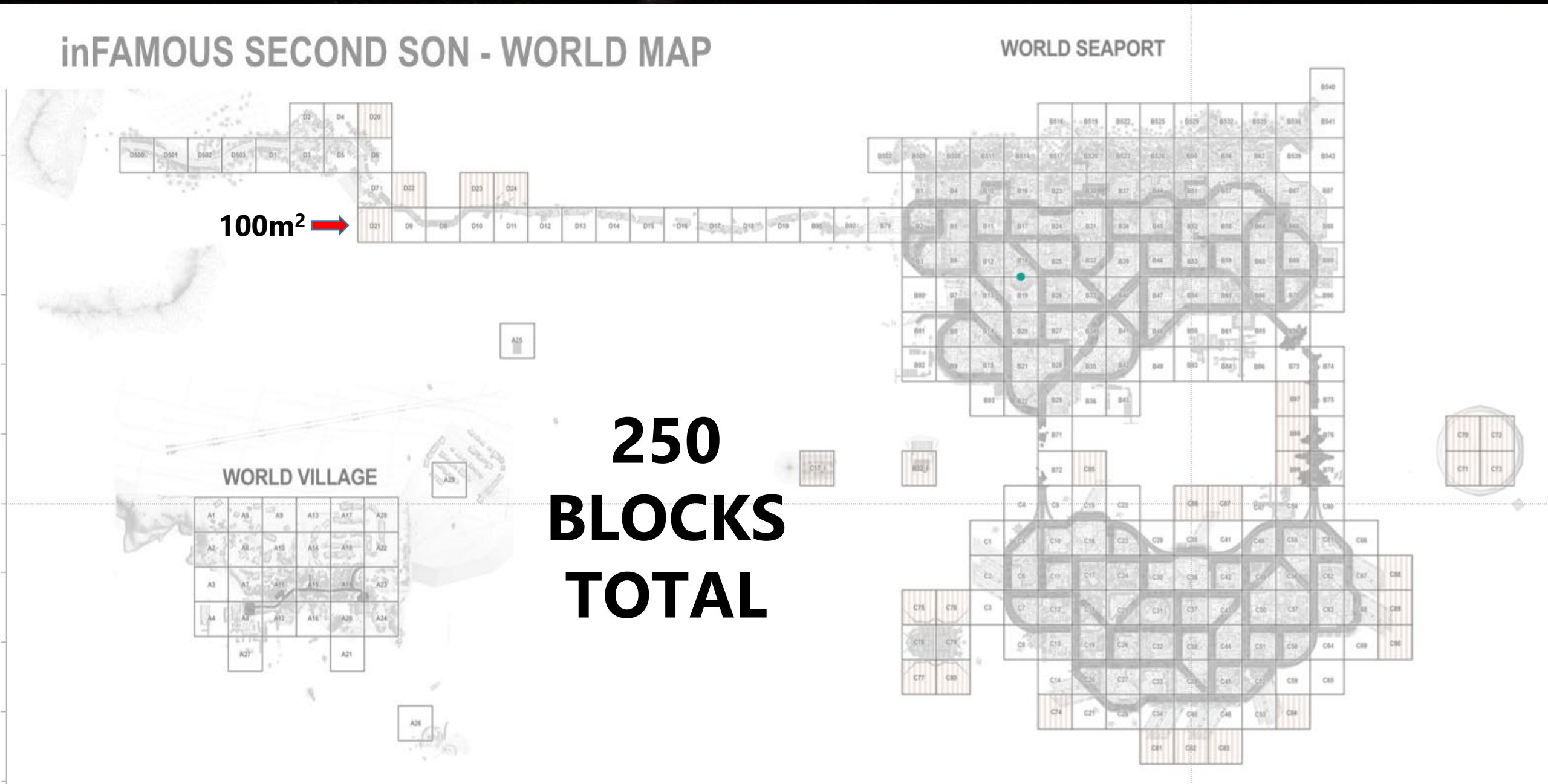
2012

IN THE BEGINNING…

GHOST

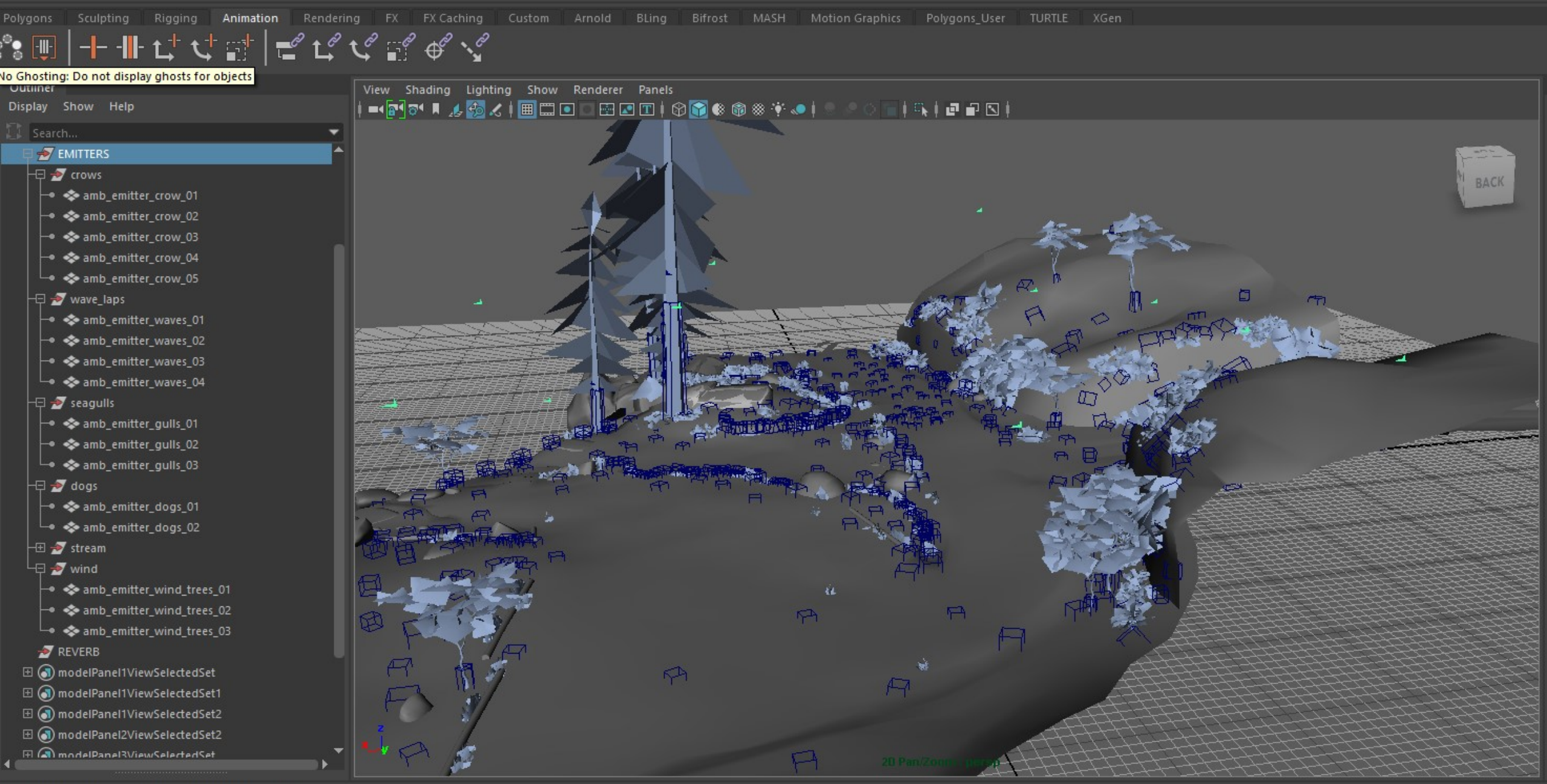

SEATTLES
SEATTLES

IN THE BEGINNING…



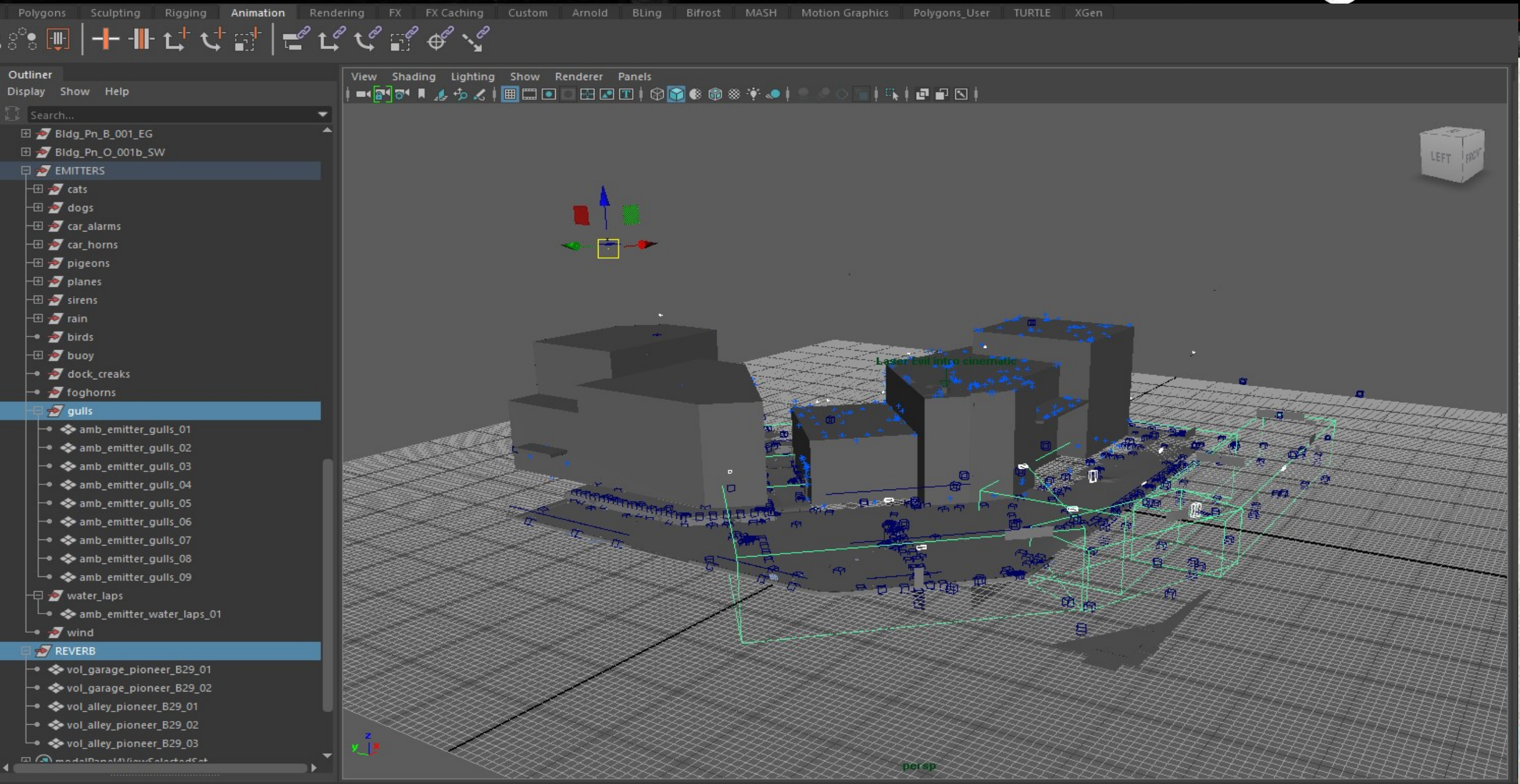
IN THE BEGINNING...

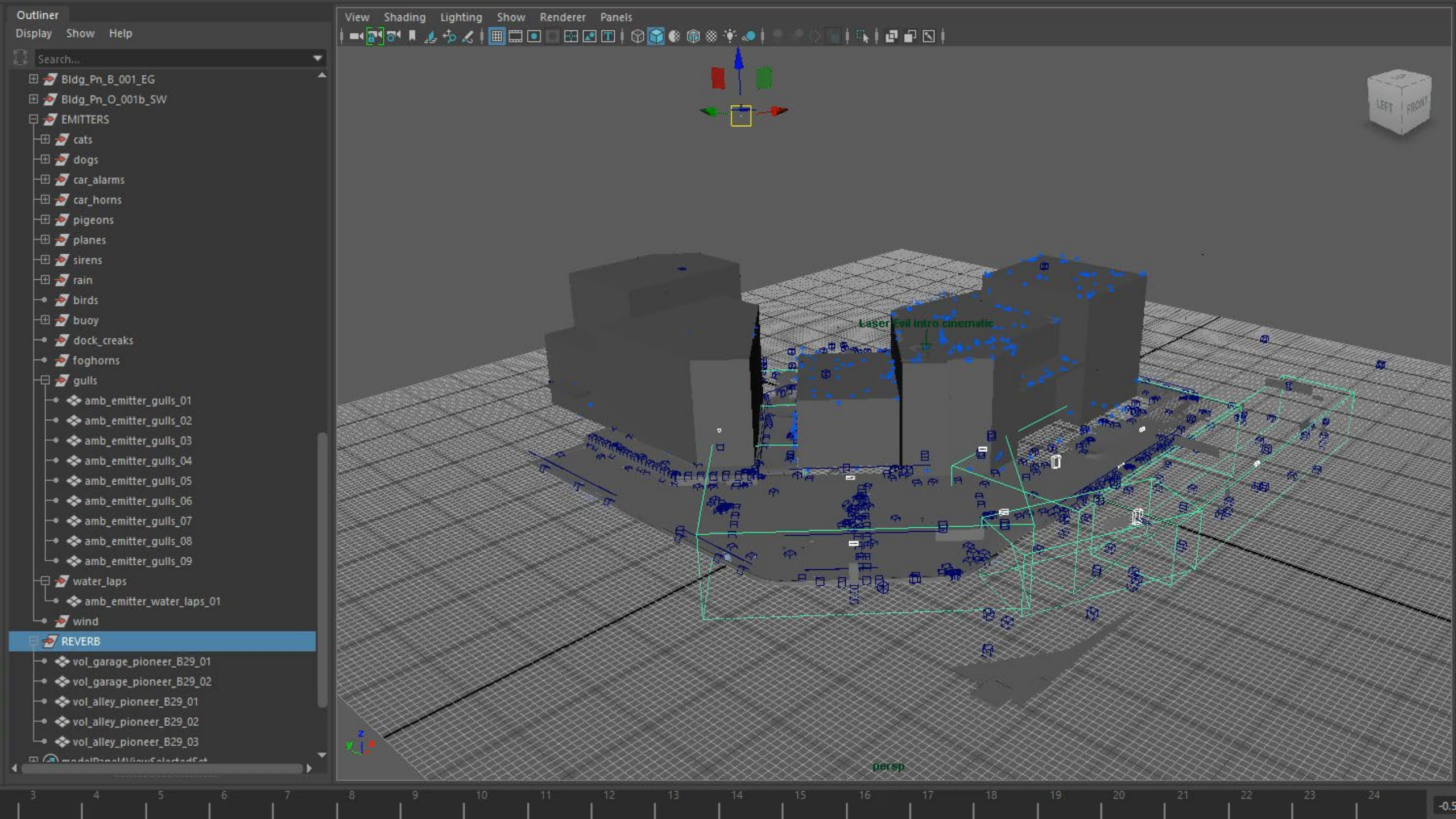
GHOST



IN THE BEGINNING...

GHOST




Outliner
Display
Show
Help
Search...
BIdg_Pn_B_001_EG
BIdg_Pn_O_001b_SW
EMITTERS
cats
dogs
car_alarms
car_horns
pigeons
planes
sirens
rain
birds
buoy
dock_creaks
foghorns
gulls
amb_emitter_gulls_01
amb_emitter_gulls_02
amb_emitter_gulls_03
amb_emitter_gulls_04
amb_emitter_gulls_05
amb_emitter_gulls_06
amb_emitter_gulls_07
amb_emitter_gulls_08
amb_emitter_gulls_09
water_laps
amb_emitter_water_laps_01
wind
REVERB
vol_garage_pioneer_B29_01
vol_garage_pioneer_B29_02
vol_alley_pioneer_B29_01
vol_alley_pioneer_B29_02
vol_alley_pioneer_B29_03
View
Shading
Lighting
Show
Renderer
Panels
Laser Eye intro cinematic
LEFT
FRONT
persp
3
4
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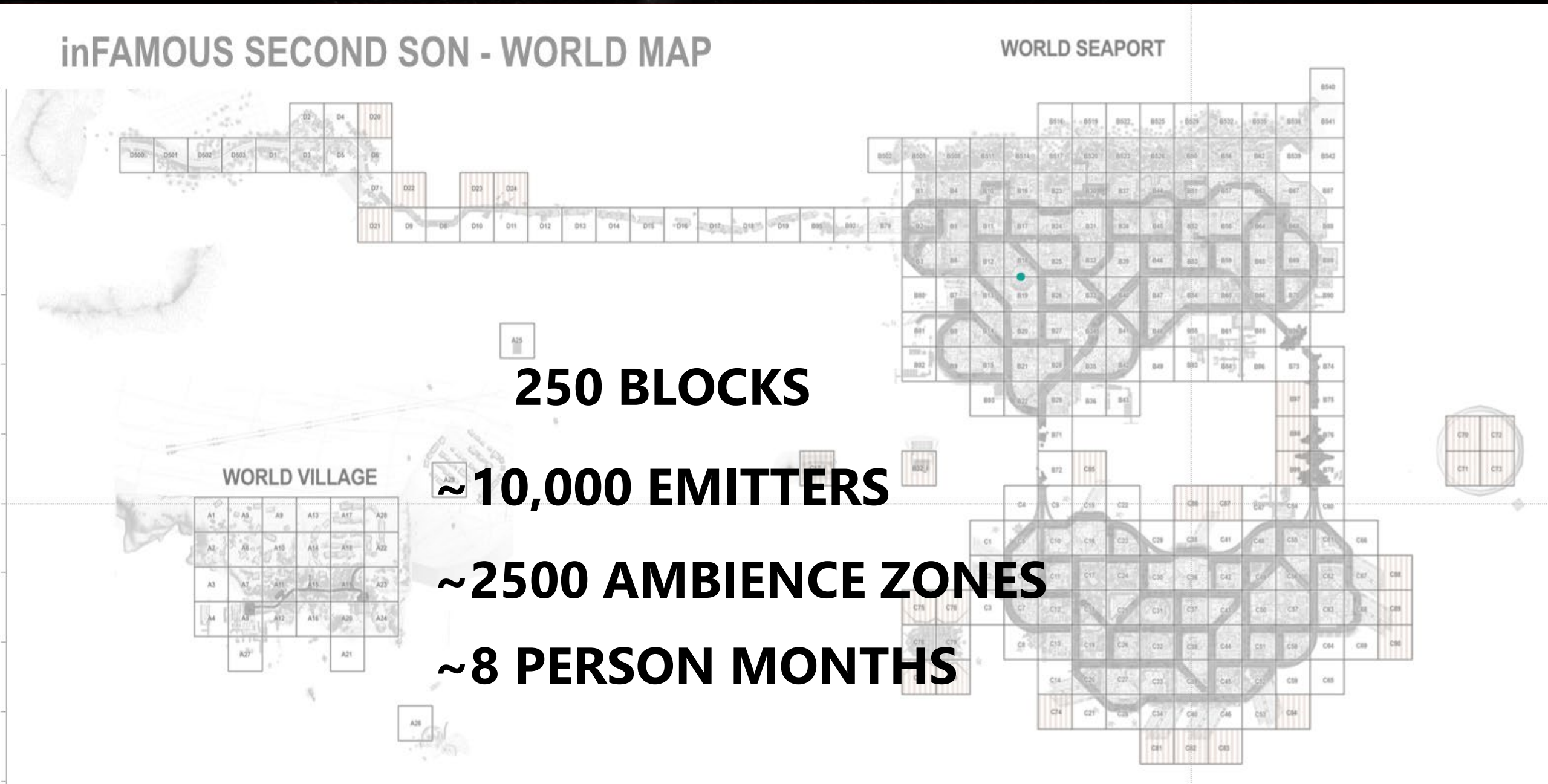
IN THE BEGINNING…



250 BLOCKS

~10,000 EMITTERS

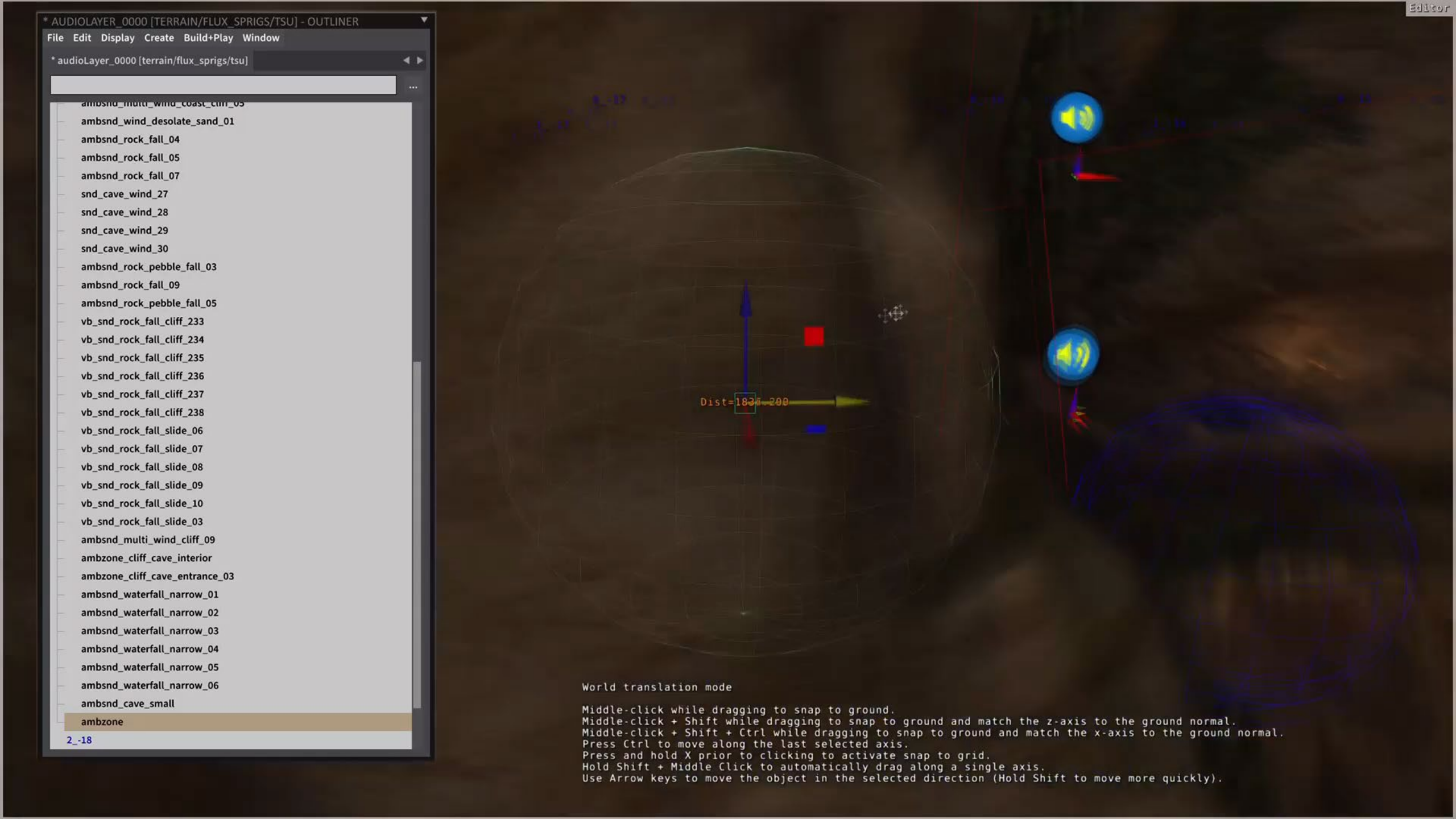
~2500 AMBIENCE ZONES

~8 PERSON MONTHS

EARLY IMPROVEMENTS

GHOST

EARLY IMPROVEMENTS


* AUDIOLAYER_0000 [TERRAIN/FLUX_SPRIGS/TSU] - OUTLINER
File Edit Display Create Build+Play Window
* audioLayer_0000 [terrain/flux_sprigs/tsu]
ambsnd_wind_desolate_sand_01
ambsnd_rock_fall_04
ambsnd_rock_fall_05
ambsnd_rock_fall_07
snd_cave_wind_27
snd_cave_wind_28
snd_cave_wind_29
snd_cave_wind_30
ambsnd_rock_pebble_fall_03
ambsnd_rock_fall_09
ambsnd_rock_pebble_fall_05
vb_snd_rock_fall_cliff_233
vb_snd_rock_fall_cliff_234
vb_snd_rock_fall_cliff_235
vb_snd_rock_fall_cliff_236
vb_snd_rock_fall_cliff_237
vb_snd_rock_fall_cliff_238
vb_snd_rock_fall_slide_06
vb_snd_rock_fall_slide_07
vb_snd_rock_fall_slide_08
vb_snd_rock_fall_slide_09
vb_snd_rock_fall_slide_10
vb_snd_rock_fall_slide_03
ambsnd_multi_wind_cliff_09
ambzone_cliff_cave_interior
ambzone_cliff_cave_entrance_03
ambsnd_waterfall_narrow_01
ambsnd_waterfall_narrow_02
ambsnd_waterfall_narrow_03
ambsnd_waterfall_narrow_04
ambsnd_waterfall_narrow_05
ambsnd_waterfall_narrow_06
ambsnd_cave_small
ambzone
2_-18
Dist=
World translation mode
Middle-click while dragging to snap to ground.
Middle-click + Shift while dragging to snap to ground and match the z-axis to the ground normal.
Middle-click + Shift + Ctrl while dragging to snap to ground and match the x-axis to the ground normal.
Press Ctrl to move along the last selected axis.
Press and hold X prior to clicking to activate snap to grid.
Hold Shift + Middle Click to automatically drag along a single axis.
Use Arrow keys to move the object in the selected direction (Hold Shift to move more quickly).


GHOST
OF TSUSHIMA

HOLY SHIT!!!!!

9.3 YEARS?!?!?!?!?!

=

OPERS CONFERENCE | July 19-23, 2021 | #GDC21

SCALE

DYNAMIC

AUTHORING

THE ONE SENTENCE SOLUTION

GHOST

“While we want to maintain designer driven creation and detail, we also need to make the authoring system as easy and hands-off as possible to deal with a world of this scope. Wherever possible, we intend to allow or create tools to handle a bulk of the authoring. “

STEP 1:
PLANNING AND PROTOTYPING

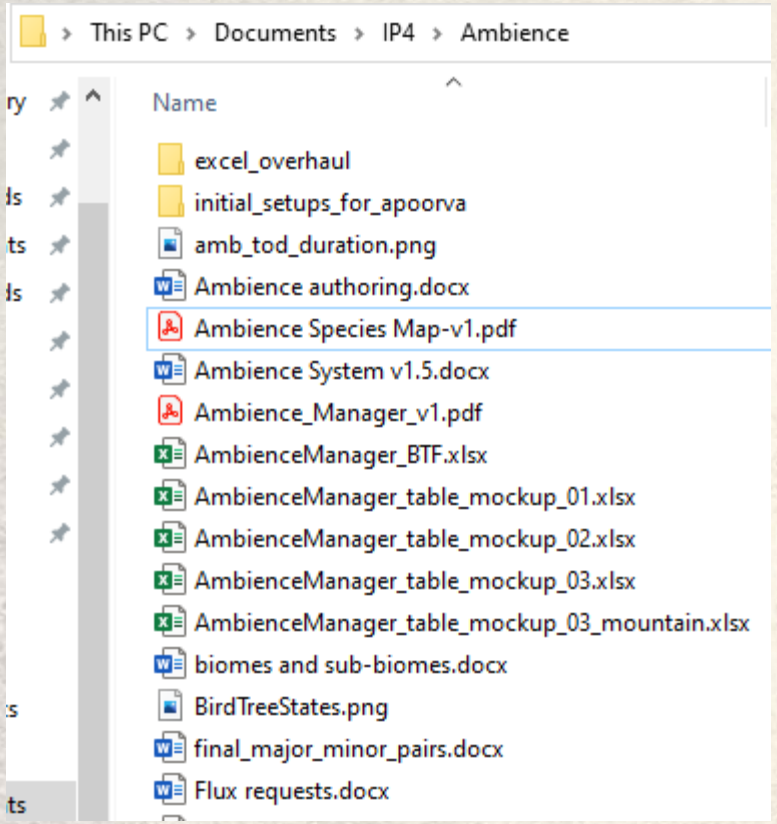
What we have

- Maya-based world editor
- Maya based emitter and volume authoring
- **NEW!** Engine-based emitter and volume authoring

What we NEED

- QUICK, ITERATIVE TOOL
- ROBUST FEATURE SET
- IN-ENGINE DEBUGGING AND VISUALIZATION

MOCKUPS




```
/NAME: ambscn_forest_conifer_01
/CLS: AMBIENCE_SCENE
    /LIMIT: sndcatk=bird num=5
    /LIMIT: sndcatk=bird_warbler num=1
    /LIMIT: sndcakt=wind num=3
    /LIMIT: sndcatk=insect num=3
    /LIMIT: sndcatk=rain num=4
    /LIMIT: sndcatk=wood_creak num=2
    /RULE:
        /AND
        /IN_RANGE: fact=time_of_day min=6 max=19.5
            /SOUND: amb_bird_forest_conifer_01 weight=65
            /SOUND: amb_bird_forest_crow_01 weight=15
            /SOUND: amb_bird_japanese_warbler weight=5
            /SOUND: amb_flies_buzz weight=15 free_pos=7.5 5.5 10
    /RULE:
        /OR
        /IN_RANGE: fact=time_of_day min=5.5 max=9
        /IN_RANGE: fact=time_of_day min=18 max=20.5
            /SOUND: amb_bird_forest_wagtail_01
    /RULE:
        /AND
            /IN_RANGE: fact=time_of_day min=7.5 max=19
            /IS: fact=general_location value=kamijima
                /SOUND: amb_bird_snowtail_hawk_01
    /RULE:
        /IN_RANGE: fact=wind_speed min=0.1 max=1
            /SOUND: amb_wind_trees_conifer distance=2 18 max_instances=4 free_pos=6 6 12
    /RULE:
        /IN_RANGE: fact=wind_speed min=0.4 max=1
            /SOUND: amb_redpine_branch_creak_01 max_instances=1
    /RULE:
        /IN_RANGE: fact=time_of_day min=20 max=05.5
            /SOUND: amb_owl_scops_01 distance=5 20
            /SOUND: amb_owl_short_eared_01
    /RULE:
        /AND
        /IN_RANGE: fact=time_of_day min=20 max=05.5
        /IS: fact=is_raining value=false
            /SOUND: amb_cicada_01_loop
    /RULE:
        /IS: fact=is_raining value=true
            /SOUND: amb_rain_tree_conifer
```

Procedural generation is creating data based on provided inputs and constraints in conjunction with a system of logic.

AMBIENT SOUND MANAGER

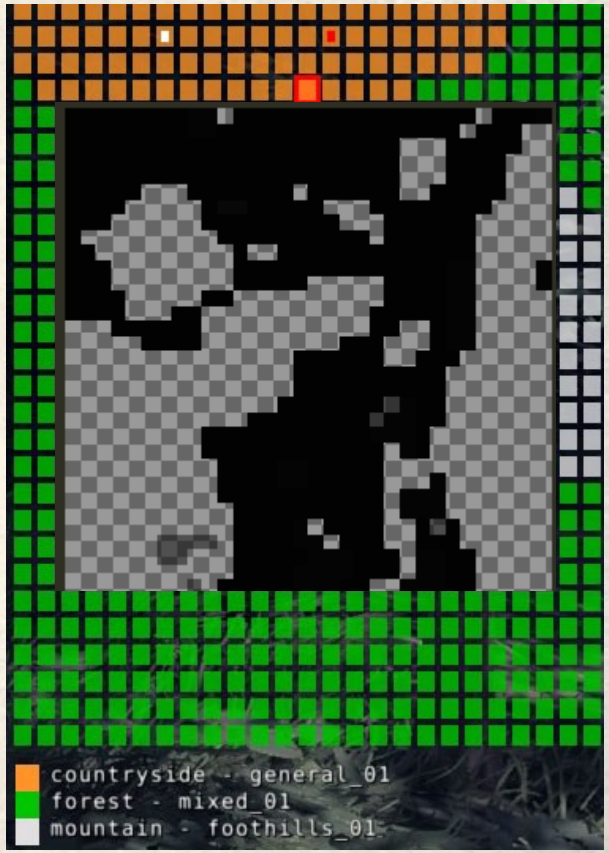
Audio environments were “painted” as a low fidelity bitmap.

Built-in hierarchy of Major and Minor

Major = top level environment, e.g., Forest

Minor = detailed environment, e.g., Deciduous

Allowed for large scale designer customization.



Two major types of emitters:

- **One Shot**
  - truly random sounds with a start/end
  - play as normal emitters
  - the number of these playing at anytime is limited.

- **Looping**
  - pseudorandom sounds that loop, constant ambience
  - play as multi-point emitters for performance purposes.

Most information specified in an Excel sheet:

Type	Name	#	Sound Category	Input - Calculation Constraints		
type	name	num	sound_cat	tod	wind	rain
Category	bird	11		DawnDusk	LogDecreasing	LogDecreasing

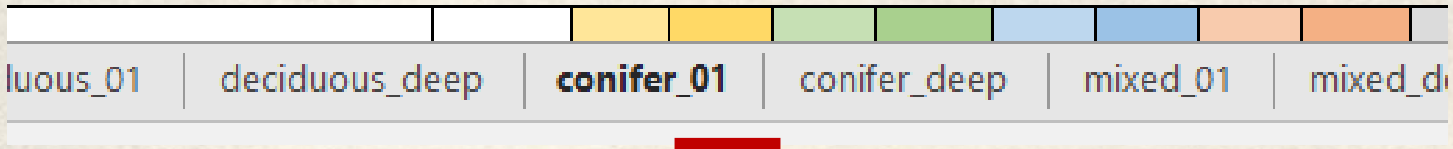
Input - State Constraints					Input - Spatial Constraints	
sound_group	sound_state	min_distance	max_distance	snap_to_phys	minor	prefecture

Output			
min_trigger	max_trigger	min_offset	max_offset

Hierarchical rule system: user defined defaults that are inherited.

- ambient_defaults.xlsx
  - forest.xlsx
    - deciduous
    - coniferous
    - bamboo
  - mountain.xlsx
  - ...

ITERATION = IMPROVEMENTS



Input - Spatia
minor
clearcut, scorched
deciduous_deep, conifer_deep, mixed_deep

Bucket individual sounds into categories to reduce the amount of copy/paste.

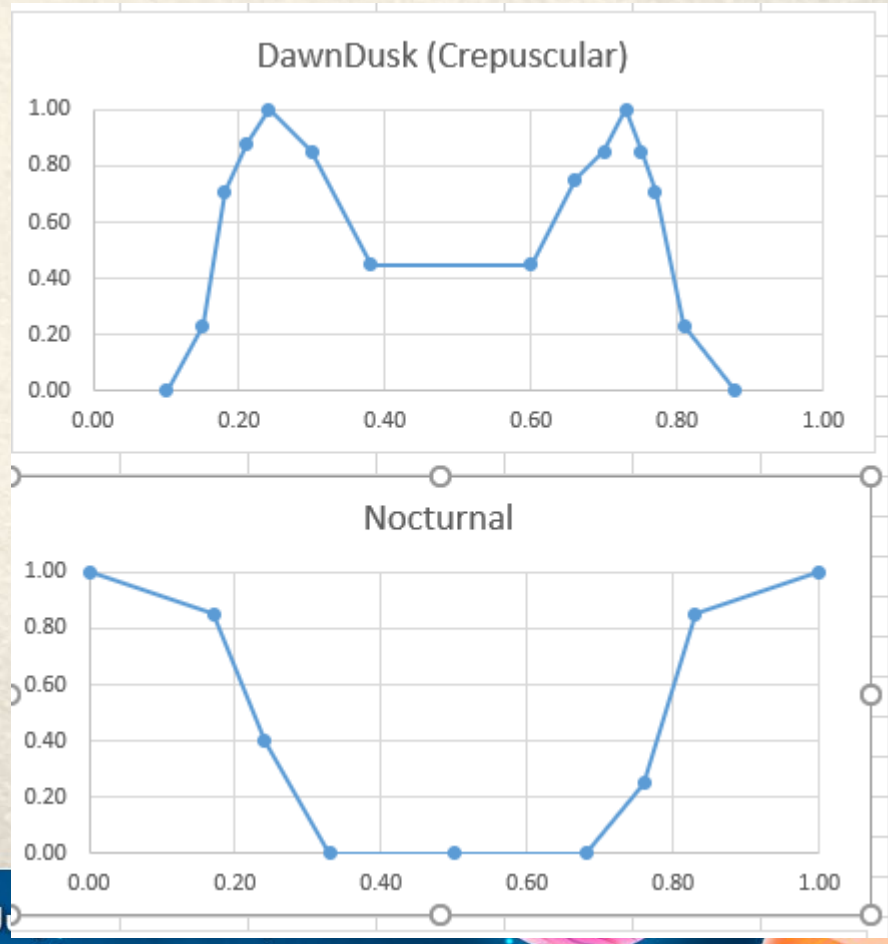
1S	amb_bird_otsuki_foothills_seq	0.4	5	5.25	0	0.59	0.6	1	105	190	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	5	5.25	0.6	1	0.6	1	150	190	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	5	5.25	0.6	1	0	0.59	95	190	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	18.5	18.8	0	0.59	0	0.59	70	100	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	18.5	18.8	0	0.59	0.6	1	105	190	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	18.5	18.8	0.6	1	0.6	1	150	190	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	18.5	18.8	0.6	1	0	0.59	95	190	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	18.8	19	0	0.59	0	0.59	80	110	8	18
1S	amb_bird_otsuki_foothills_seq	0.4	18.8	19	0	0.59	0.6	1	115	200	8	18
1S	amb_bird_otsuki_foothills_seq	0.4	18.8	19	0.6	1	0.6	1	155	200	8	18
1S	amb_bird_otsuki_foothills_seq	0.4	18.8	19	0.6	1	0	0.59	105	200	8	
1S	amb_bird_otsuki_foothills_seq	0.4	19	19.3	0	0.59	0	0.59	90	120	10	
1S	amb_bird_otsuki_foothills_seq	0.4	19	19.3	0	0.59	0.6	1	125	210	10	
1S	amb_bird_otsuki_foothills_seq	0.4	19	19.3	0.6	1	0.6	1	165	210	10	20
1S	amb_bird_otsuki_foothills_seq	0.4	19	19.3	0.6	1	0	0.59	115	210	10	20
1S	amb_bird_otsuki_foothills_seq	0.4	19.3	19.5	0	0.59	0	0.59	100	130	15	25
1S	amb_bird_otsuki_foothills_seq	0.4	19.3	19.5	0	0.59	0.6	1	135	220	15	25
1S	amb_bird_otsuki_foothills_seq	0.4	19.3	19.5	0.6	1	0.6	1	175	220	15	25
1S	amb_bird_otsuki_foothills_seq	0.4	19.3	19.5	0.6	1	0	0.59	125	220	15	25
1S	amb_bird_otsuki_foothills_seq	0.4	5.25	18.5	0	0.59	0	0.59	15	30	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	5.25	18.5	0	0.59	0.6	1	50	120	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	5.25	18.5	0.6	1	0.6	1	90	120	5	15
1S	amb_bird_otsuki_foothills_seq	0.4	5.25	18.5	0.6	1	0	0.59	40	120	5	15

Type	Name	#	Sound Category
type	name	num	sound_cat
Category	bird	6	
Category	owl	2	
Category	foliage	5	
Category	foliage	2	
1S	amb_frog_dybowski_brown_chirp	0.3	amphibian
	amb_frog_tree_high_pitch	0.3	amphibian
	amb_bird_otsuki_foothills_seq	0.4	bird
	amb_bird_jungle_crow_caw_seq_01	0.65	bird
1S	amb_bird_kite_black_call	0.2	bird
1S	amb_bird_mnt_song_ogura_chirp	0.2	bird
1S	amb_bird_japanesebushwarbler_01	0.45	bird
1S	amb_bird_raven_caw_01	0.4	bird
1S	amb_bird_grey_wagtail_group	0.3	bird
1S	amb_bird_grey_wagtail_idle_chirp	0.3	bird
1S	amb_bird_redflank_bluetail_flyaway	0.3	bird

Provide abstract constraints rather than explicit numbers for the majority of calculation constraints.

4	5	5.25	0	0.59	0.6	1	105	190
4	5	5.25	0.6	1	0.6	1	150	190
4	5	5.25	0.6	1	0	0.59	95	190
4	18.5	18.8	0	0.59	0	0.59	70	100
4	18.5	18.8	0	0.59	0.6	1	105	190
4	18.5	18.8	0.6	1	0.6	1	150	190
4	18.5	18.8	0.6	1	0	0.59	95	190
4	18.8	19	0	0.59	0	0.59	80	110
4	18.8	19	0	0.59	0.6	1	115	200
4	18.8	19	0.6	1	0.6	1	155	200
4	18.8	19	0.6	1	0	0.59	105	200
4	19	19.3	0	0.59	0	0.59	90	120
4	19	19.3	0	0.59	0.6	1	125	210
4	19	19.3	0.6	1	0.6	1	165	210
4	19	19.3	0.6	1	0	0.59	115	210
4	19.3	19.5	0	0.59	0	0.59	100	130
4	19.3	19.5	0	0.59	0.6	1	135	220
4	19.3	19.5	0.6	1	0.6	1	175	220
4	19.3	19.5	0.6	1	0	0.59	125	220
4	5.25	18.5	0	0.59	0	0.59	15	30
4	5.25	18.5	0	0.59	0.6	1	50	120
4	5.25	18.5	0.6	1	0.6	1	90	120
4	5.25	18.5	0.6	1	0	0.59	40	120

Input - Calculation Constraints		
tod	wind	rain
DawnDusk	LogDecreasing	LogDecreasing
DawnDusk	LogDecreasing	LogDecreasing
DawnDusk	LogDecreasing	LogDecreasing
DawnDusk	LogDecreasing	LogDecreasing
Nocturnal	LogDecreasing	LogDecreasing
Nocturnal	Constant	LogDecreasing
Diurnal	Constant	LogDecreasing
Constant	LinearIncreasing	Constant
Constant	LinearIncreasing	Constant
Diurnal	LogDecreasing	LogDecreasing
Constant	LinearIncreasing	Constant



FINAL RESULT

Type	Name	#	Sound Category	Input - Calculation Constraints			Input - State Constraints					Input - Spatial Constraints		Output			
type	name	num	sound_cat	tod	wind	rain	sound_group	sound_state	min_distance	max_distance	snap_to_phys	minor	prefecture	min_trigger	max_trigger	min_offset	max_offset
Reverb	aux_forest	1										foothills, mid					
Reverb	aux_canyon	1										canyon					
Category	bird	10		DawnDusk	LogDecreasing	LogDecreasing			4	25				5	15	2	5
Category	bird	8		DawnDusk	LogDecreasing	LogDecreasing			6	25		mid, canyon		6	20	2	5
Category	bird	7		DawnDusk	LogDecreasing	LogDecreasing			8	30		high, snowy, cliff		5	20	3	6
Category	bird	6		DawnDusk	LogDecreasing	LogDecreasing			8	30			kamiagataisland	15	50	3	7
Category	owl	2		Nocturnal	LogDecreasing	LogDecreasing			10	40				5	20	3	6
Category	foliage	5		Constant	LinearIncreasing	Constant			3	10				2	10	1	4
Category	foliage	2		Constant	LinearIncreasing	Constant			3	10		high, cliff, canyon		2	8	2	4
1S	amb_frog_dybowski_brown_chirp	0.3	amphibian									foothills	izuharaisland+toyotamaisland				
1S	amb_frog_tree_high_pitch	0.3	amphibian									mid	izuharaisland+toyotamaisland				
1S	amb_bird_otsuki_foothills_seq	0.4	bird									foothills					
1S	amb_bird_jungle_crow_caw_seq_01	0.65	bird									foothills, high, mid					
1S	amb_bird_kite_black_call	0.2	bird														


0: amphibian_eve: 0/0 (max=1) [Dusk , LogDecreasing , LogDecreasing]
1: amphibian : 2/2 (max=3) [Diurnal , LogDecreasing , Constant]
2: bird : 5/5 (max=6) [DawnDusk , LogDecreasing , LogDecreasing]
3: foliage : 2/2 (max=5) [Constant , LinearIncreasing, Constant]
4: insect_day : 5/5 (max=6) [Diurnal , Constant , LogDecreasing]
5: insect_dusk : 7/7 (max=10) [Dusk , LogDecreasing , LogDecreasing]
6: insect_night: 0/0 (max=8) [Nocturnal , LogDecreasing , LogDecreasing]
7: Legends : 8/5 (max=5) [Constant , Constant , Constant]
8: mammal : 0/0 (max=1) [Diurnal , LogDecreasing , LogDecreasing]
9: mammal_night: 0/0 (max=2) [Nocturnal , Constant , LogDecreasing]
10: owl : 0/0 (max=4) [Nocturnal , Constant , LogDecreasing]
11: rock_fall : 0/1 (max=4) [Constant , LinearIncreasing, Constant]
12: water_taps : 5/5 (max=5) [Constant , Constant , Constant]
13: wind_gust : 2/2 (max=5) [Constant , LinearIncreasing, Constant]
14: wind_gust_night: 0/0 (max=4) [Nocturnal , LogIncreasing , Constant]
15: wood_creak : 4/4 (max=9) [Constant , LinearIncreasing, Constant]
ToD: 15.72
Wind (Base): 0.21
Wind (Gust): 0.57
Rain: 0.00
Water_river
Water_lake
Mountain_cliff
Forest_clearcut
Forest_deciduous_deep
Forest_deciduous
Countryside_settled_mongol
Countryside_grassland
Countryside_general
Countryside_fallback
[x150] engine :: update pre-solve :: [williamr] Tried to use TANDEM_USABLE tu_npc_clean_horse_shoe.xml|tu_npc_clean_horse_shoe with role horse, but it is in an


PAINT APP
File Edit Build Recalc Help
Paintable
Ambient Audio
Brush Spacing
0.391
Brush Value
Countryside_grassland
Brush Diamet
37.545
Show Color Map
Refresh Color Map
LOG
Paint App
L1 + R1

WORKFLOW IMPROVEMENTS

GHOST

* - Expression Editor

File Edit Evaluate Bake Window

Preview Selected | Clear Preview | Lock Preview | Hide Growth | Hide Grass

Preview Color 1.00 1.00 1.00

Filter: | Mode: Name and Text

Blends | Wetness | Grass Type | Grass Height | Ocean Color | Ocean Foam | Biome Type | Ambient Audio

Ambient Audio

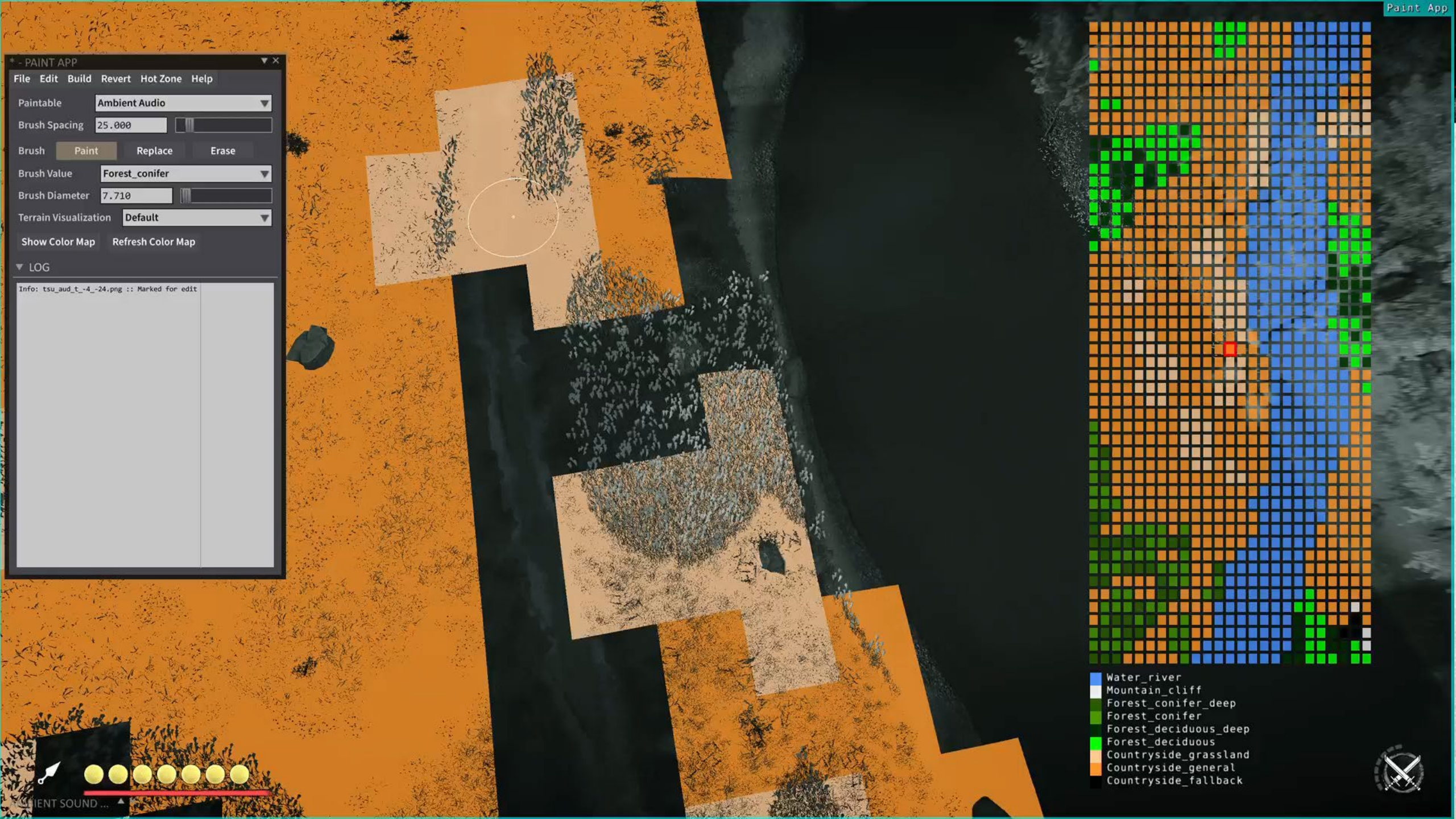
Move Up | Move Down

Name	Expression
Water_open_water	1
Countryside_fallback	dist(refmask_ocean) > 0.0
Mountain_ocean_cliff	(oceanCliff + altOceanCliff) - (g_height <= 0) > dist(ecotope_izu_kaneda)
Shoreline_sand	((((flatsand + wetsand - sealevel_limit) - beach_kam_sand * 2) < dist(refmask_ocean)) > keyframe(g_height, 0.0, 0.000, 1.0, 1.0)
Water_coastline	((g_height_smooth > -8) - (g_height > -5))
Shoreline_rock	(map(-6, -5, g_height)* ((sea_edge * perlin(10)) - (g_height > -1) + ((cliffs * 2) - (g_height > 5))))
Mountain_snowy	((g_height>0) * south_kam_limit)
Forest_conifer	(eco_toy_omi_t + forest_kam_cedar + leaves_cedar + (dist(ecotope_izu_azamo)<0) + (dist(ecotope_izu_komatsu)<0) + (moss_forest>0) + (eco_kam_cedar_t>0
Forest_conifer_deep	(keyframe(forest_conifer, 0.0, -5.0, 0.95, -5.0, 1.0, 1.0) - (perlin(2) >= .55))
Forest_deciduous	((dist(ecotope_toy_autumn)<0) + (dist(ecotope_izu_basic) < 0) + forest_floor_base + gold_origin + fern_base + eco_kam_red_berry_t + red_maple_total)
Forest_deciduous_deep	(keyframe(forest_deciduous, 0.0, -5.0, 0.95, -5.0, 1.0, 1.0) - (perlin(2) >= .45))
Forest_mixed	0.0
Forest_mixed_deep	0.0
Forest_clearcut	max(0, g_flavor_mongol > 0)
Forest_bamboo	bamboo_all > 0
Forest_scorched	burned_kam + burned_scorch_base + eco_kam_dormant_t
Wetlands_generic	((marshes + swamp_mudd + marsh_frac + eco_toy_waterlily_t) + ((dist(ecotope_toy_marsh) < 0) + (dist(ecotope_toy_waterlily) < 0) + (dist(ecotope_toy_r
Mountain_foothills	cliff_edging - (g_height <= 65)
Countryside_settled_farm	g_flavor_farm * map(30, -10, dist(refmask_designvoid)) + rice_origin + (dist(ecotope_toy_farm) < 0)
Countryside_settled_vi...	flavor_town + (toy * invert(grass_no_designvoid_h))
Countryside_settled_mo...	g_flavor_mongol
Countryside_general	max(smoothstep(9, 0.0, dist_any_road), map(0, .25, road_hidden)) - ((Forest_conifer>0) + (Forest_deciduous>0) + (Forest_bamboo>0) + (Forest_scorched>
Mountain_mid	(g_height >= 100.0) - ((forest_bamboo>0) + (forest_deciduous>0) + (forest_conifer>0))
Mountain_high	(g_height >= 150.0) - ((forest_bamboo>0) + (forest_deciduous>0) + (forest_conifer>0))
Mountain_cliff	cliff_top - (g_height <= 15) + cliff_bottom - (g_height <= 15) + cliff_face - (g_height <= 15) + cliff_body - (g_height <= 15)
Mountain_canyon	0.0
Water_lake	lakestones + (invert(grass_no_river) * 0.15) + stream_rocks
Water_frozen_lake	((g_posY >= 5000) * (lakestones + (invert(grass_no_river) * 0.15) + stream_rocks))
Water_creek	0.0
Water_river	river_main
Water_river_eddy	0.0
Countryside_grassland	sneak_grass
Countryside_settled_re...	(dist(ecotope_izu_unique)<0)

Blend Expression Toolbox

Add | Delete | Set Group | Rename | Move Up | Move Down | Expand All | Collapse All | ?

Name	Expression
defaultExclusionsSkipRoads	map(.5, 0, max(beach_base, max(river_bed_base, lake_bed_base))) * (waterdepth < 1) * i
defaultExclusionsForSnow	map(.5, 0, max(river_bed_base, lake_bed_base)) * (waterdepth < 1) * map(-2, 2, dist(re
beach_omi	toy * (dist(ecotope_izu_beach) < 0)
beach_puddle_adjust	min(dist(ecotope_izu_blacksand), dist(ecotope_izu_beach)) < 0
flow_map	lerp(.333, .25, min(map(5, 30, g_slope_smooth), map(-1, 1, g_curvature)))
blacksand_wateredge	max(map(-4.5, -5, g_height_smooth), overlay(map(12, 1, dist(refmask_ocean)), perlin(2
wetness_waves	keyframe(g_height_smooth, -4.75, .85, -4.4, .48, -2.5, 0)
wetness_waves_blacksand	keyframe(g_height_smooth, -4.85, .8, -4.75, .48, -3, 0)
wetness_waves_coast	lerp(lerp(wetness_waves, wetness_waves_kam, kam), wetness_waves_blacksand, dist(ecotop
wetness_mudflat	lerp(.333, 1.5, map(.5, -1, g_curvature)) * map(-2.75, -4.25, g_height_smooth) * map(1
wetness_base	pow(flow_map, lerp(1, 1.5, map(.15, .5, gpu_grass) * map(1, 0.25, beach_base)))
wetness_wateredge	keyframe(waterdepth, -1.5, 0, -.18, .45, 1, .666) * water_masks_inland
wetness_previous	(1/3 + clamp((w_flatsand * 0.05) + (w_mudflats_comp) + (w_marshes_bias * 0.75) + (w_(
wetness_waves_kam	keyframe(g_height_smooth, -4.85, .8, -4.75, .48, -3, 0)
river_rocky_kubara	map(1875, 1900, g_posy)
RICE_PADDY	
rice_origin	keyframe(dist(refmask_ricepaddy), -1.625, 1.000, 1.293, 0.000)
rice_origin_extended	keyframe(dist(refmask_ricepaddy), 1.897, 1.000, 4.815, 0.000)
flat_slope	(smoothstep(8, 0, g_slope))
rice_curv	keyframe(g_curvature, 0.000, 1.000, 0.500, -1.000)
map_rice_curv	map(0.9, -1, rice_curv)
rice_berm	invert(keyframe(g_curvature, 0.100, 1.000, 0.600, -1.000)) * rice_origin_extended
rice_field	(rice_origin * rice_curv) - map_rice_curv
rice_noise	map(-0.5, 0.8, worley) * tundra + worley2 + noise_white_med2
rice_paddies	(rice_field * rice_noise)
w_rice	(wetness_difference_key * wetness_slope_marsh) - map_rice_curv
w_rice_noise	difference(noise_octave, noise_octave2)
w_rice_difference	difference(w_rice, w_rice_noise)
w_rice_common	puddles_common + w_rice_noise
w_rice_comp	(w_rice_common * rice_field) * noise_white_giant
RIVER	
pebble_curvature	keyframe(g_curvature, -0.3, 0.000, 0.2, 1.000) * pebblestones + lakestones
pebble_noise	keyframe(perlin_octave(0.15, 10), 0.000, 1.000, 0.300, 1.000, 0.960, 0.000, 1.000, 0.(
pebble_depth_cull	keyframe(g_curvature, -0.729, 1.000, -0.009, 0.000)
edge_pebble	keyframe(dist(refmask_river), 2.000, 0.000, 3.006, 0.600, 8.400, 0.000)
edge_pebble_comp	(edge_pebble * perlin(2))
pebble_angle_cull	keyframe(smoothstep(25.000, 90.000, g_slope()), 0.000, 0.000, 0.02, 1.000)
pebble_comp	(pebble_curvature * pebble_noise) + (pebble_north + edge_pebble_comp + peb_fracs + str
lakestones	keyframe(dist(refmask_lake), -1.646, 1.000, 9.070, 0.000)
pebblestones	keyframe(dist(refmask_river), 0.000, 1.000, 26.889, 0.000) + (lakestones)
river_edge	keyframe(dist(refmask_river), -1.390, 0.000, 1.143, 1.000, 2.873, 1.000, 5, 0.000) * p
river_edge2	keyframe(dist(refmask_river), -1.324, 0.000, 1, 1.000, 2, 1.000, 16.426, 0.000) * (noi


Paint App
* - PAINT APP
File Edit Build Revert Hot Zone Help
Paintable
Ambient Audio
Brush Spacing
25.000
Brush
Paint
Replace
Erase
Brush Value
Forest_conifer
Brush Diameter
7.710
Terrain Visualization
Default
Show Color Map
Refresh Color Map
LOG
Info: tsu_aud_t_-4_-24.png :: Marked for edit
Water_river
Mountain_cliff
Forest_conifer_deep
Forest_conifer
Forest_deciduous_deep
Forest_deciduous
Countryside_grassland
Countryside_general
Countryside_fallback


[x1] Cloth sim does not support non-uniform scale on object loc_izu_ariake_inn_a.xml|loc_izu_ariake_inn_a [billro]

WORKFLOW IMPROVEMENTS

Type	Name	#	Sound Category	Input - Calculation Constraints			Input - State Constraints					Inpu
type	name	num	sound_cat	tod	wind	rain	sound_group	sound_state	min_distance	max_distance	snap_to_phys	mir
MP	rain_bamboo	1									Bamboo	
MP	rain_dirt	0.8									Dirt	
MP	rain_fabric	1									Fabric	
MP	rain_grass	0.8									Grass	
MP	rain_gravel	0.8									Gravel	
MP	rain_leather	1									Leather	
MP	rain_leaves	0.8									Leaves	
MP	rain_mud	0.8									Mud	
MP	rain_packeddirt	0.8									PackedDirt	
MP	rain_puddle	1									Puddle	
MP	rain_sand	0.8									Sand	
MP	rain_solidmetal	1									SolidMetal	
MP	rain_stone	0.8									Stone	
MP	rain_straw	1									Straw	
MP	rain_tile	1									Tile	
MP	rain_unspecified	0.7									Unspecified	
MP	rain_water	0.8									Water	
MP	rain_wood	1									Wood	
MP_ENTRY	amb_multi_rain_on_ash_01_loop	1	rain_ash									
MP_ENTRY	amb_multi_rain_on_bamboo_surface_01_loop	1	rain_bamboo									
MP_ENTRY	amb_multi_rain_on_dirt_01_loop	1	rain_dirt									
MP_ENTRY	amb_multi_rain_on_dirt_02_loop	1	rain_dirt									


multi_point|amb_multi_rain_forest_general_01_loop(58644)
- amb_multi_rain_forest_general_01_loop (vol=0.5337)
multi_point|amb_multi_rain_forest_general_01_loop(58644)
- amb_multi_rain_forest_general_01_loop (vol=0.5337)
multi_point|amb_multi_rain_forest_general_01_loop(58644)
- amb_multi_rain_forest_general_01_loop (vol=0.5337)
multi_point|amb_multi_rain_on_grass_03_loop(58646)
- amb_multi_rain_on_grass_03_loop (vol=0.7132)
hero_sml|c_root|c_hips|(13496)
- ch_hero_movement_cape_loop (not playing)
- amb_rain_on_hero_loop (not playing)
- vo_hero_breathing_loop (not playing)
multi_point|amb_multi_rain_on_grass_02_loop(58645)
- amb_multi_rain_on_grass_02_loop (vol=0.7442)
multi_point|amb_multi_rain_on_grass_02_loop(58645)
- amb_multi_rain_on_grass_02_loop (vol=0.7442)

WIND…AND MORE HAPPY ACCIDENTS


environment 00 (North) is 4
environment 01 (South) is 4
environment 02 (West) is 4
environment 03 (East) is 2

A FINAL HAPPY ACCIDENT ACCIDENT ACCIDENT


THE IRON HOOK
Travel with Ryuzo
m_gp_hook_rat1-01~hero
m_gp_hook_rat1-02~ryuzo
Sound 1000574138 None Error (not found)
Sound 1000573f78 None Error (not found)
Sound 1000573eb8 None Error (not found)
Sound 1000573d78 None Error (not found)
Sound 1000573c38 None Error (not found)
Sound 1000573af8 None Error (not found)
Sound 10005739b8 None Error (not found)
Sound 1000573878 None Error (not found)
Sound 100056bdf8 None Error (not found)
m_gp_hook_rat1-01~hero How were your men captured?
Ryuzo: m_gp_hook_rat1-02~ryuzo Remember that map you gave me?

- **Better use of world data to generate environment maps, perhaps tie this into the actual environments?**
- **Richer set of contextual features, rather than faking it (e.g., wildlife react to explosions, post-rain drips, etc…)**
- **Interior sounds, portals, etc.**
- **Integrate other systems (vfx, weather, etc.)**
- **Faster in-engine iteration to reduce time to see result (move from Excel -> IGE)**

Identify the constraints of your problem.

Functional decomposition makes it easier to handle scope.

Prototype your data model in Excel or text.

Start early, review often, cut liberally.

Plan early and be prepared to pivot

Keep your team size in mind

Don't be afraid to ask (others) for help

MORE GHOST GDC TALKS!

- Scoring the Open World Samurai Epic: 'Ghost of Tsushima’
- EXPLORATION IN GHOST OF TSUSHIMA: LETTING THE ISLAND GUIDE YOU
- BLOWING FROM THE WEST: SIMULATING WIND IN 'GHOST OF TSUSHIMA’
- ZEN OF STREAMING: BUILDING AND LOADING 'GHOST OF TSUSHIMA’
- ADVANCED GRAPHICS SUMMIT: PROCEDURAL GRASS IN 'GHOST OF TSUSHIMA’
- HONORING THE BLADE: LETHALITY AND COMBAT BALANCE IN 'GHOST OF TSUSHIMA’
- MASTER OF THE KATANA: MELEE COMBAT IN GHOST OF TSUSHIMA
- Creating Feudal Japan from Across the Pacific
- SAMURAI LANDSCAPES: BUILDING AND RENDERING TSUSHIMA ISLAND ON PS4

THANK YOU!

WE'RE HIRING!

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